Ethiopian Economic Association (EEA)

PROCEEDINGS OF THE FIFTH INTERNATIONAL CONFERENCE ON THE ETHIOPIAN ECONOMY

Edited by

Getnet Alemu

Edilegnaw Wale

Volume III

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FOREWORD

The Ethiopian Economic Association (EEA) is happy to issue the proceedings of the 5th International Conference (the 16th Annual Conference) on the Ethiopian Economy that was held from June 7 – 9, 2007 at UN Conference Centre. EEA has been organizing annual conferences on the Ethiopian Economy every year as part of its overall objectives to contribute to the economic advancement of Ethiopia through dissemination of economic research findings; promotion of dialogue on socio-economic issues; promotion of education in economics in higher learning institutions; enhancing national, continental and global networks of professionals and institutions; and advancement of the professional interests of its members.

In quest of its mission, EEA has been actively engaged in economic research, training, organization of International and National conferences and round table discussions on the Ethiopian economy and the dissemination of the results of these activities through its professional journals and various publications. It has also been engaged in providing professional opinion and reflections on many issues affecting the development of this country.

As a result of these and other efforts of the Association, EEA has established itself as a truly independent source of socio-economic policy options and data base in Ethiopia for the Ethiopian Government, the Ethiopian people and the International Community at large.

The 5th International Conference on the Ethiopian Economy was attended by about 450 participants. The conference was organized in five Plenary Sessions and four concurrent sessions. Panel discussion was also organized on the Current State of the Ethiopian Economy. The main speakers of the panel discussion were H.E. Ato Neway Gebreab, Director EDRI and chief Economic Advisor of the PM; Ishac Diwan, WB Country Representative to Ethiopia and the Sudan; Geni Kulgman, WB Lead Economist; Mulat Demeke, Economic Department of AAU; and Haile Kibret, EEA/EEPRI. In addition, keynote speech was delivered by Prof. Dr. Joachim Von Braun, Director General of IFPRI on Rural-Urban Linkages for Growth, Employment and Poverty Reduction.

Some of the sessions were co-organized with the World Bank, African Development Bank, Economic Commission for Africa (ECA), International Food Policy Research Institute (IFPRI), Ethiopian Development Research Institute (EDRI), Poverty Action

Network (PANE) and Forum for Social Studies (FSS). The Plenary Sessions discussed about 15 papers on Poverty, Future Agriculture, Urban-rural Linkages. Labour Market, African Development, Environment, Investment, Public Finance etc. Similarly, in the concurrent sessions about 68 papers were presented in the area of macro and sectoral issues, of which 49 papers were presented by individuals while the rest 19 papers were delivered by co-organizers.

Out of the total 49 papers presented by individuals on this 5th International Conference, the editorial committee received 39 papers from authors and reviewed them. Comments and suggestions including editorial comments were communicated to authors for improvement. Among the 39 papers, the editorial committee selected 23 papers to be included in this edition. In addition, 11 papers which were presented by co-organizing institutions also reviewed and included in this edition. All these papers are organized into three volumes. Volume I contains ***Industry, Trade, Finance and Development;*** Volume II contains ***Social Sectors (Poverty, Health, Education)*** and Volume III contains **Water, Natural Resource and Agricultural Practices.**

I would like to take this opportunity to express my heartfelt gratitude, on my own behalf and on behalf of the Ethiopian Economic Association, to the many people and organizations that made the conference a resounding success. First and foremost, I thank the authors of the papers and the audience whose active participations made the conference meaningful and dynamic. The UN Economic Commission for Africa deserves huge thanks for granting us the free use of the UN Conference Centre. The African Development Bank, Commercial Bank of Ethiopia, Bankers Association, Ethiopian Airlines, Future Agriculture, and Ethiopian Manufacturing Industries Association are sincerely acknowledged for sponsoring the conference. The many professionals who dedicated their time to the conference and served as chairpersons deserve due thanks for their special contributions.

The staffs of the EEA/EEPRI deserve a special recognition for their enthusiasm and perseverance in managing the conference from inception to completion. I also want to extend my personal gratitude to the Organizing Committee and members of the Executive Committee of the Ethiopian Economic Association for the dedicated services and the leadership they provided to the Association.

I would like to seize this moment to express our gratitude to the Consortium of Donors who have funded the conference and all other activities of EEA/EEPRI and maintained continued interest in our Association. These are: Friedrich Ebert Stiftung of Germany (FES), Embassies of UK (DFID), Ireland (DCI), Sweden (SIDA), the

Netherlands, Norwegian Church Aid and the African Capacity Building Foundation (ACBF).

Finally, I would like to extend my sincere gratitude to H.E, Ato Tadesse Haile, State Minister of the Ministry of Trade and Industry, for his an insightful keynote address; ministers, parliament members, and other senior government officials who spared their busy schedule and participated in the conference.

Wolday Amha (Ph.D)
President of the Ethiopian Economic Association

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Water, Natural Resource and Agricultural Practices

IMPACT ASSESSMENT OF RAINWATER HARVESTING PONDS: THE CASE OF ALABA WOREDA, ETHIOPIA

Rebeka Amha[1]

Abstract

We find that farm households have started to grow new crops (vegetables and perennial crops) as a result of water availability from the water harvesting ponds. Results of Probit analysis on the determinants of adoption of rainwater harvesting ponds shows that household size, education status of household head, ownership of livestock (cattle, oxen and pack animals), homestead plots and type of pond explained adoption statistically significantly. Results of analysis of qualitative information, consistent, with the Probit model results, also showed that labor requirement, economic problem to use simpler water lifting and watering equipments, inability to easily understand the benefit of the technology and problems related with the structure of the RWH technology adopted were some of the major problems faced by households, and have a negative impact on the technology adoption rate.

The Ordinary Least Square estimation of the determinants of the value of crop production shows that adoption of RWH has a positive and statistically significant total effect on value of crop production. This shows that RWH ponds have both direct and indirect significant impact on value of crop production. We also find that households with RWH technology use more labor and seed but less oxen power compared with those households who have not adopted the technology. Moreover, labor and seed inputs have positively significant impact on yield while the effect of oxen power is insignificant. These results show that RWHP has significant indirect impact on value of crop production through its effect on intensity of input use.

Labor requirements and cost considerations appear to be important factors that influence household's adoption of RWH technology. This implies that research and development interventions need to take account of the labor and cost demands of the technology. The effectiveness of the technology adoption is mainly constrained by problems related to water lifting and watering equipments, and accidents occurring

[1] Research Assistant, ILRI, Addis Ababa. E-mail: r.amha@cgiar.org
Berhanu Gebremedhin[2]
[2]Scientist-Agricultural Economist, ILRI, Addis Ababa

due to absence of roof cover and fence to the ponds. This implies that support will be needed to provide affordable but improved water lifting and watering equipments, and give training to farm households on construction and use of roof covers and fences to the ponds. As households shift to high value but perishable commodities due to the RWH, emphasis needs to be given to marketing extension, especially in facilitating markets and market linkages to farmers.

1. Background

Ethiopia, like other Sub-Saharan African (SSA) countries, is an agrarian economy, with a very small industrial sector. The agricultural sector, on average, accounts for about 45% of the GDP, 90% of merchandise export earnings, 80% of employment, more than 90% of the total foreign exchange earnings, 70% of the raw material supplies for agro-industries, and is also a major supplier of food stuff for consumers in the country. Smallholders who produce more than 90% of the total agricultural output and cultivate close to 95% of the total cropped land dominate the sector. Agricultural production is highly dependent on the vagaries of nature with significant variability in production and actual production patterns (Demeke et al, 2005).

Due to population increase in the highland areas, more and more marginal areas are being used for agriculture which led to the degradation of the natural resources .One of the major challenges to rural development in the country is how to promote food production to meet the ever-increasing demand of the growing population. Rainfall in the arid and semi-arid areas is generally insufficient to meet the basic needs of crop production. In degraded areas with poor vegetation cover and infertile soil, rainfall is lost almost completely through direct evaporation or uncontrolled runoff. Thus, overcoming the limitations of these arid and semi-arid areas and making good use of the vast agricultural potential under the Ethiopian context, is a necessity rather than a choice. Thus, there is need for appropriate interventions to address the prevailing constraints using suitable technologies for improved and sustainable agricultural production.

There is now increasing interest to the low cost alternative generally referred to as 'water harvesting' especially for small scale farming systems. Runoff, instead of being considered as a problem, can be harvested and used for different purposes, which otherwise is lost and causes soil erosion. Various methods of rainwater harvesting are available, through which rainwater is captured, stored and used at times of water scarcity. Rainwater harvesting can be broadly defined as a collection and concentration of runoff for productive purposes like crop, fodder, pasture or trees production, livestock and domestic water supply (Ngigi, 2003).

Collection and storage of rainwater for different purposes has been a common practice since ancient times. The system was used thousand years ago in many parts of the world. There are also evidences indicating ancient churches, monasteries and castles in Ethiopia used to collect rainwater from rooftops and ground catchments. Birkas in Somalia region and different runoff basins in Konso are good examples of the traditional rainwater harvesting practices in Ethiopia. Moreover embankment and excavated ponds[2] for agriculture use and water supply, runoff farming and various types of soil moisture conservation techniques for crop production could be mentioned as examples (Nega, 2004)

To mitigate the erratic nature of rain fall in the arid and semi-arid parts of the country, which threatens the lives of millions of people, a national food security strategy based on the development and implementation of rainwater harvesting technologies either at a village or household level was adopted after 1991. The Federal Government had allocated a budget for food security programs in the regions, an amount equal to ETB 100 million and ETB one billion during the 2002 and 2003 fiscal years, respectively. Of the total budget, most of it was used by regional states for the construction of rainwater harvesting technologies including household ponds, in collaboration with the Federal Ministry of Agriculture and Rural Development (Rami, 2003).

Even if government efforts of household level water harvesting schemes are wide spread in Alaba, which this paper focused, the performance obtained was not assessed. Due to this reason, there was a need to assess the impact of the existing rainwater harvesting systems in Alaba Woreda to determine their effectiveness and sustainability. In addition, there was a need to assess the condition of indigenous rainwater harvesting technologies and practices in Alaba. Hence, this study is aimed to fill this gap of knowledge in the region.

Hence, this study is aimed at assessing the impact of rainwater harvesting ponds on crop yield using a quantitative approach supplemented by a qualitative approach in Alaba. In particular the study focuses on:

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[2]According to (Nega, 2005) they are defined as follows.
Pond: is small tank or reservoir and is constructed for the purpose of storing the surface runoff
Excavated pond: is a pond type constructed by digging the soil from the ground
Embankment pond: type of pond constructed across stream or water course consisting of an earthen dam.

- Identifying the determinants of household decision to adopt rainwater harvesting ponds.
- Examining the impact of rainwater harvesting ponds on crop yield, input use and cropping pattern.
- Assess the constraints and options to improve rainwater harvesting ponds
- Assess the differential impact of the technology by gender
- Derive policy implications to improve the performance of the rainwater harvesting ponds.

The study is expected to identify problems encountered, so that possible measures are taken when these interventions are replicated in other parts of the Woreda or the country. Besides, being an empirical study it will help to add to the empirical literature that uses the combination of both quantitative and qualitative approach in assessing the impact of RWH technology interventions on agricultural production. Finally, understanding the impact of the RWH technologies on agricultural productivity and the determinant factors of rainwater harvesting ponds, which affect productivity or level of yield, is a vital issue for designing appropriate agricultural development policies and strategies, as well as technology interventions. Therefore, the outcome of this study may serve as a source of additional information which may be of significant use to policy makers and planners during the designing and implementation of RWH technology strategies.

The study was conducted amid some limitations. One of the limitations is the unavailability of base line data. Such data would reflect the condition of the farm household's agricultural production process pre-technology intervention, and would have been helpful to compare more comprehensively and evaluate the relative effect of the technology intervention on agricultural productivity overtime. The other limitation of this study is related to the lack of accurate measures and valuation techniques to include the environmental benefits and costs that accrue from the RWH technology intervention.

2. Literature Review

Large-scale dam and irrigation projects have not been widely implemented in Ethiopia as they have often proved to be too expensive and demanding in construction and maintenance. Therefore, water harvesting tanks and ponds at the village or household level are proposed as a practical and effective alternative to improve the lives of rural people at minimum cost and with minimal outside inputs. In theory, household water harvesting can be done mainly through the effort of the individual farmer. Use of stored rainwater could supplement natural rainfall and make farming families less vulnerable to drought and therefore less dependent on outside help in harder times (Takele, 2002).

India has a long tradition of rainwater harvesting so much so that it is regarded as one of the dying tradition of the country[3]. However, it has been reviving apace in many parts of the country, particularly in rain scarce areas. Derwadi village, a village in the central state of Maharashtra, is one of such dry villages of India. A remote village with no assurance to drinking water, with farming being mainly rain fed based and agricultural production can't meet more than three-month food of the village. The villagers established a link with an Indo-German watershed Development NGO called Watershed Organization Trust (WOTR), which later assisted them to construct contour trenches, farm and contour bunds, and check dams. A degraded land then stared to provide adequate water both for drinking and for irrigation, thus paving the way for transformation of the lives of the villagers. They not only managed to diversify from traditional pearl millet to other host of crops ranging from various vegetables to cotton, but also managed to produce the crops in surplus and be able to sell, perhaps for the first time, to big towns.

The other experience with rainwater harvesting from India is Gandhigram village of Gujarati state. This village is also one of the water scarce areas of the country, constantly suffering from acute water scarcity both for consumption and production. Assisted by a local NGO called Shri Vivekanand Research and Training Institute, the community started to build communal dams- small and big- in 1995 so as to store rainwater and use it during dry season. A committee was formed from among the beneficiaries to oversee the distribution of the water and maintenance of the dams. They evolved an interesting management mechanism where each household is asked to pay Rs 3 (equivalent of $0.067) per month for water supply for consumption purpose, and Rs 250(equivalent to $5.56) per ha for irrigation purpose. The community managed not only to secure sustained supplies of water for domestic consumption, but also was able to embark upon producing high value crops like ground nuts, wheat and onion. They managed to increase their agricultural yield and work availability has also increased for land less laborers. As it has become beneficial, the momentum for rainwater harvesting continued in the village as is evident from community's interest to increase the number of dams by constructing new ones. Interestingly enough, they are now on the stage of forming a cooperative for processing and marketing their agricultural products.

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[3] This document on India's experience is obtained from website www.rainwaterharvesting.org/rural, where an interesting account of experience with rainwater harvesting in more than 20 Indian villages is presented.

By the 1990's, Zambia's southern province was recording unprecedented levels of food insecurity, hunger and general poverty. Government food, seed and fertilizer relief support become the norm rather than the exception for many households. During the 2002/2003 season, over 12% of the farm households were estimated to have adopted conservation agriculture technologies which included the use of rainwater harvesting. This was estimated to involve at least 50,000 hectares. The experience of Zambia shows that crop yields have on the minimum doubled. Maize yield rose from under 0.5t/ha to above 2t/ha and cotton from 1.5t/ha to 3t/ha under conventional as compared to conservation agriculture respectively. This has been attributed to improved rainwater harvesting made possible by the planting stations and surface cover. Most farmers have diversified their cropping system to include crops such as maize, beans and sunflower. Increased production at the household level in the last five years has introduced the rapid re-birth of a cash economy among the communities. This has propelled private entrepreneurship in agricultural related trading. Large and small private entrepreneurs have emerged and are selling agricultural inputs and other household commodities as well as buying off the crop. Most households are able to put up for sale 20-30% of their produce. The ultimate effect is enhanced livelihoods (UNEP, 2005).

Hatibu et al (2004) tried to quantify the effect on farmers' income and living standards of different rainwater harvesting methods, taking two districts, Maswa from north and Same districts from Eastern parts, of Tanzania. All types, viz. in-situ, micro and macro catchments and rainwater harvesting with storage are all practiced in the two regions in descending order of prevalence; in-situ is more prevalent in both regions followed by micro and macro catchments, with rainwater harvesting with storage being the least. The harvested rainwater is used mainly to grow maize in *Same* area while it is used for rice in *Maswa* region. Good rainwater harvesting increases yield of maize (in Same area) by four fold of rain fed yield level, and two fold for rice (in Maswa area)(Ibid).

It is only recently that rainwater harvesting has started to receive significant attention from Ethiopian government though it has a long history. It has been regarded as one of the crucial tools to achieve food self-sufficiency, and is being implemented on a large scale particularly in water scarce areas of the country. As the phenomenon is quite recent, detailed study hasn't been made. However, some preliminary studies have been made on some parts of the country. Rami (2003) is one of such studies, and is basically an account of two weeks field visit in Amhara and Tigray regions. The emphasis is mainly on rainwater harvesting implementation related problems in the regions and the prospects of using it for the stated objective of attaining food self-sufficiency. It has been found that RWH is top of the agenda in the two regions, as is the case at national level, with some times over ambitious plans of constructing wells and ponds.

The success in attaining the planed amounts of tanks and ponds to be constructed and the perceptions of the beneficiaries are found mixed. Shortages of required construction raw materials, lack of timely dispersal of finance and shortage of skilled labor have been among the factors inhibiting the attainments of the stated goals. This is evident from Amhara region where it once was planned to construct 29005 tanks made of cement and plastic but only 12614 tanks were constructed. Furthermore, the tanks constructed so far are found to be substandard, many collapsed and majority leak and seep water, the main factor being lack of experienced masons and supervisors and mismatch between the type of soil in the area and the tank construction method. The tanks were first tested in Adama area and implemented in the two regions, with basically different soil structures from Adama area, without-taking into account the specificities of the two regions (Rami, 2003). In addition, most of the construction was assigned to each Woreda as a quota resulting in less attention being paid to quality as compared to number. Further, the implementation tended to be top-down approach, particularly in Amhara region, and this has also contributed its share to the problems (Ibid).

Besides, rainwater harvesting is found to have undesirable, but not unexpected, side effects. For instance many people and livestock have been drowned into the tanks and ponds, with often no fences and live saving mechanisms like ladder and ropes (Ibid). However, it doesn't mean that rainwater harvesting didn't have any positive effects on the community. It has enabled them to grow crops of short growing periods like vegetables. And some have had good experience, as is the case in Tigray region where, for instance, "a farmer and his wife were able within a single season to pay their old extension credit of more than 1000 Birr through the planting and sale of vegetables (cabbages, tomatoes, beans and peppers) (Ibid). The upshot is that rainwater harvesting is beset with challenges and can be an utter failure and end up in undesirable negative consequences if not cautiously approached. However, it can play immense role in helping attain food security if implemented with thorough consultations with the beneficiaries and is accompanied with other activities like afforestation and soil conservation and fertility enhancing practices.

Kerr et.al (2005) employed quantitative analysis (as with and without design mainly employing instrumental variable approach) and also qualitative information to better understand interest in relation to relevant research questions, and to identify the projects' unintended consequences in evaluating the performance of watershed projects in India. Specifically, the study tries to identify: the successful projects, the approaches adopted which lead to the success and additional characteristics of particular villages' contribution to achieve improved natural resource management, higher agricultural productivity, and reduced poverty. The results of the study show that in both of the states, participatory projects combined with sound technical inputs performed better as compared to technocratic, top-down counterpart. Evidence also found on the existence of potential poverty alleviation trade-off during an effort to increase agricultural productivity and conserve natural resources through watershed development (Shiferaw et.al, 2003).

3. Methods of the Study

Sampling and Data

The data for the analysis is obtained from a household and plot level survey in Alaba Woreda. The Woreda is located 310 km south of Addis Ababa and about 85 km southwest of the Southern Nations Nationalities and Peoples Regional (SNNPR) state capital of Awassa. A semi-structured questionnaire has been employed to interview household heads.

A total of 152 households which are selected using a stratified sampling technique have been surveyed. Based on farming system practiced, the 73 peasant associations in the Woreda are stratified in to two, namely 43 peasant associations with Teff/ Haricot Bean Livestock and 30 peasant associations with Pepper/ Livestock farming system. From each stratum 2 peasant associations were selected randomly and the households within each of the four peasant associations were further stratified by adoption of RWH technology. In the end, from each of the four randomly selected peasant associations, a total of 38 households were randomly selected, where 19 of the farm households adopting the technology and 19 farm households without the technology stratum.

Moreover, interview has been done with experts working in the OoARD (office of Agricultural and Rural Development). Secondary data was also used from publications, books, articles etc. to supplement the data.

Data Analysis

Qualitative approaches are increasingly used in conjunction with quantitative approaches and such combinations can enhance the validity and reliability of impact evaluations. While quantitative approaches allow statistical tests for causality and isolation of programme effects from other confounding influences, quantitative methods excel at answering impact assessment questions about 'what' and 'how much', whereas qualitative methods are preferred for exploring questions of 'how' and 'why'. A mix of quantitative and qualitative approaches is ideal because it provides the quantifiable impacts of the intervention as well as an explanation of the processes and relationships that yielded such outcomes (Shiferaw et.al, 2005).

Descriptive Analysis

This part mainly focuses on describing the impact of rainwater harvesting ponds on the cropping pattern. Cropping pattern of the farm household's has been assessed based on the farming system.

Econometrics Approach

Empirical model and econometric estimation

Since there is no predetermined model that can be used in the quantitative estimation, following Pender and Gebremedhin (2004), models for the use of inputs on each plot (from equation 2 up to equation 6); adoption of RWH ponds (equation 1); and the value of crop production on each plot in 2005/06 (from equation 7 to equation 9) are adopted in this study.

To identify the determinant factors that influence the farm households' decision to adopt RWH pond or to invest on various types of RWH ponds, a probit model is estimated. Hence, a ***RWHp*** dummy variable (where 1=household with RWH technology and 0=household without RWH technology) is modeled as a function of village-level factors ($\boldsymbol{X_V}$), plot-level factors ($\boldsymbol{X_p}$), household-level factors ($\boldsymbol{X_h}$) and pond type which can be plastic covered or concert basement (**P**).These can be written as follows:

$$\mathbf{RWHp = f\,(X_V, X_P, X_h\,, P)} \qquad \mathbf{(1)}$$

Where, Household- level factor ($\mathbf{X_h}$) includes:

- Human capital (demographic features) - age, household size, educational status.

- Physical capital - land holding, value of all assets owned, value of livestock which includes oxen, packed animals, poultry, cattle etc.
- Social capital- membership in local organization and associations.
- Financial capital-households saving and credit access.

Village-level factors ($\mathbf{X_v}$) includes:

- Indicators of agricultural potential: rainfall condition(here due to lack of adequate information at PA level, during estimation, location dummies has been used in order to capture the difference in rainfall, altitude, population density and other environmental factors for the four PAs included in the study).
- Household access to services and infrastructure: walking time from the farm household's residence to the nearest input/ output town market, village market, Cooperative shops and all-weather and seasonal road.

Plot-level factors ($\mathbf{X_p}$) - Natural capital

- Indicators of quality of the plot (size of plot, slope of the plot, soil depth, soil type and soil fertility of the plot), how the household acquired the plot, the purpose for which the plot is used and walking time from farm household's residence to the plot in hours.

In the crop production regression and input use regressions, a logarithmic Cobb-Douglas specification is used. This leads to a theoretically consistent specification for output and input demands, and reduces problems due to outliers and non-normality of the error term found when using a linear specification (Pender and Gebremedhin, 2004). Thus, the use of inputs – Labor days/ha (**lnL**), Oxen power days/ha (**lnO**), Seeds kg/ha (**lnS**), use of Fertilizer (**F**), and use of Manure/Compost (**M/C**), are modeled as a function of explanatory variables including village-level factors ($\mathbf{X_V}$), plot-level factors ($\mathbf{X_p}$), household-level factors ($\mathbf{X_h}$) and the predicted value of adoption of rainwater harvesting ponds (**RWHp**).The models for the variable inputs can be written as follows:

$$\ln L = f(X_V, X_P, X_h, RWHp) \quad (2)$$

$$\ln X_K = f(X_V, X_P, X_h, RWHp) \quad (3)$$

$$\ln S = f(X_V, X_P, X_h, RWHp) \quad (4)$$

$$F = f(X_V, X_P, X_h, RWHp) \quad (5)$$

$$M/C = f(X_V, X_P, X_h, RWHp) \quad (6)$$

Where, **ln** stands for logarithm

The econometric model used depends on the nature of the dependent variable. For use of labor, oxen power and seeds on cultivated plots, the least squares regression is used while the regression equations for the variable inputs, fertilizer and manure/compost, Probit model is used since the dependent variable is dummy variable.

Finally, in assessing the impact of RWH ponds on agricultural output, the value of the agricultural output harvested from a plot is modeled in three different alternatives. First, a full model of the value of crop production from a plot is modeled as a function of village-level factors (X_V), plot-level factors (X_p) and household-level factors (X_h). Besides, the use of variable inputs Labor (**In*L***), Oxen power (**InO**), Seeds (**In*S***), Fertilizer (***F***), Manure or Compost (***M/C***) and the predicted value for adoption of RWH ponds (***RWHp***) are included. A full model of the value of crop production from a plot can be written as follows:

$$\mathbf{LnY= f\ (InL,\ InO,\ InS,\ F,\ M/C,\ X_V,\ X_P,\ X_h,\ RWHp)} \qquad \textit{(7)}$$

However, in the second regression, household-level characteristics (X_h) and adoption of RWH pond (***RWHp***) are omitted. This is because the effect of these variables on production may be indirectly through the use of inputs. Thus, the second - structural model of the value of crop yield is modeled as a function of all factor inputs by excluding household-level factors (X_h) and adoption of RWH pond (***RWHp***) from the regression. Thus the second model of the value of crop yield from a plot is given as follows:

$$\mathbf{LnY= f\ (InL,\ InO,\ InS,\ F,\ M/C,\ X_V,\ X_P)} \qquad \mathbf{(8)}$$

The third model developed in this study for the value of crop production is a reduced-form equation, which includes all village-level, plot-level, household-level characteristics as explanatory variables and the predicted value for adoption of RWH ponds. However, it excludes the use of inputs like Labor (**In*L***), Oxen power (**InO**), Seeds (**In*S***), Fertilizer (***F***) and Manure or Compost (***M/C)*** from the model. This specification can avoid the potential for endogenity bias. And also to examine the total effect of all factors on crop production, and whether it is a direct effect on production or indirectly through its effect on the use of inputs and adoption of RWH ponds.

The models for reduced- form specification of the value of crop production from a plot can be written as follows:

$$LnY = f(X_v, X_p, X_{h,}\ RWHp) \qquad (9)$$

In all cases, the least square regression was used to estimate the value of crop production. Generally, one important point that should be noted is that, for equation 2,3,4,7 and 8 robust regression is undertaken to avoid the hetroskedasticity problem that was observed during estimation. And also problem of multicolinearity and omission of variables has been checked.

Qualitative Analysis

These approach analysis the perception of experts and farmers regarding the constraints and opportunities of RWH technologies. The qualitative information was gathered using an open-ended question that was included in the questionnaire in order to augment the results of the econometrics analysis.

4. Results and Discussions

Impact on Cropping Pattern

As part of the assessment for the impact of RWH technology intervention on the farm household's crop choice decision, the study has employed a descriptive analysis of the crop mix for those with RWH technology in the different farming systems. Here, the crop types are classified into categories such as annual crops, perennial crops, vegetables, spices, others and no new crops. As can be seen from the table below, of the total number of the crop types sawn by all the sample households (382 plots), 188 observations are in the teff/haricot bean/livestock farming system category and 194 observations are under the pepper/livestock farming system category.

In the teff /haricot bean/livestock farming system, of the total *188* observations, 60.1% grow vegetables. In the vegetable crop category cabbage, onions and carrot account 16.5%, 14.9% and 12.2%, respectively. On the other hand, in the pepper/ livestock farming system, of the total 194 observations, 67% is from vegetables category. In the category, cabbage, beet root, tomato, carrot and onion accounts more respectively.

Table 1: Types of crop grown after start to use the technology based on farming system

Farming System	Type of crops grown	Nothing new	Annuals Crops	Perennial Crops	Vegetables	Spices	Others	Total
		Category of crop types grown						
Teff/Haricot bean /livestock	No new crop grown	40 (21.3)						40
	Chat		1 (.5)					1
	Coffee			12 (6.4)				12
	Banana		1(.5)					1
	Sugarcane			1 (.5)				1
	Avocado		2 (1.1)					2
	Papaya		4 (2.1)					4
	Onions				28 (14.9)			28
	Ginger(Jinjible)				1 (.5)			1
	Pepper					6 (3.2)		6
	Carrot				23 (12.2)			23
	Tomato				7 (3.7)			7
	Cabbage				31 (16.5)			31
	Chilli Pepper					2 (1.1)		2
	Kale				4 (2.1)			4
	Sweet potatoes				1 (.5)			1
	Garlic				3 (1.6)			3
	Beet root				15 (8)			15
	If other specify						6 (3.2)	6
	Total	**40 (21.3)**	**8 (4.3)**	**13 (6.9)**	**113 (60.1)**	**8 (4.3)**	**6 (3.2)**	**188**
Pepper/ livestock	No new crop grown	38 (19.6)						38
	Chat		2 (1)					2
	Coffee			8 (4.1)				8
	Orange		1 (.5)					1
	Banana		2 (1)					2
	Pineapple		1 (.5)					1
	Avocado		2 (1)					2
	Mango		1 (.5)					1
	Papaya		2 (1)					2
	Onions				17 (8.8)			17
	Pepper					4 (2.1)		4
	Carrot				19 (9.8)			19
	Tomato				20 (10.3)			20
	Cabbage				32 (16.5)			32
	Lettuce/'Selata'/				5 (2.6)			5
	Kale				6 (3.1)			6
	'Kosta'				4 (2.1)			4
	Sweet potatoes				1 (.5)			1
	Garlic				1 (.5)			1
	Mandarin		1 (.5)					1
	Beet root				25 (12.9)			25
	If other specify						2 (1)	2
	Total	**38 (19.6)**	**12 (6.2)**	**8 (4.1)**	**130 (67)**	**4 (2.1)**	**2 (1)**	**194**

Determinants of adoption of RWH pond, input use and crop yield

As can be seen from Table 1, result of the crop mix shows that, the household focuses more on marketable agricultural products like vegetables and perennial crops after they start to use the technology. This could have a positive impact on the farm household income as well as level of living. However, the level and magnitude of benefit accrue to the farm household will significantly depend on market and infrastructure accessibility. This is because most of the crop categories sawn in farm households with rainwater harvesting technology are perishable like vegetables. Hence, unless these products are able to reach to consumers immediately after harvested, either their market value will decrease with time or it might be a loss to the farm household. Besides, an examination of the type of crops grown under the vegetable category witnessed that most farm households have concentrated on specific crops (tomato, cabbage, onions, and carrot) and the production and supply of these crops in large quantities might reduce the price of the commodities and there by affect the economic feasibility of the technology. Thus, effort should be made to supply variety seeds to farmers so as to diversify the type of crops grown.

Determinants of Households Decision to Adopt RWH Pond

The estimation results of the Probit model for the determinants of household's decision to adopt RWH technology is presented in Table 2. As can be shown in the table, from the dummies for location, Ulegeba Kukke shows statistical significance at 10% level. No association has been found between village level factors and technology adoption decision.

Household human capital

Household size is positively correlated with the adoption decision of rainwater harvesting ponds at 5% level of significance. This means households with large family size are more likely to adopt the technology. This is due to the case that they can compensate costs involved in hiring labor for any activity that the technology demands. The implication is that research and development interventions need to take account of the labor and cost demand of the technology. Households who can read and write and those who are educated up to grade seven are more likely to adopt RWH. The positive association can occur with the expectation that they can understand the benefit more easily and are more open to access information than illiterate households. This implies that expansion of education in the woreda will have a positive impact in increasing the adoption decision rate.

Household physical capital endowment

From the household physical resource endowment indicators included in the model, oxen, cattle and pack animals have depicted positive correlation with adoption decision of the technology. This indicates that adoption of the technology requires large resources, thus households with a better physical resource are more likely to invest on technology interventions than those with few physical resource. However, it should be noted that the significant explanatory variables have insignificant effect in magnitude implying its less importance to make policy implication.

Plot level factors

Among the plot level factors, household decision to adopt RWH pond is more likely in homestead plot. The result indicates farm household's effort to fully utilize family labor so as to meet the human resource requirement during construction and utilization of water. This will reduce the finance that could otherwise be needed for hiring labor. The most interesting implication of this result is that, the accumulated water is used to produce crops with high market value rather than used as supplementary source of water during dry spells, as initially intended by government when the technology was introduced as country level. Ponds with concrete basement have shown statistically significant negative correlation with adoption of rainwater harvesting pond at 1% level. This implies that the higher cost involved in pond construction will result in less technology adoption decision.

Table-2: Determinants of adoption of RWH pond (Probit)

	Probit use of RWH technology		
Explanatory Variables	**Coefficient (dF/dx) ‡**	**Z**	**P>z**
Peasant association dummy,cf., Mudda Dinokosa			
Ulegebba Kukke	-0.0007837*	-1.85	0.065
Andegna Hansha	-0.0004302	-1.01	0.312
Hamata	-0.0003513	-0.72	0.472
Household access to services and infrastructure			
Walking time to the nearest town market (in hrs)	-0.0001269	-0.61	0.545
Walking time to the nearest village market (in hrs)	0.0001965	1	0.316
Walking time to the nearest cooperative shops (in hrs)	0.0001392	0.52	0.603
Walking time to the nearest all weather road (in hrs)	0.0002143	1.02	0.308
Walking time to the nearest seasonal road (in hrs)	-0.0000296	-0.06	0.954
Rain fall condition, cf., low			
Medium	-0.0004712	-0.84	0.401
High	-0.000446	-1.46	0.145
Household size	0.000111**	1.96	0.05
Age of household head (in Ln)	0.0002167	0.29	0.772

Table 2 continued…

Education level of household head, cf., illiterate			
Read and write	0.0079635***	3.25	0.001
Up to 4th grade	0.0018686	1.44	0.149
Up to 7th grade	0.00026301*	1.86	0.063
Up to 10th grade	7.41E-06	0.01	0.991
Household resource endowment			
Land owned (in ha)	-0.000184	-0.85	0.395
Value of cattle (both local & cross bred cows, calves, heifers, yearling, bulls)	3.59E-07**	1.98	0.048
Value of oxen (local and breed)	5.24E-07**	2.2	0.027
Value of sheep and goat	-4.44E-07	-0.72	0.472
Value of pack animals (donkey, horse, mule)	6.69E-07*	1.88	0.06
Value of poultry (both local & improved)	2.19E-07	0.64	0.519
Value of beehives (improved, modified, traditional)	3.85E-08	0.27	0.79
Value of all assets owned (plow set, farm equip, motor pump, radio,..	-3.23E-08	-0.33	0.74
Household membership in local organization, cf., members in Edir and other local organizations			
Membership in Edir only	0.0002847	0.7	0.487
Household membership in associations, cf., association members			
No membership in association	-9.37E-06	-0.02	0.985
Household financial capital , 1= yes			
Household with credit Access,1= yes	-0.0000753	-0.17	0.865
Household savings, yes=1	-0.0002764	-0.71	0.478
How household acquired the plot, cf., rented and share cropping			
Allocated by the state	0.5627719	0.00	0.997
Inherited	0.5999944	0.00	0.998
Slope of the plot, cf., steep slope			
Flat	0.0044407	0.00	0.999
Moderate	0.0686505	0.00	0.999
Soil depth of the plot, cf., deep			
Shallow	-0.0002766	-0.32	0.751
Medium	-0.0001365	-0.11	0.912
Soil fertility level of the plot, cf., low fertility			
High fertility	0.0141321	1.25	0.21
Moderate fertility	0.0010029	1.11	0.267
Purpose for which the land is used, cf., grazing ,woodlots and spice land			
Cropland	-0.0002559	-0.33	0.74
Homestead	0.0695164***	4.8	0.000
Plot size in ha (in Ln)	0.0005554	0.94	0.345
Walking distance from household's residence to the plot (in hrs)	-0.00168	-0.72	0.472
Type of pond, cf., ponds with plastic cover and those without a cover			
Ponds with concrete basement	-0.377571***	-4.54	0.000
Number of observations	1036		
LR chi2 (41)	350.92		
Prob > chi2	0.0000		
Pseudo R2	0.6399		

*** is significant at 1%; ** is significant at 5%; * is significant at 10%

‡Reported coefficients represent effect of a unit change in explanatory variable on probability of adopting RWH technology.

Determinants of Agricultural Input Use

The estimation result for the agricultural inputs: labor person days per hectare, oxen power days per hectare, seed - kg/ha, fertilizer and manure or compost is presented in Table 3.

Impact on use of Oxen Power

The estimation regression analysis also indicates that, adoption of rainwater harvesting technology has a negative statistically significant association with use of oxen power, more likely due to lower use of oxen power and more human labor on homestead plots where the technology is mostly adopted[4].

From the household access to services and infrastructure indicators, only nearness to village market is significantly correlated with more use of oxen power. Probably the correlation could be because of the possibility to get more seed and fertilizer enabling them to use more oxen power in order to increase their agricultural productivity.

In the household level factors, household size, heads who can read and write, and those who are educated up to fourth grade are positively associated with the use of oxen power at 1% level of significance. This implies those households having large family size and educated members are more likely to use oxen power to utilize labor available in the family to produce more output. From the physical resource indicators, owned land has shown positive correlation with the use of oxen power at 5% level of significance, which implies that more oxen power will be used by heads who own more land. In addition, ownership of goats and sheep, and beehive are statistically significant at 10% level. The significance might imply household's involvement in sheep, goat or honey trading to get extra income and use more oxen power in order to increase agricultural production especially in cases when the household has large land size.

The amount of oxen power used has shown significant positive association with flat and moderately sloped plots in comparison to steep plots. The result might indicate farmers risk aversion behavior due to crop failure which could be caused by high runoff problem. Plots with medium soil depth are less likely to use oxen power compared to plots with deep soil depth. Homestead plots have statically significant negative correlation at 1% level. This means, it is less likely that households will use oxen power on homestead plots. However, the likely use of oxen power is shown to

[4] Considering oxen as physical capital has a positive impact on the decision of the HH to use RWHP because HH with a better physical resource are more likely to invest on technology interventions(helps them to cover cost involved)

be significantly higher in crop land plots. An interesting result is found in the relationship between plot size and oxen power days per hectare, where larger plot size is significantly associated with lower oxen power days per hectare[5].

Impact on use of Seed

As expected the estimation of the regression analysis indicates that, adoption of RWH pond has statistically significant association with more likely use of seed. This could probably imply the impact of the RWH technology on crop production is indirectly through its effect on intensity of agricultural inputs.

The regression result depicts that no evidence has been found between location dummies and amount of seed used. From the village level indicators, closeness to town and village market is significantly associated with more use of seed, probably the household heads are less likely to be engaged in non-farm labor employment and hence, more emphasis be given to crop production.

With respect to household size, large family size is significantly associated with more use of seed, probably indicating that the members in the household utilize labor by working in agricultural activity which demands more seed. From the education status, households with heads who can read and write, and those with formal education up to fourth grade have shown positive association with use of seed relative to illiterate headed households. Households endowed with large sized land are significantly associated with more use of seed. No significant correlation has been observed between social and financial factors, and amount of seed used.

Impact on Labor use

As anticipated the estimation of the regression analysis indicate that, adoption of RWH technology has a positive statstically significant association with use of higher labor, most likely due to the higher level of labor requirement during watering, construction and other activities involved.

As can be seen from the result of the regression analysis, location dummy of Hamata PA is associated with more likely use of labor input at 5% level of significance. From the correlation between household access to infrastructure and service indicators and use of labor input, closeness to village market, town market and seasonal roads are associated with higher intensity in use of labor input. Probably household heads are engaged in farming activity by utilizing more seed, oxen and fertilizer use.

[5] When consider oxen power days **per hectare**, it's about the efficient utilization of oxen power.

Table 3: Determinant factors of input use during 2005/06 agricultural fiscal year

Explanatory Variables	Ln (Seed/ha)	Ln (Oxen-days/ha)	Ln (Labor-day/ha)	Whether fertilizer were used	Whether manure/ compost were used
Peasant association dummy,cf., Mudda Dinokosa					
Ulegebba Kukke	-0.245172	0.15099*	0.058052	0.0655231	-0.0197904
Andegna Hansha	0.214534	0.203828***	0.039733	-0.1935646***	0.079232
Hamata	0.001953	0.168604**	0.172659**	-0.1475076**	-0.0190538
Household access to services and infrastructure					
Walking time to the nearest town market (in hrs)	-0.104291**	-0.016135	0.020109	0.206203	-0.0265866*
Walking time to the nearest village market (in hrs)	-0.125701**	-0.072537***	-0.117138***	-0.0425217*	-0.0363848**
Walking time to the nearest cooperative shops (in hrs)	0.034241	-0.02963	-0.057824*	-0.0280787	-0.0054926
Walking time to the nearest all weather road (in hrs)	0.040986	-0.011034	0.022569	-0.0090631	0.0078478
Walking time to the nearest seasonal road (in hrs)	0.184175	0.097555	-0.110871*	0.0753763	-0.129366***
Rain fall condition, cf., low					
Medium	-0.084553	0.112657**	-0.054333	0.0087776	0.0026803
High	-0.091135	0.008501	-0.212387***	0.0527761	0.2818222***
Household size	0.026266*	0.021049***	0.043193***	-0.0024128	0.0094189*
Age of household head (in Ln)	0.125784	0.108762	-0.181818*	-0.0654953	0.0254648
Education level of household head, cf., illiterate					
Read and write	0.230052*	0.231572***	-0.087174	-0.0931605	0.0654167
Up to 4th grade	0.257753*	0.192213***	-0.078671	0.0288443	-0.0862418**
Up to 7th grade	0.083556	-0.024551	0.002305	-0.0171464	0.0307067
Up to 10th grade	0.071938	0.080617	-0.053017	-0.0293807	-0.0785635
Household resource endowment					
Land owned (in ha)	0.007845*	0.006203**	0.00167	0.0027194	-0.0037889**
Value of cattle (both local & cross bred cows, calves, heifers, yearling, bulls)	-1.73E-05	-5.90E-05	-6.98E-05***	4.99E-06	-0.0000345**
Value of oxen (local and breed)	4.28E-05	2.83E-05	4.82E-05*	0.0000103	0.0000485***
Value of sheep and goat	0.000167	0.000129*	-9.97E-07	-5.99E-06	-5.83E-06
Value of pack animals (donkey, horse, mule)	-0.000118	-0.000051	-8.93E-05**	7.97E-06	-5.84E-06
Value of poultry (both local & improved)	-0.000809	0.000172	0.000323	-0.00039	0.0003529
Value of beehives (improved, modified, traditional)	-0.00041	0.000376*	0.000197	0.0003235*	-0.0004251***
Value of all assets owned (plow set, farm equip, motor pump, radio, ...)	3.62E-06	-1.66E-05	-2.19E-05	7.05E-06	-3.57E-06
Household membership in local organization, cf., members in Edir and other local organizations					
Membership in Edir only	-0.215644	-0.115894	-0.210552***	-0.089469	0.0591204
Household membership in associations, cf., association members					
No membership in association	-0.094869	-0.191782***	0.042779	-0.0621948	-0.0014808
Household financial capital , 1= yes					
Household with credit Access,1= yes	-0.137139	0.070683	-0.06814	0.0624094	0.056192*
Household savings, yes=1	-0.072473	-0.327655***	-0.114424**	0.0126967	0.1128724***

Table – 3 continued

Explanatory Variables	Ln (Seed/ha)	Ln (Oxen-day/ha)	Ln (Labor-day/ha)	Whether fertilizer were used	Whether manure/ compost were used
How household acquired the plot, cf., rented and share cropping					
Allocated by the state	-0.506682***	-0.141824*	0.084312	-0.1988535***	0.158752***
Inherited	-0.382232***	-0.169708**	-0.111456*	-0.1364283**	0.1498123**
Slope of the plot, cf., steep slope					
Flat	-0.119189	0.530278*	0.446515*	0.1701381	0.3856669*
Moderate	-0.10287	0.51544*	0.547266**	0.1265144	0.2790531**
Soil depth of the plot, cf., deep					
Shallow	-0.021532	0.129045	-0.117212	-0.0475644	0.2127672
Medium	-0.000324	-0.300583***	-0.315847***	0.0428845	0.1378711*
Soil fertility level of the plot, cf., low fertility					
High fertility	0.048873	0.101733	0.035063	-0.0829447	0.1586607**
Moderate fertility	0.144556	0.089368	0.062933	-0.0517906	0.479061
Purpose for which the land is used, cf, grazing ,woodlots and spice land					
Crop land	0.419156***	0.37224***	0.614584***	0.4647761***	-0.0924947**
Homestead	3.09079***	-0.340097***	-0.472505***	-0.5890224***	0.4247779***
Plot size in ha (in Ln)	-0.180882	-0.912926***	-0.779754***	-0.2589599***	0.539933
Walking distance from household's residence to the plot (in hrs)	3.312421	0.011153	-0.12605	0.2058507**	-0.1616669
Adoption of Rain Water Harvesting technology (predicted value), 1=yes	3.312421***	-0.291091*	0.265723*	0.1043238	0.0748814
Constant	4.448353***	4.83144***	6.78531***		
Number of observations	1036	1036	1036	1036	1036
F (41,994)	8.80	14.08	14.46		
Prob > F	0.0000	0.0000	0.0000		
R squared					
LR chi2 (41)				281.62	353.37
Prob > chi2				0.0000	0.0000
Pseudo R2				0.1964	0.3137

*** is significant at 1%; ** is significant at 5%; * is significant at 10%

Reported coefficients represent effect of a unit change in explanatory variable on probability of use of the mean of the data

Ln represents natural logarithm

Furthermore, in relation to the household physical resource endowment, ownership of more oxen power is likely to utilize more labor input than in cattle and pack animal ownership. This is probably due to complementarities. An important point that should be noted is the insignificant impact of this variables when consider the magnitude. In relation to household head's membership in local organization, the study witnessed that, members in Edir and other related local organization are more likely to use labor input than those who are members in Edir only. In addition, households with saving are less likely to use labor input, probably suggesting household's involvement in activities other than agriculture.

The result also shows a mixed correlation between plot level factors and labor input use. For instance, labor input use is significantly greater on plots with flat and medium slope than plots with steep slope, perhaps indicating farmers risk aversion behavior and their emphasis on short term benefit. Since steep sloped plots are more exposed to soil erosion problem. Moreover, less of labor input is used on inherited and plots with medium soil depth. Homestead plots have statstically significant negative association at 1% level. However, more use of labor input is observed on cropland plots. In the relationship between plot size and labor person days per hectare, larger plot size is found to be significantly associated with lower labor person days per hectare. This is about the efficiency of labor input.

Impact on use of Fertilizer

As can be seen on Table 3, the adoption of RWH technology is shown to have insignificant impact on use of fertilizer suggesting that its impact on crop production isn't seen indirectly through its effect on fertilizer input. From the village level factors, walking time to the nearest village market has a negative correlation with fertilizer use at 10% level of significance. That means households closer to the village market are more likely to use fertilizer. No evidence has been found on the existence of correlation between the likely use of fertilizer and factors like human, social and financial capital part of the household level indicators. Further more, strong positive correlation has been found between value of beehives and the likely use of fertilizer, which is perhaps due to households focus on beekeeping activity enabling them to buy more fertilizer using the incremental income.

In relation to the association between plot level factors and the likely use of fertilizer, crop land plots are shown to have positive association with the use of fertilizer at 1% level of significance. Less fertilizer use is observed on homestead plots due to more possibility to use manure or compost than buy fertilizer. In small plot size it is more likely to use higher amount of fertilizer which is mainly due to an increase in efficiency when household's own small sized plots. Moreover, plots closer to the residence of the farm household have depicted significant correlation with more likely use of fertilizer.

Impact on use of Manure or Compost

As can be depicted from Table 3, adoption of RWH technology is found to have insignificant impact on manure or compost. No evidence has been found on the existence of correlation between the use of manure or compost and the location dummies. From the location dummies, household's nearness to village market, town market and seasonal road is more likely to use manure or compost inputs. Probably this is due to the use of more labor seed input when the household is closer to this services. In areas where there is high rainfall, more use of manure or compost is observed.

Furthermore, from the household level factors, households with large family are more likely to use manure or compost, probably due to the availability of labor to carry manure or compost to the farm land. With respect to educational status, household heads with formal education up to fourth grade are less likely to use manure or compost relative to illiterate heads. Most likely this could be affected either by educated headed households positive correlation with more likely use of fertilizer there by reducing the likely use of manure or compost or these households are constrained by labor required to carry manure or compost to the farm.

In relation to household's physical resource endowment, ownership of large sized land is correlated with less likely use of manure or compost, probably due to its high demand for labor input to carry manure or compost to wider farm lands. Ownership of large number of oxen is correlated with more likely use of manure or compost. Those engaged in livestock production as shown by ownership of large number of cattle and beehives are less likely to use manure or compost.

With respect to the financial capital part, households who have access to credit are more likely to use manure or compost input. Probably due to the possibility of using the credit to buy seed, oxen etc might lead to demand more manure or compost. In addition, those with saving are also more likely to use manure or compost. Probably due to their preference to spent it on other things than on fertilizer by replacing it with manure or compost.

Finally, in relation to the association between plot level factors and the likely use of manure or compost, the result witnessed that, state owned and inherited plots are positively correlated with more use of manure or compost. On the other hand, on flat and moderately steep plots, households are more likely to use manure or compost than on those steep sloped plots, probably to avoid risk of crop failure. Medium soil depth is more likely to use manure or compost. Plots that are highly fertile are more likely to use manure or compost than those infertile once because it will be risky for the household to use the input on infertile plot than fertile once. Households are less likely to use manure or compost on cropland plots but more likely to use it on homestead plots, probably due to its closeness to the residence of the farm household.

Impact on Crop Yield

Table - 4 presents the full model of the value of crop yield (column-2). Here, variables such as household level factors; household – human, social, physical, and financial capital endowment; and adoption decision of RWH technology that were included in the unrestricted OLS regression have been found to be jointly statistically insignificant. In column – 3 and column– 4 results of the structural and reduced models are shown respectively.

The impact of adoption of RWH technology on crop production can be explained in two ways, directly or indirectly. The direct impact is through the effect of better availability of water, whereas the indirect impact is through its effect on intensity in use of agricultural inputs. The estimation result of the study indicate that, adoption of RWH technology is shown to be positively correlated with value of yield at 1% level of significance. This might imply that RWHP have both direct and indirect significant impact on value of crop production. An examination of the indirect impact shows that, households with RWH technology are significantly correlated with higher use of labor and seed but lower use of oxen power than those without the technology. Intensity in use of labor and seed input has a positively significant impact on yield while oxen power has insignificant impact on yield.

As can be seen from the structural model for the value of crop yield, in the village level factors, seasonal road have negative statistical significance at 10%. With respect to the impact of plot fertility on value of crop yield, households are more likely to produce more output in moderately fertile plots than infertile once. As can be observed from the table, cropland and homestead plots are more likely to produce more yield. Besides, the result indicates the positive impact of use of labor, fertilizer and seed on value of crop yield. In the reduced model of crop yield, depicted in column 4 of Table 4, village level factors, plot level factors, household level factors and household rainwater harvesting technology adoption decision were included in the regression and assessed with respect to their impact on the value of crop yield.

The village level factors don’t explain variation in the value of crop production. Moreover, from the household level factors, household size has shown positive association with value of crop yield at 10% level of significance. This implies that households having large family size are more likely to produce more output. From the household physical capital endowment, greater ownership of cattle has shown association with higher value of crop yield and statistically significant at 10%. From the plot level factors included, state owned plot are more likely to produce more output than rented plots. Possibly indicating household's high future discount rate and become less likely to invest on productivity enhancing activities on rented plot. Plots with shallow and medium soil depth are less likely to produce more output than plots with deep soil depth. It is also shown that, cropland and homestead plots are more likely to produce more output compared with grazing, woodlots and spice plots. In addition, a negative significant association is observed between plot size and value of crop yield.

As in the result of the reduced model, household family size is positively correlated with value of yield at 10% level of significance implying that large family will produce more output. Households with large family size have shown significant association with use of higher labor, seed, oxen and more likely use of manure or compost. Intensity in use of labor has a positive impact on yield at 1% level of significance. This suggests that yield averages 11% higher per additional labor a household uses. Moreover, average yield increases by around 9% per additional seed amount used by the household. Even though fertilizer isn't significantly affected by household size, fertilizer is positively correlated with value of yield at 1% level of significance. That means yield is more likely to increase with more use of fertilizer input. Household age and education have insignificant impact on value of yield. However, household age has a significant impact on labor. Old age is negatively associated with labor input use.

Variations in resource endowment among households will obviously have an impact on the level of crop yield either directly or indirectly through their effect on the household's demand for agricultural inputs. Of the household physical capital endowment factors, ownership of cattle has a positive impact on the value of crop yield. However, it has insignificant impact when consider the magnitude to make policy implication. Households with saving are negatively associated with labor and oxen inputs use. Probably they might prefer to be involved in non-farm activities. Household access to services and infrastructure facilitates the movement of inputs to and outputs from rural parts to towns, where large market is available. The regression result shows an increase in yield when the household is located closer to seasonal road and is statistically significant. Households closer to village market are able to use higher amount of seed, labor, oxen and more likely to use fertilizer and manure or compost input. In addition, households closer to cooperative shops and seasonal roads are more likely to use labor input and those nearer to town market are able to increase seed amount.

Table 4: Determinants factors of value of crop yield

Explanatory Variables	Ln (Value of yield/ha) Full Model ‡	Structural Model ¶	Reduced Model
Peasant association dummy,cf., Mudda Dinokosa			
Ulegebba Kukke	-0.240465**	-0.16942**	-0.272749***
Andegna Hansha	-0.091321	-0.05626	-0.101886
Hamata	-0.332615***	-0.29741***	-0.387513***
Household access to services and infrastructure			
Walking time to the nearest town market (in hrs)	-0.037325	-0.02798	-0.037513
Walking time to the nearest village market (in hrs)	0.039986	0.041098	0.01502
Walking time to the nearest cooperative shops (in hrs)	-0.017744	-0.03863	-0.016557
Walking time to the nearest all weather road (in hrs)	-0.020955	-0.01405	-0.020943
Walking time to the nearest seasonal road (in hrs)	-0.13985*	-0.16159**	-0.083644
Rain fall condition, cf., low			
Medium	0.016212	0.01092	0.003531
High	0.10563	0.095822	0.08433
Household size	0.008924		0.015446*
Age of household head (in Ln)	-0.1558997		-0.13447
Education level of household head, cf., illiterate			
Read and write	0.007438		-0.059152
Up to 4th grade	0.064804		0.110153
Up to 7th grade	0.058197		0.079857
Up to 10th grade	0.123428		0.107066
Household resource endowment			
Land owned (in ha)	0.00154		0.0031
Value of cattle (both local & cross bred cows, calves, heifers, yearling, bulls)	4.44E-05*		4.55E-05*
Value of oxen (local and breed)	-3.44E-05		-1.22E-05
Value of sheep and goat	9.65E-05		8.20E-05
Value of pack animals (donkey, horse, mule)	8.94E-06		-3.14E-05
Value of poultry (both local & improved)	0.000275		0.00021
Value of beehives (improved, modified, traditional)	4.64E-06		-3.61E-05
Value of all assets owned (plow set, farm equip, motor pump, radio, ..)	-8.60E-06		-7.41E-07
Household membership in local organization, cf., members in Edir and other local organizations			
Membership in Edir only	-0.12421		-0.14033
Household membership in associations, cf., association members			
No membership in association	0.133489*		0.077884
Household financial capital , 1= yes			
Household with credit Access,1= yes	0.084706		0.045664
Household savings, yes=1	0.01175		-0.000479
How household acquired the plot, cf., rented and share cropping			
Allocated by the state	0.285989***	0.220717***	0.175439**
Inherited	0.14397*	0.09171	0.047545

Table – 4 continued

Explanatory Variables	Ln (Value of yield/ha)		
	Full Model	Structural Model	Reduced Model
Slope of the plot, cf., steep slope			
Flat	0.107935	-0.05085	0.157219
Moderate	0.213	0.052619	0.253161
Soil depth of the plot, cf., deep			
Shallow	-0.342699**	-0.2061	-0.276843*
Medium	-0.320594**	-0.2085	-0.269564*
Soil fertility level of the plot, cf.,low fertility			
High fertility	0.083002	0.12039	0.042061
Moderate fertility	0.10888	0.136898*	0.099062
Purpose for which the land is used, cf.,grazing ,woodlots and spice land			
Cropland	0.545698***	0.53749***	0.692927***
Homestead	0.22273*	0.273696***	0.376867***
Plot size in ha (in Ln)	-0.056483	-0.02842	-0.123963*
Walking distance from household's residence to the plot (in hrs)	0.085783	0.101174	0.077678
Labor-day/ha (in Ln)	0.101176***	0.110689***	
Oxen-day/ha (in Ln)	0.018104	0.006066	
Seed/ha (in Ln)	0.086711***	0.086715***	
Use of fertilizer,1= yes	0.164603***	0.171696***	
Use of manure/compost, 1= yes	-0.115259*	-0.11909*	
Adoption of Rain Water Harvesting technology (predicted value),1=yes	0.055424		0.510136***
Constant	6.686813*	6.272492***	7.859654***
Number of observations	1036	1036	1036
F (46,989)	8.11		
F(27,1008)		12.18	
F (41,994)			6.14
Prob > F	0.0000	0.0000	0.0000
R squared	0.125	0.0967	0.0953

*** is significant at 1%; ** is significant at 5%; and * is significant at 10%.

Ln= natural logarithm.

‡ Reported coefficients represent effect of a unit change in explanatory variable on probability of use of the mean of the data.

¶ Variables that were jointly statistically insignificant in the unrestricted OLS regression were excluded from the structural model

The result of the value of crop yield also shows that, state owned plots witnessed statistically significant association with higher value of crop yield. Probably, suggesting that farmers are more likely to invest on productivity enhancing activities on state owned plots. It is also shown that shallow and medium soil depth has statistically significant association with lower yield than on deep soil depth. Finally, crop land and homestead plots are shown to have positive association with value of yield.

Perceptions of the constraints and opportunities in adoption and use of RWH technologies

Farmers were asked to rank the purpose for which the accumulated water was used based on the amount of water utilized in each activity. As can be seen in Table 5 below, households use the pond water for different purposes. About 40.8% of households responded that they use the water for vegetable production as a supplementary during dry spell periods to be their first choice. In the second rank, 27.6% of the households use the water for nursering. About 23.7% and 18.4% of the households use it for drinking and livestock respectively.

Table 5: The purpose of the pond water (average utilization of pond water)

	Rank1	*Rank 2*	*Rank 3*	*Rank 4*
	Freq(%)	**Freq(%)**	**Freq(%)**	**Freq(%)**
For HHH drinking water	7(9. 2)	15 (19. 74)	**18(23.7)**	2 (2.6)
Drinking water for livestock	4(5. 3)	13 (17.11)	9(11.8)	**14(18.4)**
Nursering	26(34.2)	**21 (27.6)**	12 (15.8)	1(1. 32)
Vegetable production	**31(40.8)**	14 (18.4)	1 (1. 32)	3(3. 95)
Spices production	2(2.6)	1 (1. 32)		
Fruit production		2 (2.6)		
Washing cloth and food cooking	6(7.9)	10(13.16)	19 (25)	4(5. 3)
Total	76(100)	76(100)	59(77.6)	24(31.6)

Table 6 depicts cross tabulation of the type of RWH technologies adopted at plot level with their corresponding equipments used for water lifting and application. As shown in the table, 65.3% of the households represent those who adopted plastic-lined RWH pond and those waiting for plastic sheet. Concrete structures made of clay and/or cement accounts 34.7%. Of the total 47 households with plastic cover and none basement, 38.3% use metal Bucket for lifting and watering plants while 29.8% of the households use big plastic container '*Jerikan*'. Besides, households with concrete based ponds mainly use metal bucket.

In addition, the last raw of Table 6 shows the distribution of each type of water lifting and application equipments used in the total 72 plots with RWH technology. Majority of them (36.1%) use metal Bucket for lifting and watering plants followed by use of big plastic container (26.4%) and 'commendary' (16.7%).The highest percentage in the use of metal Bucket indicates the difficulty for a farm household in terms of time as well as labor days required to irrigate the entire plantation in the plot. This difficulty is due to lack of capital for buying or renting simpler equipments which is affecting the rate of rainwater harvesting technology adoption.

Table 6. Cross tabulation between type of RWH technology and type of water lifting equipments used

	Type of water lifting equipments used								
	Pulley	'Commendary'	Pot	Tridle pump	Jog	'Jerikan'	'Tanika'	Bucket	Total
Ponds covered with plastic and none covered basement	2(4.3)[b]	7(14.9)	2(4.3)		1(2.13)	14(29.8)	3(6.4)	18(38.3)	47(65.3)
% of Total	2.8	9.7	2.8		1.4	19.4	4.2	25	
Ponds with concrete basement	5(20)	5(20)		1(4)		5(20)	1(4)	8(32)	25(34.7)
% of Total	6.9	6. 9		1. 4		6. 9	1. 4	11.1	
Total	7(9.7)	12(16.7)	2(2.8)	1(1.4)	1(1.4)	19(26.4)	4(5.6)	26(36.1)	72(100)

[b] Values in brackets are percentages.

As can be seen on Table 7 below, only 19.7% of the households that adopt the technology have a cover for their pond while 80.3% are without cover. This might result in lots of problems like accident on animals and kids. Of the households with a cover for their ponds 33.3% and 26.7% of them use wood (trees) and Satera respectively. Besides, 68.4% of the households who adopt pond use fence to avoid risk while 31.6% of them don't use fence. Most of the households use wood as a material to do the fence.

Households with RWH technology were asked to list problems they encountered during implementation and utilization of the technology. These include problems related to RWH pond (33.7%), 37.9% of the total frequency of responses represents problems related with lack of simpler equipments, 5.76% of responses mentioned problems related with agricultural inputs and 9.47% cited problems related with health. Thus, problems related to equipments used during pond utilization are shown to be the dominant one. This will create problem of water application by using heavy materials which will reduce interest to produce vegetables in wider area.

Table 7. If the pond has a cover and fence

Does your RWH pond have cover?		If yes, what are the materials used?		Does the pond have fence to avoid risk?		If yes, what are the materials used ?	
	Freq(%)		**Freq(%)**		**Freq(%)**		**Freq(%)**
Yes	15(19.7)	Wood	5(33.3)	Yes	52 (68.4)	Wood (acacia tree)	20 (38.5)
no	61(80.3)	Cob	2 (13. 3)	no	24 (31.6)	Cob	2(3.85)
Total	76(100)	'Satera'	4(26.7)	**Total**	76(100)	'Kenchibe'	12 (23.1)
		Wood and 'kenchibe'	2(13. 3)			Cob and 'kenchibe'	3(5.77)
		Wood and 'Sinkita'	2(13. 3)			Wood and 'kenchibe'	13 (25)
		Total	15(100)			'Kenchibe' and thorn	2 (3.85)
						Total	52(100)

* Sinkita and kenchibe are kinds of bush trees. Satera is a grass material

Of the pond related problems, accident on animals and kids, absence of roof cover followed by quick dry up of the accumulated water problems take the highest share of 39.4, 36.8 and 14.4 percent respectively. The highest percentage observed in the accident could be due to absence of cover for the pond, absence of fence for the pond, and wrong location of the pond which might increase accident on kids due to closeness to the house. The high proportion of uncovered ponds could be due to lack of finance or may be due to less awareness given by the experts or probably due to weakness of the households. Quick dry up of the pond water could be related to the RWH technology or structural design of the technology which emanates from lack of extension workers with the necessary skill about the technology during construction or even lack of roof cover for the pond. In summary, majority of the problems cited by respondent households revolves around two issues: those related to RWH ponds and equipment problems.

Possible solutions were suggested by households with RWH technology to overcome the aforementioned problems. Most of the solutions suggested focuses mainly on the need for government support in terms of finance, arranging training or experience sharing tour to household heads. Around 81.5% of the households responded that they need government or other organization's support to supply them with more simple modern materials. This could be done either by sharing 50% of the cost or via long term credit so that they can produce more since they are unaffordable at household level. And it will also help to avoid waste of labor power and time in the process of water application.

Table 8: List of Benefits

S.No		CATEGORY OF THE BENEFITS REPORTED: Water supply for	New things	Production side	Individual opinions	Total
1	domestic use	33 (43.4)				33 (13.15)
2	new food varieties in our diet		47(61.7)			47(18.73)
3	Reduce consumption expenditure by producing what we used to buy from the market		28(36.8)			28(11.16)
4	For animals especially for those who can't go long distance to drink water.	37(48.7)				37(14.7)
5	It was able to get water for households easily and timely	29(38. 2)				29(11. 55)
6	Produce vegetable beyond home consumption and get money to be used for different purposes by selling the remaining amount.		26(34.1)			26(10. 36)
7	Helps to use water for permanent plants during the dry season e.g. Chat, Coffee, Papaya etc			6(7.8)		6(2. 39)
8	Enable us to produce more than once in a year by using the pond water during dry spell period			9(11.8)		9(3. 59)
9	create new job opportunity by developing the habit of working in dry season and use their time better than before		20(26. 3)			20(7.97)
10	Can avoid dry up of pepper nursering by using water in the pond			14(18.4)		14(5.58)
11	The negative side out weights positive one because the pond construction isn't dome well and it has no plastic cover				1(1. 3)	1(0.4)
12	I'm glad that the pond isn't covered by plastic or cement basement because it will help not to create bad smell when small animals died				1(1. 3)	1(0.4)
	Total	99(39.4)	121(48.21)	29(11.6)	2(0.8)	251(100)

In addition, for problems related to RWH ponds, governments or other organizations help or credit to make them buy iron roof instead of using raw materials that don't stay long. The need for professional help on the need of having cover and fence to minimize risk accounts for 38.1%. On the other hand, 18.3% indicates the need to have continuous assessment to have positive impact on how to use and produce in each season and will help to give solution for problems that households face.

Households with RWH technology were asked to list benefits that they get after they start to use the technology. And in general the total frequency of responses (251) reported the benefits sited by farmers to be classified in to four major categories. As can be seen from Table 8, new things known after they start to utilize pond seem to dominate accounting for (48.21%) followed by benefits related to water supply or availability to be 39.4% of the of the total frequency of responses.

Of the new benefits observed, 61.7% of the households respond the existence of new food varieties in their diet. In addition, the existence of water in their compound was seen as very beneficial for animals especially for those who can't travel long distance to drink water and for domestic use accounting 48.7% and 43.4% respectively. Of the total 11.6% respondents from the production side, 18.4% of the households responded that it is used to avoid nursering of pepper from being dried.

Finally, half of the sampled households were asked about the factors hindering them to adopt the technology. Of the total responses reported, reasons mentioned related to lack of financial capital represent 41.8% particularly related to poor economic situation to cover cost involved in pond implementation. Besides, 17.2% of them are related to lack of knowledge and follow up on the technology. Whereas, problem of small sized plot/farm land around the homestead and less work initiation account for 10.7% each from the total responses reported.

Gender and RWH Technologies

At present, there is a growing tendency towards the adoption of low cost and simple alternative water management technologies like rainwater harvesting technologies. RWH technologies have the potential to contribute towards the Millennium Development Goals (MDGs) with a view of eradicating poverty and hunger, provision of safe drinking water and sanitation, ensuring environmental sustainability, promoting gender equity and women empowerment. It is one way of improving the living conditions of millions of people, particularly those living in the dry areas. Water scarcity especially for domestic and agricultural purposes compromises the role of women in food production. Hence, provision of water by promoting rainwater harvesting and management technologies reduces the burden on rural women and thus increasing their productivity.

This part tries to see the participation of women in male headed households in planning and decision making stage, construction, maintenance, clearance and watching stages. In addition, it will try to address the question if women are benefited and in what terms, and the reasons if they aren't benefited from adoption of the technology. Besides, female headed households were asked if they are selected as beneficiaries and how they are selected, and if not, why not. The constraints that they face to use RWH technology are also considered.

Most households replied that there is equal responsibility among women and men to participate in planning and decision making accounting for 85.5% of the total rainwater harvesting technology adopters. This is followed by 17.1% of households who have mentioned that during planning, the women suggest the time for the work to provide a better food service. With regard to construction, 57.9% of the households said that, women participated directly (by supplying water) and indirectly (by preparing food and coffee) for workers. And about 33% of the households suggested that, women assisted by providing the needed raw material (like stone, sand, cement from home to where they work etc) and removing the soil from around the pond to a bit far area.

In the case of women participation in maintenance, clearance and watching, 72.4% of the households responded that they mainly participate in watching kids and animals from getting into the pond accidentally since they spent most of their time at home. This is followed by their participation in cleaning the area of the pond accounting 55.3%. Women participation during the dry season to carry out soil or sand that enters into the ponds in rainy season has taken 50% of the household's response. And about 30% of the households participated in maintenance by bringing water, raw material, food service and protecting the pond from being destroyed.

In relation to female headed households, 67.1% of the households who adopt RWH technology responded that they aren't selected as beneficiaries whereas the remaining 32.9% are selected to be beneficiaries. Out of the 67.1%, 68.6% of them mentioned that the main reason is economic and manpower problem. Less interest and initiation due to less participation in agricultural work account for 17.6% of the household's response. About 16% of the households responded that bias exists towards male headed households on the ground that the ladies can't go through the hard work, and the same percentage for the reason that they don't have anyone to teach them about its use and purpose. On the other hand, out of those households who responded that female-headed households are selected to be beneficiaries, 52% said that government or agricultural extension is voluntary to give chance for anybody depending on their working ability in agriculture. About 44% replied that it depends on their capacity to cover cost involved in pond construction. Moreover, 36% of them responded that it is their own initiation that matters.

With regard to the benefits achieved by women from the adoption of the technology, about 78% of the households responded that they are beneficiaries in terms of reduction in expenditure by using vegetable produced for home consumption and selling the remaining. Moreover, 61.8% of the households consider the time saved in fetching water and 22.4% on ability to eat different and new food varieties.

Generally, the result implies that women are getting benefit from the technology adoption as any member of the family. Their participation in the technology adoption is mainly in watching the ponds. They also have contribution in planning and decision making stage, and in giving support during construction, maintenance and clearance of the pond. Female headed households are being constrained to be beneficiaries due to economic and manpower shortage.

5. Conclusions and Recommendations

5.1 Conclusions

Rainfall in the arid and semi-arid areas is generally insufficient to meet the basic needs of crop production. In degraded areas with poor vegetation cover and infertile soil, most of the rainfall is lost through direct evaporation or uncontrolled runoff. Thus, overcoming the limitations of these arid and semi-arid areas and making good use of the vast agricultural potential under the Ethiopian context is a necessity. Hence, to alleviate these development constraints, the Federal government and Regional states, and NGOs working in research and development, have invested huge resource on rainwater harvesting technology.

In this study, methodologies including descriptive (cropping pattern), econometrics and qualitative analysis are used to assess the determinants of households' adoption of rainwater harvesting ponds, and its impact on agricultural intensification and yield in Alaba Woreda. Interview has also been done with experts on rainwater harvesting ponds.

The finding in the cropping pattern shows that, farm households have started to grow new crops (vegetables and perennial crops) as a result of water availability from the water harvesting ponds. The crops are those which are highly priced and marketable ones implying the potential of RWH technologies to enhance a farm household's income. However, the benefit depends on market and infrastructure accessibility, and diversification in the types of the crops. Results of Probit analysis on the determinants of adoption of rainwater harvesting ponds shows that household size, education status of household head, ownership of livestock (cattle, oxen and pack animals), homestead plots and type of pond explained adoption statistically significantly.

In accordance with government's target, the Ordinary Least Square estimation of the determinants of the value of crop production shows that adoption of RWH has a positive and statistically significant total effect on value of crop production. This shows that RWH ponds have both direct and indirect significant impact on value of crop production. We also find that households with RWH technology use more labor and seed but less oxen power compared with those households who have not adopted the technology. Moreover, labor and seed inputs have positively significant impact on yield while the effect of oxen power is insignificant. These results show that in addition to its direct impact, RWH has significant indirect impact on value of crop production through its effect on intensity of input use.

Results of the qualitative information, consistent, with the crop mix and econometric results, also showed that households started to grow crops that weren't grown previously. In addition, it indicates that effectiveness of the technology adoption is mainly constrained by problems related to water lifting and watering equipments, and accidents occurring due to absence of roof cover and fence to the ponds. Generally, directly or indirectly, labor requirements and cost considerations appear to be important factors that influence household's adoption of RWH technology.

5.2 Recommendations

The benefit found from the high valued and perishable commodities due to RWH, depends on market and infrastructure accessibility, and diversification in the types of the crops. Thus, efforts should be made to assess various agricultural commodities as well as giving emphasis to marketing extension, especially in facilitating markets and market linkages to farmers.

The impact of household RWH technology adoption on the value of crop yield has been found to be statistically significant. Therefore, to mitigate the erratic nature of rain fall in the arid and semi-arid parts of the country, development and implementation of rain water harvesting technologies will be helpful to promote productivity and sustainable intensification of the rain fed agriculture. However, the success of the technology adoption is mainly constrained by problems related to water lifting and watering equipments, and accidents occurring due to absence of roof cover and fence to the ponds. This implies that support will be needed to provide affordable but improved water lifting and watering equipments, and give training to farm households on construction and use of roof covers and fences to the ponds.

Labor requirements and cost considerations appear to be important factors that influence household's adoption of RWH technology. This implies that research and development interventions need to take account of the labor and cost demands of the technology.

Reference

Demeke M. and Ferede T., (2005). The Performance of Grain Marketing in Ethiopia: The Case of Addis Ababa Central Market, in S. W. Omamo, S. Babu, and A. Temu (eds) "The Future of Smallholder Farming in Eastern Africa: The Roles of states, markets and civil society", IFPRI Eastern Africa Food Policy Network Report.

Hatibu N., Senkondo M., Mutabazi K. and Msangi K. "Economics of Rainwater Harvesting for Crop Enterprise in Semi-Arid Areas" downloaded from www.regional.org.au/cs/2004/symposia/1/4/276_hatibu.htm, accessed in October 2004

Kerr, J. M. and Kimberly, R. C., 2005. Evaluating Watershed Project Performance in India: A Practical Econometric Approach. In: Shiferaw, B., Freeman, H. A., and Swinton, S. M. (Eds.) Natural Resource Management in Agriculture: Methods for Assessing Economic and Environmental Impacts. UK: CABI Publishing in association with The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India; 2005.

Nega H., 2004. Managing rainwater in dry land areas of Ethiopia for improved agricultural development: The Ministry of Agriculture experience. Paper presented in the second General Assembly Proceedings of Ethiopian Rainwater Harvesting Association.

Nega H., 2005. Training manual on Rainwater Harvesting and Utilization Techniques. Addis Ababa, Ethiopia

Ngigi, S.N., 2003. Rain water harvesting for Improved Food Security. Promoting Technologies in the Greater Horn of Africa. Greater Horn of Africa Rainwater Partnership (GHARP).Kenya Rainwater Association (KRA).

Pender J. and Gebremedhin B., 2004. Impacts of policies and technologies in dry land agriculture: Evidence from northern Ethiopia. In Challenges and Strategies for Dry land Agriculture. CSSA Special Publication no. 32.

Rämi H., 2003. Ponds filled with challenges. Water harvesting-experiences in Amhara and Tigray. UN OCHA-Ethiopia

Shiferaw B. and Freeman, H.A., 2003. Methods for Assessing the Impacts of Natural Resource Management Research. A summary of the proceedings. ICRISAT, Patancheru 502 324, Andhra Pradesh, India.

Shiferaw B., Freeman, H.A. and Swinton, S.M., 2005. Natural Resource Management in Agriculture. Methods for Assessing Economic and Environmental Impacts. CABI publishing

Takele E., 2006. Review on the effectiveness and impacts of small- scale irrigation in Ethiopia. WB.

UNEP, 2005. Rainwater Harvesting and the Millennium Development Goals.

www.rainwaterharvesting.org/rural, An interesting account on Rainwater harvesting Experience of India

PROSPECTS AND CHALLENGES OF WATER SUPPLY AND SANITATION IN ETHIOPIA WITH RESPECT TO MDGS

Teshome Adugna[1]

Abstract

Water supply and sanitation are two most important sectors in development. The objectives of this study are to describe the water supply and sanitation coverage, to identify the source of water supply and types of sanitation, to study the regional, urban and rural distribution of water supply and sanitation facilities in the country. In addition to these, the study analyses the expected improvement of water supply and sanitation coverage with its required cost to meet the Millennium Development Goals of water supply and sanitation in Ethiopia. The study uses descriptive analysis to address its stated objectives.

The study reveals that water supply and sanitation coverage in Ethiopia is one of the lowest in the world, which is 39.4 percent and 11.5 percent in 2004 respectively. 63.9 percent of water supply came from unprotected source of water as compared to 35.9 percent water supply source that came from protected well/spring, public and private tap. In the same way, unprotected sanitation takes around 69 percent of sanitation facility. Only 31 percent of the people use protected sanitation that are flush and pit latrine toilet in the same year. The Millennium Development Goals expected to provide water supply and sanitation for 36 million and 45 million people at the end of the development goals respectively.

Sustainability of water supply and sanitation scheme, lack of financial and skilled person, poor cost recovery, poor absorptive capacity, absence of clearly stated responsibilities between region, woreda and community water committee are the major problems that will encounter the implementation of the program. The Federal or regional governments should conduct awareness campaign to local people, provide suitable vocational and technical training, improve absorptive capacity of aid or loan that available for water supply and sanitation projects in order to meet the stated targets.

[1] PhD student, *Innsbruck University,Austria*

1 Introduction

Ethiopia is among the poorest countries in the world, ranking 170 out of 177 in the UN Human Development Index (HDI) in 2005. The country also the second most populated countries in Africa with 78 million people in 2006. Higher level of poverty prevalence, poor access for education, health, water supply and sanitation are the characteristics of the countries in the last many decades. One sixth of all African who need access to water live in Ethiopia(Eth. UN team, 2004).The higher incidence of water and excreta –related disease in the country result from unsatisfactory water supplies and poor waste disposal system. Diarrhoeal disease takes the life of 1.8 million people each year, most of them children under five (UNICEF, 2004). In addition to this a number of children unable to attained school and women in forced to travel a long distance to collect water from river and lakes or other sources. Access to water supply and sanitation reduce these challenges in the country.

In realizing the challenge in the country within a time bound and targeted frameworks, the Government of Ethiopia (GoE) accepted and localized the Millennium Development Gaols (MDGs) with its PASDEP[2]. Goal seven of the millennium declaration is to ensure environmental sustainable. Target ten of this goal is to halve the shortage of water supply and sanitation at the end of the millennium development goals (2015).This paper has eleven sections. The second section describes the objectives of the study. The third section discusses the historical development of millennium development goals. In this section you will see the different views that have been forwarded by world leaders to solve the problems of developing courtiers at UN general assembly since 1960s.

The fourth section explains the direct and indirect role of water supply and sanitation to meet all goals of the millennium declaration. In the fifth section you will see the water supply and sanitation situation in Ethiopia. In this part we will see the water supply and sanitation coverage as compared to with selected countries. The next section explains the trends of water supply and sanitation in Ethiopia. Section seven studies the sources of water supply and types of sanitation facilities in the country. Section eight highlight the water supply and sanitation policy in Ethiopia. Section nine analyses the MDGs water supply and sanitation targets and the required level of financial cost to achieve the millennium development goals in the countries. The next

[2] PASDEP is the abbreviation of new poverty reduction strategy that is knows as Plan of Action for Sustainable Development to End Poverty.

section identifies the challenges of water supply and sanitation provision to meet the MDGs. The last section is conclusion and recommendations.

The study used the secondary date that collected from difference sources: Ministry of Water Resource of Ethiopia, World Health Organization, World Bank and other publication of government and non governmental office. The method of analysis is simple description like percentage, ratio, tabulation and graph.

2. Objective of the study

The general objective of the study is to see the prospects and challenges of water supply and sanitation to meet the Millennium Development Goals of halving the problem of water supply and sanitation in Ethiopia. The specific objectives are:

- To review the historical development of Millennium Development Goals.
- To study the water supply and sanitation coverage of the country by comparing with selected countries.
- To see the major sources of drinking water supply and types of sanitation facilities available in Ethiopia.
- To analyse the Millennium Development Goals water supply and sanitation targets
- To study the infrastructures and financial requirement to meet the water supply and sanitation up to the end of 2015.
- To identify the challenges that will be facing to meet the WSS Millennium Development Goals.
- To forward the possible recommendation to meet MDGs WSS target.

3. Background to the development of the MDGs

The Millennium Development Goals (MDGs) are the end product of numerous UN development conferences from the 1960s to 1990s. These all UN development decades (First, Second, Third and Fourth Development decades) focused largely on economic growth. The first UN Development Decade was launched by the General Assembly in December 1961. It called on all member states to intensify their efforts to mobilize support for measures required to accelerate progress toward self-sustaining economic growth and social advancement in the developing countries. With each developing country setting its own target, the objective would be a minimum annual growth rate of 5% in aggregate national income by the end of the decade.

In 1970, the General Assembly adopted a resolution outlining an international development strategy for the second UN Development Decade. The main objectives of the plan were to promote sustained economic growth, particularly in the developing countries; ensure a higher standard of living, and facilitate the process of narrowing the gap between the developed and developing countries. The General Assembly declared that the developing countries bore primary responsibility for their development but that their efforts would be insufficient without increased financial assistance and more favorable economic and commercial policies on the part of the developed countries. Under the goals and objectives of the second decade, the General Assembly stated that the average annual rate of growth in the gross product of the developing countries as a whole should be at least 6%, with the possibility of attaining a higher rate in the second half of the decade. Such a rate of growth would imply an average annual expansion of 4% in agricultural output and 8% in manufacturing output.

The third UN development decade which begin on 1, January 1981, focused on New International Economic Order (NIEO), which introduced by developing countries. The new international development strategy was adopted by the General Assembly for the third UN Development Decade. It agreed to the goals and objectives of the strategy and to translate them into reality by adopting a coherent set of interrelated, concrete and effective policy measures in all sectors of development

The strategy set forth goals and objectives for an accelerated development of the developing countries in the period 1981–90, including the following: (1) a 7% average annual rate of growth of gross domestic product (GDP); (2) a 7.5% annual rate of expansion of exports and an 8% annual rate of expansion of imports of goods and services; (3) an increase in gross domestic savings to reach about 24% of GDP by 1990; (4) a rapid and substantial increase in official development assistance by all developed countries, to reach or surpass the target of 0.7% of GNP of developed countries; (5) a 4% average annual rate of expansion of agricultural production; and (6) a 9% annual rate of expansion of manufacturing output. Other goals and objectives of the strategy included the attainment, by the year 2000, of full employment, of universal primary school enrollment, and of life expectancy of 60 years as a minimum, with infant mortality rates no higher than 50 per 1,000 live births.

In 1990, the General Assembly concluded that its goals for the Third UN Development Decade had not been attained. It set new priorities and goals for the growth of the developing member nations with its International Development Strategy (IDS) for the Fourth United Nations Development Decade (1991–2000). Within one year of its passage, however, the former USSR had dissolved, forever changing the landscape of international economic relations. Many of the assumptions on which the IDS had been based were upset by the historic forces that were thus set in motion.

In September 1990, the Second United Nations Conference on the Least Developed Countries set targets for official development assistance (ODA) to those nations. The General Assembly, through the new IDS, urged industrialized countries to reach or surpass the target of official development assistance given to developing countries. It also recommended that developing countries try to raise their rate of industrialization by 8–10% and increase their annual food production by 4%.

The implementation of the commitment of IDS was not successful according to the study committee report conducted in October 1999. The report went on to differentiate between growth, which may carry with it negative social consequences and development, which means more than simply increased purchasing power (as reflected in gross domestic product per capita).According to the report, development also pertains to education, health, and environmental standards, as well as to social (including gender) equity. For this reason, "the spotlight is now shifting from a focus on macroeconomic challenges to a number of institutional preconditions, including good governance, transparency and accountability, decentralization and participation and social security.

As a result, the MDGs reflect the emerging role of human rights in the international community, focusing on the economic, social and cultural rights enumerated in the Universal Declaration of Human Rights (rights to food, education, health care, and decent standard of living). The Goals also reflect a mixture of economic theory and human rights since a variety of human rights advocacy groups and civil society organizations participated in the drafting of the Goals.

The International Development Goals, drafted in 1996 by the Development Assistance Committee of the Organisation for Economic Co-operation and Development (OECD), also strongly influenced the MDGs. Seven of the eight MDGs are exactly the same as the OECD goals. Like the OECD goals, the first seven MDGs are time-bound and measurable. The eighth MDG is not time-bound, but instead more of an aspirational goal. The UN also simulated the manner in which to

OECD goals relied on bilateral donors to further their development goals. Unlike the OECD goals, however, the MDGs were formally adopted by developed and developing countries alike.

Table 1: Millennium Development Goals with their respective targets

MDGs Goals	MDGs Targets
Goal 1: Eradicate Extreme Hunger and Poverty	1. Halve, between 1990 and 2015, the proportion of people whose income is less than $1 a day 2. Halve, between 1990 and 2015, the proportion of people who suffer from hunger
Goal 2: Achieve Universal Primary Education	**3.** Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling
Goal 3: Promote Gender Equality and Empower Women	4. Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015
Goal 4: Reduce Child Mortality	**5.** Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate
Goal 5: Improve Maternal Health	**6.** Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio
Goal 6: Combat HIV/AIDS, Malaria and other diseases	7. Have halted by 2015 and begun to reverse the spread of HIV/AIDS 8. Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases
Goal 7: Ensure Environmental Sustainability	**9.** Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources **10.** Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation **11.** Have achieved by 2020 a significant improvement in the lives of at least 100 million slum dwellers
Goal 8: Develop a Global Partnership for Development	**12.** Develop further an open, rule-based, predictable, nondiscriminatory trading and financial system (includes a commitment to good governance, development, and poverty reduction? both nationally and internationally) **13.** Address the special needs of the Least Developed Countries (includes tariff- and quota-free access for Least Developed Countries? exports, enhanced program of debt relief for heavily indebted poor countries [HIPCs] and cancellation of official bilateral debt, and more generous official development assistance for countries committed to poverty reduction) 14. Address the special needs of landlocked developing countries and small island developing states (through the Program of Action for the Sustainable Development of Small Island Developing States and 22nd General Assembly provisions) 15. Deal comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long term

In September 2000 the United Nations General Assembly, representing 189 countries, unanimously adopted the Millennium Declaration. As per the United Nations General Assembly's request, the Secretary General and various UN agencies, as well as representatives of the World Bank, International Monetary Fund (IMF), and Organization for Economic Cooperation and Development (OECD), devised a plan for achieving the Millennium Declaration's objectives – resulting in 8 goals, 18 targets and 48 indicators known as the Millennium Development Goals (MDGs).

The MDGs are a set of time-bound and measurable goals and targets designed to decrease poverty, hunger, disease, illiteracy, environmental devastation and discrimination against women. The MDGs are a unique approach to these worldly problems – they confer obligations on both rich and poor governments, but place a heavier burden on rich countries in terms of financial and materials provision. The compressive nature of MDGs, targets and indicators also pose several problems as well as opportunity for the countries that embraced them. Table 1 shows the eight goals and eighteen targets of millennium development goals.

4. Role of water supply and sanitation to meet MDGs

Until recently, the multiple benefits or roles of domestic water supply and sanitation not received as much attention as they deserved. It was usually considered water supply and sanitation as largely a "public health" benefit. Now a broad range of non-health benefits have started to be recognized and targeted in an increasing number of studies and report. In the recent draft white paper on water service in South Africa economic activities are explicitly recognized. "Municipalities do not and should not only provide water service necessary for basic health and hygiene. It is important that municipalities' undertake health education, facilitate the provision of higher level of service for domestic used and provide service which supports the economic development and well being of communities" (Draft white paper, 2003).

These broad benefit of water supply and sanitation also revealed in the study by WaterAid, a leading NGO working in household water provision (WaterAid , 2001).This study reported on an impact associated of older water supply and sanitation project in India, Ethiopia, Ghana and Tanzania. The results showed that there are a wider range of positive impacts that were not in the design of the water project.

These indicate meeting the water supply and sanitation target set by the international community for 2015 is a fundamental for achieving the other Millennium Development Goals, such as alleviating poverty, hunger and malnutrition; reducing child mortality; increase gender equality; providing more opportunity for education and ensuring environmental sustainability. The MDGs and associated targets are an opportunities for prioritizing water on the basic of its ability to impact overall poverty and contribute to significant socioeconomic and environmental gains (IRINA, 2006). Water supply and sanitation can contribute, directly or indirectly, to meeting all the other MDGs (John Soussan, 2003). Despite the strong link between each MDG, in order to understand clearly, let us see briefly the role of water supply and sanitation against each goal of Millennium Development Declarations.

The first goal of millennium declaration is to reduce poverty (to halve the proportion of the world's people whose income is less than $1 a day) and hunger (to reduce the proportion of the world's people who suffer from hunger) in 2015. Hear water and sanitation is an important ingredient to achieve these goals at the end of stated year. Provision of water near to the household village or house saves time and effort to use it for other wage earning and other social activities by households. Based on the study conducted by WaterAid (Ibid) time spent in collecting water reduced from an average of six to eight hours to five to twenty minutes in Ethiopia. These affect the household activity; specially women and children participation in the household. Indirectly, therefore water provision increases opportunities for improving household income and nutritional level through assisting in the diversification of livelihood activities.

Water related poverty occurs because people are either denied dependable water resource or because they lack the capacity to use them. We usually invest not for water sack rather for poverty's sake. Accessibility of water supply and sanitation provide extra time for the household for wage earning activity. Every dollar spent on water supply and sanitation and water resource management is an investment with strong, potential for solid return. The return in multiple sectors could range from USD 3 to USD 34 for every dollar invested to meet the Millennium Development Goals water and sanitation targets (WHO, 2006).At the world Water Week Symposium in Stockholm in 2002, Klaus Topfer, who until 2006 was the longstanding chief of UN Environment program (UNEP), said "without adequate clean water, there can be no escape from poverty," (Irina, 2006).

The second goal of the millennium declaration is to achieve universal primary education. The provision of water supply and sanitation increase school attendance by children (especially girls) resulting from enough time to go school. Reduced water carrying burdens improves school attendance, especially for girls and raises education levels. Separate sanitation facilities for girls in school increase their school participation. School children are especially prone to worm infection; improving sanitation and hygiene can prevent these infections and contribute to improved school attendance and better concentration.

Box 1: Impact of water supply on household

I have seen a very radical change here. Before we only had unprotected source of water. My family suffered badly. My three year old daughter died from this water. There were parasites which gave us illnesses and stomach problems. So many children used to die, but now this has changed and children do not die from these diseases.

Before we used to have to go to the health clinics all of the time, often every day. I used to spend time walking there and hours just queuing to be seen, but now I can save my time and money. I have bought 20 chickens and one goat from the money I have saved. With the time I can work on my maize and pepper crop can work on my maize and pepper crop

Source: WaterAid, 2006

In Tanzania, 12% more children were found to attend school when safe water available within 15 minutes rather than one hour from their home. (Ibid, P.56).Staggering 270 million school attendance days could be gained if the MDGs target are met. Therefore the provision of water and sanitation near to home or school enable us to achieve the universal primary education of millennium declaration.

The third millennium declaration is to promote gender equality and empowers women. Today million of people, mainly women struggle to locate and transport water for drinking, cooking and washing need of their families. Access to water near home will save time for women and girls. This saved time can be spent on productive activities and education, which lay the groundwork for economic growth. Women are particularly concerned about the safety and cleanliness of sanitation facility. For them, sanitation means more than just latrines; they want safe private places with sufficient water for personal use and washing cloth and better drainage to avoid dirty water remaining in the streets.

Especially when water supply improvements are coupled with opportunity to create income trough microenterprises, time released from water collection is converted into income earned. This brings several benefits; reduce drudgery, higher household income and consequently greater women's empowerment through changing gender relations within the household. An improvement of water supply to the extent that women spend one hour per day on collecting water would result in an improvement of the annual income with upper boundaries of between Rs 750 and Rs 5520. Alternatively, each women might gain between 45 and 152 eight hour days annually for domestic, social and development activities (Van WIJK, 2001).

The fourth goal of millennium declaration is to reduce child mortality. Children are particularly at risk from water-related diseases such as diarrhea and parasitic diseases. Lack of sanitation also increases the risk of outbreaks of cholera, typhoid and dysentery. The provision of water and sanitation highly contribute for the reduction of child mortality in most developing countries. It is estimated that unsafe water and a lack of basic sanitation and hygiene every year claim the live of more than 1.5 million children under five years old from diarrhea. But those who die are by no means the only children affected many million more have their development disrupted and their health undermined by diarrhea or other water related disease.

An evaluation seminar held in 1992 as a follow-up to the first UN international Decade for clean drinking water (1981-1990) found that half the incidents of infant and child mortality in central Africa Republic were due to water related diseases (IRINA,2006). WHO estimates that in 2005, 1.6 million children under age 5 (an average of 4500 every day) died from the consequences of unsafe water and inadequate hygiene. In order to reduce the mortality rate of the child we have to provide clean water with adequate sanitation facility. It protects the children from water related disease and enables them to get enough nutrition.

The fifth millennium declaration is to improve maternal health. Just a few decade ago in most developing countries and even now in some vast proportion of people have suffered and are suffering from all sort of disease due to lack of access to safe drinking water and use of unsafe water. Adequate and safe drinking water and sanitation for all is an effective way of protecting the expansion of water born diseases such as diarrhea, cholera, dysentery, etc, which are potential cause of loss of life. The provision of water highly benefits women or mother who travel long distance and spend their time to get water and sanitation. Because they are the one who has more direct contact as compare to men. In order to improve the health status of mother we have to achieve water supply and sanitation target of Millennium Development Goals.

The sixth millennium declaration is similar with the previous two declarations. It is to combat HIV/AIDs, Malaria and other disease in 2015. HIV/AIDS has become the most global epidemic ever. Improved water and sanitation services can play a crucial role in slowing the progression of HIV and in reducing the number of AIDS related death. Safe drinking is necessary for taking medicines, while nearly latrines make life more tolerable for weak patients (Eleien Kammina and Madeleen Wagelin, 2005). Even good water supply and sanitation are even more important to HIV/AIDS families. They help infected people to stay healthy longer and provide longer for their families. In the same way better management of water resources control the transmission of malaria and other diseases.

The other declaration of millennium summit is to ensure environmental sustainability. The sustainable economic development can be achieved if we used our recourse properly and efficiently. Today current development should not be realized by the cost of future development. Water is one of the unique resources that has strong link with all other resource. Good management of water resources is vita to environmental safety and sustainability. The miss utilization of water highly affects the environment as well as the national economic development. Degradation of freshwater ecosystem and land exacerbate the frequency and impact of droughts, floods and other natural hazards particularly in ecologically fragile area where the poor often live and can intensify competition and the potential for conflict over access the shared water resources.

5. Water supply and sanitation coverage in Ethiopia: Comparative analysis

The provision of water supply[3] and sanitation is an important sector that improves the well being of the people. Access to water supply refers to the provision of sustainable water supply to the basic need of the people. Usually it is measured in terms of percentage of people who are access for the minimum requirement of water quantity and quality. Improved drinking water technologies are those more likely to provide safe drinking water than those characterized as unimproved. The minimum requirement can vary from country to country. According to the definition of minimum requirement by the World Bank is each people should get 40 lcpd. But in Ethiopia case 20 lcpd is the minimum requirement per day per person. (CSA, 2004)

[3] In this study the focus is on quantity of water supply than quality of water supply.

Sanitation refers to the safe disposal of domestic wastes including human waste. Unsanitation disposal of human waste will result in contamination of water supply sources and spread of water born diseases. Access to sanitation also estimated by the percentage of the population using improved sanitation facilities. Improved sanitation facilities are those more likely to ensure privacy and hygienic use.

In 2004, the water supply coverage at national level was 39.4 percent in Ethiopia which is much more less than average world, SSA, Uganda and Kenya. In the same year the water coverage in world was 83 percent which is 52.2 percent higher than Ethiopia water coverage. In SSA (Sub Saharan African) countries, the average water supply coverage is 56 percent. It is also higher as compare to Ethiopia water supply coverage by 39.4 percent. Neighbors' countries like Kenya and Uganda has 62 and 60 percent water supply coverage respectively in 2004. In both countries the coverage are more than average SSA water supply unlike Ethiopia water supply coverage. These indicate that Water supply coverage in Ethiopia is the lowest even as compared to SSA countries and with its neighbors' countries.

Sanitation coverage at world level is 59 percent in 2004. In SSA country the average sanitation coverage is 37 percent. When we come to Ethiopia case, the sanitation coverage is 11.5 percent which is again the lowest as compared to SSA and other neighbors' country like Uganda (60%) and Kenya (48%). The problem of water supply and sanitation become more sever in Ethiopia when we compare the water supply and sanitation coverage in terms of urban and rural area. At World level, water supply and sanitation in rural area was 73 percent and 39 percent in 2004. In the same years, in urban area, they were 95 percent and 80 percent respectively. In SSA countries also water supply in urban area was 80 percent as compared to 42 percent in rural area. In the same way sanitation coverage was 53 percent as compared to 28 percent in rural area. In Ethiopia also in 2004, 83 percent of the urban people were access to water supply as compared to 31.4 percent in the rural area.

Table 2: Water supply and sanitation coverage in selected countries, 2004
In percentage

Country	Water supply coverage				Sanitation coverage			
	National	Urban	Rural	Urban rural Gap	National	Urban	Rural	Urban rural Gap
Kenya	62	89	46	43	48	56	43	13
Uganda	60	84	56	28	60	71	58	13
Ethiopia	39.4	83.1	31.4	51.7	11.5	49.7	3.9	45.8
SSA	56	80	42	40	37	53	28	25
S.E Asia	82	89	77	12	67	81	56	25
Latin A	91	96	73	23	77	86	49	37
World	83	95	73	22	59	80	39	41

Source: JMP[4], 2006 and AFRIC MDR- Report 2006

[4] Joint Monitoring Program conducted by UNICEF and WHO.

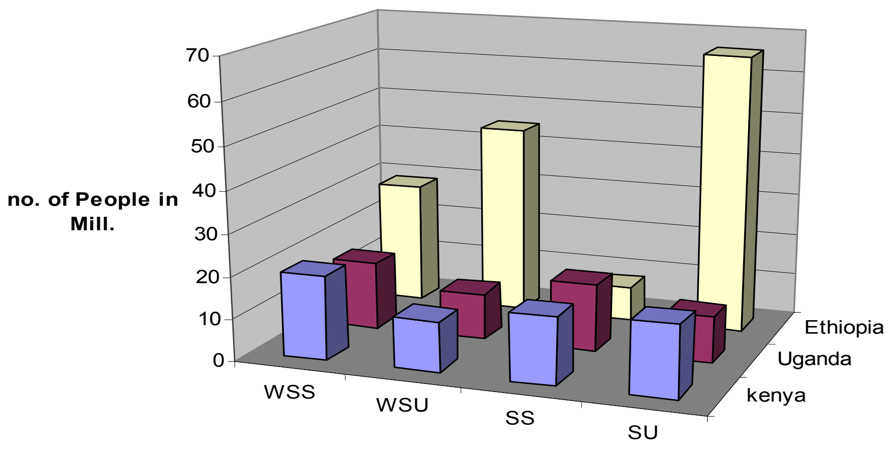
In terms of sanitation, the rural area also only 3.9 percent people got sanitation as compared to 47.7 percent. Sanitation facilities coverage of Ethiopia is one of the lower in the world. Here we can see common characteristics at World, SSA and Ethiopia in terms of urban and rural disparity in both water supply and sanitation. But what make us surprising in Ethiopia case is the magnitude of urban and rural inequality varies high as compared to other countries. As you can see in Table 2 above, Ethiopia urban and rural water supply gap is 51.7 percent as compared to World (22%), SSA (40%), Uganda (28%) and Kenya (43%). Sanitation coverage also shows the high inequality between urban and rural. In Ethiopia the gap is 45.8%, which is the highest as compared to world (41 percent), SSA (25%) and Kenya (13 %).The lower gap in Africa does not indicate that the rural area is more privileged as compared to the other part of the world.

This happen because we compared the relatively lowest coverage of urban area with the same lowest level of rural area. To come to my point in addition to lower water supply and sanitation in Ethiopia, the urban and rural inequality in terms of access for water and sanitation varies high in the country as compared to the rest of world countries.

When we observe in terms of number of people access for water, around 20 million and 16 million people are access for pure water in Uganda and Kenya respectively in 2004. In the same year, the number of people who access to water supply is 29 million. It is much more than Kenya and Uganda. When we came in to those people who are not able to get water supply, in Ethiopia around 45 million people are not access to water supply. But in Kenya and Uganda the number of people who do not access for water supply is only 11 million and 12 million respectively. As you can see in Figure 1 below, the number of people who do not get water supply in Ethiopia is 95 percent higher than the sum of number of people who do not get water in both Kenya and Uganda.

In terms of sanitation also around 66 million people not access for sanitation facility as compared to Kenya (17 million) and Uganda (11 million).Hear the total number of people who do not have access for sanitation in Ethiopia more or less equal to the total number of people in Kenya and Uganda. This implies that Ethiopia problem of water supply and sanitation is much more than any other developing countries. In addition to this, as you can see in the figure above, the number of people with access to safe water supply is exceeded the number of those with sanitation facilities. While safe water coverage is catching up with population increase, sanitation coverage is slipping (see also section below). This is partly because community expresses a higher demand for water and there are more skilled people and option available for providing water as compared to sanitation.

Figure 1: Served and unserved water supply and sanitation number of people in selected countries



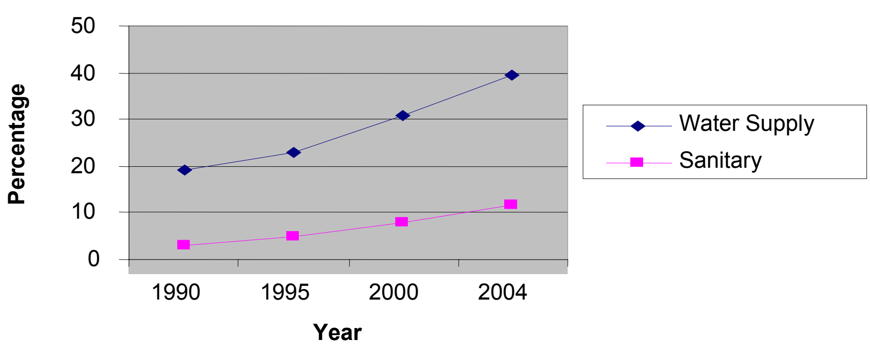
WSS: water supply served *SS: Sanitation served*
WSU: water supply unserved *SU: Sanitation unserved*

6. Trends of water supply and sanitation coverage

Looking at the trends of water supply and sanitation coverage will helps us to understand the performance of water supply and sanitation coverage during the last decades. Hear we will see the change of the water supply and sanitation coverage during 1990 to 2004. This trend can be seen the change of water supply and sanitation coverage over the years and also in terms of the number of peoples served and unnerved for both water supply and sanitation. In 1990 the water supply coverage was 19 percent at the national level. After five years the national water coverage increased to 23 percent. It increased only by 21 percent between 1990 -1995. In 2000 the water supply coverage reached 30.8 percent (34 percent increase).The performance is 13 percent higher than the earlier five years. In 2004, the water supply coverage reached to 39.4. In this year, the water supply increased by 28 percent. It is lower than the performance of water supply coverage before five years.

In 1990 the level of sanitation is 3 percent that mean 97 percent of the people could not get the sanitation facility. After five years the sanitation coverage increased from 3 percent in 1990 to 5 percent in 1995. In 2000 the sanitation converge reached to 8 percent. It increased by 60 percent as compared to the year 2000. In 2004 the coverage reach it 11.5 percent. In these five years also there is no significant change of the sanitation coverage. In the last 14 years the average increase of sanitation is only by 2 percent. The gap between sanitation and water supply are very high. The coverage of sanitation is much more less than the coverage of sanitation. The reason is the absence of effective policy and regulation. In addition to this, the other reasons is the absence of coordination between the government, private and beneficiaries sectors in providing water supply and sanitation facilities. In Ethiopia well coordinated sanitation policy is developed just last year by bringing three government Ministries: Ministry of water, Health and Education. Before, there was no any kind coordination between these ministries to provide sanitation service in the country.

Figure 2: The Trends of Water Supply and Sanitation in Selected Years



Source: CSA various publication

When we see in terms of number of people served and unserved people, in 1990, the number people served by water supply and sanitation was 5.1 million and 1.4 million respectively. In the same year the unserved people was 38.9 million water supply and 46.6 million sanitation service. After five years, the water supply increase to 12.6 million and the sanitation coverage increased to 52.3 million. After five years that is in 1995, the number of people served by water supply increased by 7.5 million and sanitation increased by 1.3 million. In the same way the unserved water supply and sanitation number of people also increased by 3.4 million and 5.6 million respectively. In terms of served number of people the increase number of water supply served people increases than sanitation. In other side the number unserved sanitation people increase higher than the number of unserved water supply served people.

In 2000, the total served water supply coverage reached to 19.1 million and unserved people also increased to 44.5 million. As compared to 1995, around 6.4 million new people served and 2.2 new unserved people. In terms of sanitation also 2.3 million people new served and 6.3 new unserved people after five years. The increment in unserved people is higher than the number of new served people. In 2004, the served and unserved water supply reached to 28 million and 43.1 million. In the same year, the sanitation served and unserved people reached to 8.1 million and 62.9 million respectively.

Table 3: Trends of number of people who served and unserved of water supply and sanitation in selected years ‘000

year	Water supply				Sanitation			
	Served people	New served	Unserved people	New unserved	Served people	New served	Unserved people	New unserved
1990	9129	-	38921	-	1441	-	46609	-
1995	12663	3534	42393	3472	2752	1311	52303	5694
2000	19112	6449	44596	2203	5096	2344	58611	6308
2004	28033	8921	43117	1479	8182	3086	62969	4358

Source: Joint Monitoring Survey 2004 and CSA

7. Source of water supply and types of sanitation facility

There are various source of water supply which in general classified in to two parts: protected (safe) and unprotected (unsafe) source of drinking water supply. According to World bank, protected source of water supply include piped water into dwelling plot or yard, public tap, tube well (borehole), protected dung well, protected spring and rainwater collection. Unprotected include unprotected dung well, unprotected spring, cart with small tank (drum), bottled water, tanker truck and surface water (river, dam, lake, pond, stream, canal and irrigation channels).According to Central Statistical Agency of Ethiopia, five sources of drinking water are identified which are known as own tap, public tap (bono), protected well/spring, unprotected well/spring and river or lakes. The first three are assumed to supply safe water and the last two are classified as unsafe source of water. This study is based on CSA (Central Statistical Agency) classification of source of water supply. There also two types of sanitation services which are known as on site and off site sanitation. In this study we focus more on site sanitation.

7.1 National source of water supply

In 1996, 67.2 percent of water supply was from unprotected source of water supply. As explained before unprotected source of water include rivers, lakes and unprotected well/spring. From unprotected source of water in this year, 48 percent of source of water came from rivers and lakes. Only 19 percent of water provided from protected well/spring. In this year 19.1 percent source of water was from protected safe source of water supply. The high share of safe water came from public tap. It is around 11.4 percent. Protected well/spring and own tap source of safe water supply take 5.5 and 2.2 percent respectively.

In 2000, the unprotected source of water coverage increased from 67.2 percent in 1996 to 72% percent .In the same way the safe source of water increased from 19.1 percent to 27.9 percent between 1996 and 2000. The unprecedented even is the increase of both source of water supply. The major reason is the higher increase of population growth as compare to the provision of safe water in the country. In other word lower growth of pure water supply as compared to the demand of the people who need protected water supply. But after four years, in 2004, the source of unprotected water supply highly declined from 72% in 2000 to 63.9 percent. Even in this year, from unprotected source of water, the share of lake and river substantially declined by 52 percent as compared to in the 1996. In contrast to this the share of the protected well/spring increased by 90 percent as compared to before eight years. This may be happen due to draying and pollution of river.

Table 4: Percentage distribution of household by source of drinking water in 2004 at national level

Source of drinking water	1996	1998	2000	2004
River, lack	48.2	43.5	33.9	27.8
Unprotected well/spring	19.0	28.5	38.1	36.1
Unsafe water	67.2	71.7	72	63.9
Protected well/spring	5.5	10.2	13.5	12.9
Public tap	11.4	10.8	13.5	18.8
Own tap	2.2	2.7	3.3	4.2
Safe water	19.1	23.7	27.9	35.9

Source: CSA, 2000 and 2004 Welfare Monitoring Survey

Note: There is “other source” of water supply other than the source of water supply category identified in the above table. In 1996 and 1998 the value of this source of water supply was 13.7 and 4.6 respectively.

In other side, in 2004 the source of safe water reached to 35.9 percent. All sub sources of safe water increased during the study period (1996-2004). But the growth rate of protected well/spring is not increased that much as compared to public tap and own tap. Though this safe source of water is less costly than the public or private tap water supply, the government could not utilize this source of water supply to solve the problem of water supply in the country. Even in terms of technology also it is not require more skilled persons and equipments like other sub sources of safe drinking water.

7.2 Urban and Rural source of water supply

There is no clear definition of urban and rural area. Most of the times urban and rural can be defined based on the provision of basic facility or the total population in the specific area. Here the study uses the total population to define urban and rural area. In Ethiopia urban refers to the area that has the number of people above 20000. The area that has less than 20000 considered as rural area. In 1996, the unsafe source of water supply takes 75.5 percent of water supply for the rural area. After eight years (in 2004), there is no significant change in the share of unsafe water source in the rural area. In this year the source of unsafe water supply takes 74.5 percent. The change is seen only in the types of unsafe source of water supply. In 1996, the water source in the rural area highly dominated by the rivers and lack. It took 53.6 percent of unsafe source of water supply. In 2004, the source of unsafe water supply shifted from river and lake to unprotected well/spring which takes 42.1 percent as compared to 32.4 percent of river and lack.

In urban area the source of unsafe water supply was 23.1 percent in 1996. This source of water supply highly decline to 7.6 percent in 2004. The unsafe source of water supply decline by 67 percent unlike to the rural area which decline only by 0.7 percent. In urban area, in addition the decline in unsafe source of water supply, the contribution of river and lake as source of water supply decline from 18.1 percent in 1996 to 3.1 percent in 2004. It declined by 83 percent as compared to 40 percent decline of lakes and river in rural area in the same years.

9.6 percent share of safe water in rural area at the beginning of the study years increased to 25.2 percent at the end of the study year. That means the safe source of water supply increased by 162 percent during the study years. From safe source of water, protected well/spring increased from 5.3 percent to 14.4 percent in the same period. That is 171 percent increment during the study years as compared to own and public tap which increased by 142 % and 500 % respectively.

Table 5: Percentage distribution of household by source of drinking water in the rural and urban areas

Source of drinking water	1996		1998		2000		2004	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
River, lack	53.6	18.1	49.5	7.0	38.9	4.5	32.4	3.1
Unprotected well/spring	21.5	5.0	32.2	4.1	43.9	3.7	42.1	4.5
Unsafe water	**75.1**	**23.1**	**81.7**	**11.1**	**82.8**	**8.2**	**74.5**	**7.6**
Protected well/spring	5.3	6.4	10.1	10.1	11.6	7.9	14.4	4.7
Public tap	4.2	51.4	3.6	54.1	5.3	62.1	10.2	64.4
Own tap	0.1	14.3	0.0	18.1	0.2	21.7	0.6	23.3
Safe water	**9.6**	**72.1**	**13.7**	**83.5**	**17.1**	**91.7**	**25.2**	**92.4**

Source: CSA, 2000 and 2004 Welfare Monitoring Survey

Note: The sum of safe and unsafe source of water supply in 1996 and 1998 is not 100. Because the remain amount represented by other source of water supply which is out of the above categories of source of water supply.

In other side the contribution safe source of water supply is very high in urban areas as compared to the rural areas. In 1996 this source of water supply took 72 %. This share increased to 92.4 percent in 2004. It increased only by 28 percent, as compared to 162 percent increase of safe source of water in the same year in rural area. This performance is seen due to the higher growth of the public and own tap in the urban area. Both source of safe water supply increased from 51.4 percent and 14.3 percent in 1996 to 64.4 percent and 23.3 percent in 2004 respectively as camper to rural area it is less costly to provide safe tap water in urban area than rural area.\that way in contrast to rural area the performance of urban tap water supply increased in the study area.

7.3 Regional wise source of water supply

Since the demise of the military government in the country in 1991, the current government delineated the country in to nine regional governments and two special administrations. These regions are Tigray, Afar, Amhara, Oromia, Somalia, Benshangul-Gumuz, Southern Nation Nationalities Regional State (SNNRT), Gambella and Harrari. The two special administrations are Addis Ababa and Dire Dawa.

As you can see in the table below, the three region: Benishangul Gumuz (72.62 percent), Amhara (71.73 percent) and Oromia (67.60 percent) water supply is from unprotected source of water supply. But share of the types of unprotected water source is different in each region based on the availability of river/lack and ground water. For instance in Benishangul Gumz which is the western part of the country with more number of rivers, the share of river as a source of water take 52.42 percent of unsafe water in the region. In other side in Amhara regional state which do not have the same number of river like other western part of the country, the source of unsafe water supply dominated by unprotected well/sprint. It takes 44.32 percent of the unprotected source of water in the region.

The other region (Hareri) and two special administrations (Addis Ababa and Dire Dawa) has low source of unprotected water supply for their people as compared to the rest of the regions in the country. In Hareri the unprotected water supply is 26.59 percent. In Addis and Dire Dawa, the unprotected water sources take 0.93 percent and 9.23 percent respectively in 2004. Harari region and the two special administration are more urbanize or much closer to the urban area as result the people in this region are not using more unsafe water source for drinking purpose. You can see in Addis Ababa the share of river and lake is only 18 percent of the unsafe source of water supply which is the lowest as compared to any other parts of the country.

Table 6: Regional wise distribution of source of water supply in 2004

Region	**River/ lake**	**Unprotected well/spring**	**Unprotected source of water**	**Protected well/spring**	**Public tap(bono)**	**Own tap**	**Safe source of water**
Tigray	23.68	22.25	**45.93**	19.23	29.49	5.27	**53.99**
Afar	35.70	15.72	**51.42**	4.17	36.83	7.57	**48.57**
Amhara	27.41	44.32	**71.73**	12.89	12.45	2.68	**28.02**
Oromia	29.20	38.40	**67.60**	11.45	17.699	2.86	**32.00**
Somale	31.87	29.14	**60.01**	6.72	29.62	2.64	**38.98**
Benishangul Gumuz	52.41	20.21	**72.62**	17.85	8.36	1.02	**27.23**
SNNRS	30.99	34.49	**64.48**	15.37	16.92	1.98	**34.27**
Harari	4.91	21.68	**26.59**	30.51	34.60	8.17	**73.28**
Addis Ababa	0.18	0.75	**00.93**	1.30	58.29	39.37	**98.96**
Dire Dawa	0.31	8.92	**9.23**	9.37	70.06	11.33	**80.76**

Source: CSA, 2004 Welfare Monitoring Survey.

When we observe the safe source of water supply distribution in the regional wise, the two special administrations, Addis Ababa and Dire Dawa has 98.96 and 80.76 in 2004 percent respectively. These two regions are more urbanized as compared to other region. Following these two administration Hareri region safe source of water supply take 73.28 percent. In Addis Ababa public tap and own tap together take 97.66 percent. Only 1.3 percent of safe source of water in Addis Ababa came from protected well/spring. In Dire Dawa (70.06 percent) and Hareri (34.60 percent public tap take high share of the safe source of water supply.

In other side, the safe source of water supply varies low in Benishangul Gumuz (27.23%), Amhara (28.02%) and SNNRT (34.27) as compared to the above region and the two special administrations. In these three regions we have different source of safe drinking water supply. In Benishangul Gumuz the high share of safe source of water supply is taken by protected well/spring which is 17.85 percent as compared to 8.36 percent of public tap and 1.02 percent of own tap.

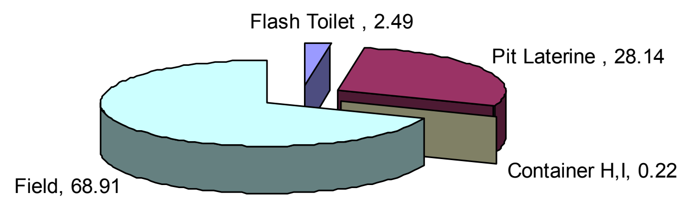
In other side in Amhara and SNNP regional states, the safe source of water supply dominated by both protected well/spring and public tap. These two sources of water supply take 12.89 and 12.45 respectively in Amhara as compared to 2.68 percent private tap. In the same way in SNNRS, protected well/spring and public tape take 15.37 percent and 16.92 percent as compared to 1.98 percent of private tap. These all analysis indicates that the private tap source of safe water supply is very low over all the country or regions. Public tap and own tap contributed only 23.3% and 0.6% for urban water supply in 2004 respectively. Here we can understand most people miss the benefit that can be obtained from private tap like saving more time and other cost as compare to using the public and protected well/spring source of water supply.

7.4 Types of sanitation facility in Ethiopia

Basic sanitation defined as access to and use of excreta and wastewater facility while at the same time ensuring a clean and healthful living environment both at home and in the immediate neighborhood of user. There are different types of sanitation that provide the service of wastewater management. It can be classified in to two parts: On sit sanitation (Pit latrine and septic system) and off site sanitation (sewerage system). On site sanitation characterize as disposal wastewater within the plot, toilet waste to subsurface dispassion system used for watering garden and trees. The off site sanitation is refers to collecting wastewater through a gravity collection system and conveying to STP. And treating the wastewater to remove pollutants in STP and disposing on land or into water bodies.

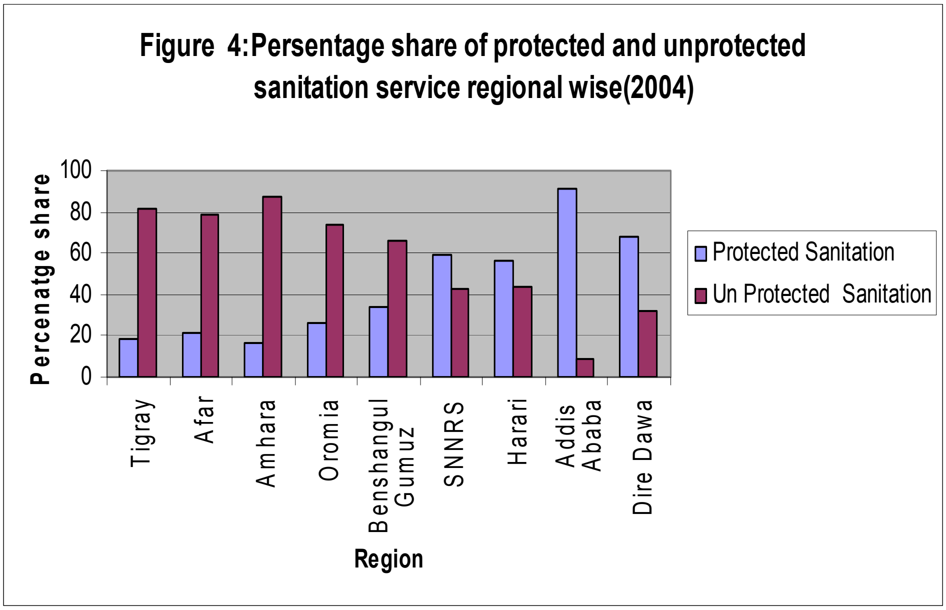
According to CSA, the sanitation (toilet facility), in Ethiopia classifies in to four parts. These are flash toilet, pit latrine, container or household material and field or forest. The first two sanitation facilities considered as safe and the other categorized under unsafe sanitation facility. The analysis in this section based on the CSA types of sanitation facility in Ethiopia. The highest share of sanitation facility in Ethiopia is field or forest facility of sanitation. As you can see in the figure below in 2004 the flash toilet services take only 2.49 percent of national sanitation facility. The other pit latrine and container or household items take 28.14 percent and 0.22 percent respectively in the same year. This indicates that unsafe sanitation facility took above 70 percent of sanitation.

Figure 3: Percentage share of different types of sanitation facilities in 2004



Source: CSA, 2004 Welfare Monitoring Survey.

Regional wise, except in Addis Ababa, in all other regional state the share of field or forest sanitation facility takes the high share of toilet service in the country. In Addis Ababa the field or forest facility share is only 6.95 percent as compared to 74.32 percent pit latrine and 16.93 percent of flush toilet. In Amhara regional state the share of field or forest sanitation facility takes 86.97 percent of toilet facility which is the highest as compared to the rest of the region. As you can see in the Figure below in Amhara regional state the percentage share of unprotected sanitation is 87.54 percent. Only 12.44 percent of sanitation facility is more protected sanitation facility. Following Amahra regional state, Tigray region is the other which has high share of unprotected sanitation (81.07 percent) as compared to the protected sanitation (18.86 percent). In contrast to this in Addis Ababa and Dire Dawa (the two special administrations) the share of protected sanitation is 91.25 percent and 68.11 percent respectively in 2004.



Source: CSA, 2004 Welfare Monitoring Survey

8. Water supply and sanitation policy in Ethiopia

Ethiopia is known as a tower of water in Eastern Africa. The total yield of groundwater was estimated to 26.1 BCM (Ethiopia water development report, 2006). In order to promote the level of water utilization we need clear water policy in general and specifically water supply and sanitation policy in the country. The water supply and sanitation policy began in Ethiopia during the First International Water Decade[5]. The military government during this time included the water supply and sanitation policy in its Ten Year Perspective Plan (TYPP) that was ranged between 1984/85 - 1993/94. The government planned to achieve the universal access for water supply and sanitation target at the end of the development year. However due to various reasons the policy could not achieve its own stated target. In addition to lack of financial and human resource, the central control administration system was the major reason for the failure of the policy during the military period.

[5] The First International Water Decade was between 1980-1990

Since the establishment of a Ministry for a water sector in 1995/96, a strategic and participatory approach has been introduced by bringing into place key sector reform initiative. The current government issued the water resource management policy in 1999. The main goal of the policy is to enhance and promote all national effort toward the efficient, equitable and optimum utilization of the available water resources of the country for significant socio-economic development on sustainable basis. The fundamental principles of the water resource management policy are:

- Water is a natural endowment commonly owned by all the people of Ethiopia
- Every Ethiopian citizen shall have access to sufficient water of acceptable quality, to sufficient basic human needs.
- Water shall be recognized both as an economic and a social good.
- Water resource is recognized both as an economic and a social good.
- Water resource development shall be underpinned on rural centered decentralized management, participatory approach as well as integrated framework.
- Management of water resource shall ensure equity, economic efficiency, system reliability and sustainability norms.
- Promotion of the participation of all stakeholders, user communities specially that of women's participation.

The sectoral part of the policy as incorporated specific issues on the area of water supply and sanitation, irrigation and hydropower. All the issues addressed in the policy are equally important. The water policy recognizes water right for basic need in view of fulfilling social equity. Rural communities have continued to be provided with safe water as long as they fully cover cost for maintenance and operation. For those living in urban centres unlike the rural area all the cost should be covered by the consumer.

In 2002 the government formulated the water sector strategy. This strategy is taken as an instrument to translate the Ethiopian Water Resource Management of the policy. The objective of the strategy is to translate the national policy in to action. To make it more specific, it sets the road map as how to make meaningful contribution towards: Improving the living slandered and general socio-economic well being of the Ethiopian people, Realizing food self-sufficient and food security, Extending water supply and sanitation coverages to large segments of the society, Generating additional hydropower, Enhancing the contribution of water resource in attaining national development priorities, and Promoting the principle of integrating water resource management.

Government of Ethiopia approved proclamation No. 268/2002, established a Water Resource Development Fund (WRDF) for channelling government budget resources and donor fund for the realization, expansion and development of urban water supply and sanitation system. Between 2002 and 2003 also the government conducted national water supply and sanitation master plan. Currently, the government undertook new institutional arrangement for implementation of water supply and sanitation policy. Decentralization, separation of regulation and service delivery and over all civil service reform are the major new arrangements that taken by the government. Decentralization has been implemented in two phases: first phase 1995-2001. Second phase started in 2002.

Water department (regional and local level) which was earlier responsible to provide water and sanitation to local people now is replaced by the water board. There are three types of water boards which known as urban, small town and rural water board. Ministry of water, Ministry of Health and Ministry of Education are responsible to realize the current government universal access water supply and sanitation.

9. MD Water Supply and Sanitation Target in Ethiopia

One of the targets of MDGs is to halve the shortage of water supply and sanitation at the end of 2015. Here the problem is which year is the base years for this target that agreed at millennium summit. Most people believed that 1990 is the base year for all Millennium Development Goals. It is difficult to accept this because the goals officially signed and accepted by the world leaders in 2000. Even if we accept 1990 as a base year, there is no enough data regarding water supply and sanitation and other social indicators. Due to this and other problems, most countries are using 2000 or the year after that as a base year to achieve the MDGs. In Ethiopia case we used 2004 as a base year due to lack of data and other problems to use the years before this year. The country MDGs need assessment also conducted based on this argument. Accepting 2004 as a base year, we will see in this section the number of people who will get the water supply and sanitation and also an infrastructure and financial resource that will be needed for achieving the water supply and sanitation millennium development goals.

9.1 Water Supply and Sanitation Target

Water supply coverage in Ethiopia context refers to the provision of water for the people between 20 to 25 lcpd (litter cubic per day) .This coverage addresses to the population with reasonable access to an adequate amount of water from an improved source, such as private or public tap, borehole, protected well /spring. The distance of water supply from home is within one kilometre according to World Bank definition of water supply coverage. The amount of water provision divided in to two periods. The first one is 20 lcpd amount of water supply from 2005-2010. The second parts is increasing water provision to 25 lcpd between 2010-2015.

Sanitation coverage is also defined as the percentage of the population with access to adequate (improved) sanitation facilities that is hygienically separated human excreta from human contact. We will have different definition in Ethiopia case for rural and urban people. The urban sanitation comprises storage, collection, transportation, treatment and aesthetic nuisance. At the same time rural sanitation refers to preservation of health of individual and community by carrying human excreta, animal and household wastes back to nature by providing comfort and convenience to users.

As you can see in the table bellow, the water supply coverage will be increase from 39.4 percent in 2004 to 70 percent in 2015. In terms of urban and rural area also the water supply and sanitation increased from 83.1 percent to 91.55 for urban and from 31.4 percent to 65.7 for rural in the same period.

Table 7: Millennium development water supply and sanitation coverage targets

Year	Water supply Coverage				Sanitation Coverage			
	national	urban	rural	No. of people access for water	national	urban	rural	No. of people access for sanitation
2004	39.4	83.1	31.4	28,002	11.5	49.7	3.9	7,703
2015	70	91.55	65.7	66,168	56	75	58	52,934
Expected No. of beneficiary				36,166	Expected No. of beneficiary			45,231

Source: Country MDGs need assessment report, 2005

In the same way the sanitation coverage will reach 56 percent at a national level in 2015 as compared to 11.5 percent in the base year. In urban the sanitation coverage will be increased by 25.3 percent. That means at the end of the MDGs, it will reach 75 percent. The rural area sanitation coverage will be improved from 3.9 percent to 58 percent at the end of MDGs[6].

[6] Currently the government set Universal Access Program for water and sanitation to achieve 100% of water supply and sanitation coverage in 2002.

In addition to the improvement in terms of coverage, it will be good if we see in terms of the total number of people who will be beneficiary by the end of the Millennium Development Goals. As you can see in the table above, more than 36 million new people will get water supply at the end of the plan. This comprise of 6,710,052 for urban and 31,207,090 for rural area. In the same way in terms of sanitation around 43.8 million new people will get basic sanitation.

9.2 Infrastructure[7]

Infrastructure of water supply and sanitation is one of the reasons that brought the shortage of water supply and sanitation in Ethiopia. In order to achieve the target set by the MDGs we need suitable new infrastructure facilities to access the stated number of people with basic water supply and sanitation. The types of infrastructure will vary based on the level of technology that we applied for the provision of water supply and sanitation service. Federal Democratic Republic Government of Ethiopia (FDRGE) reiterated in its water supply and sanitation policy documents to use suitable and local technology in provision of water supply and sanitation. The advantage of this approach is to bring sustainability of water supply and sanitation at the lower cost as compared to the earlier method.

There are three ways of intervention regarding infrastructure that required for water supply and sanitation. The first one is construction of new infrastructure, the second one is rehabilitation of the existed infrastructure and the last on is to conduct design in different part of towns in the country. The third intervention that is the study design will be conducted only at selected town (the selected town number is 909).As you can see in the Table 8 below, the number of new infrastructure that will be constructed during the coming ten years are 70,646. The rural area takes 99.5 percent of total constructions. The remains share around 0.5 percent of new construction will be taken by the urban area. In the same way the rehabilitation will be conducted for around 24,463 existed water supply and sanitation infrastructures. In this case also around 99.6 percent of rehabilitation will be conducted in rural area.

[7] Due to lack of data, in this study infrastructure refers to only different types of water supply schemes (spring development, Hand Dung well, shallow drill well and deep well drill).

Table 8: The number of new infrastructures construction target for water supply and sanitation.

Intervention	No. in Urban	Urban % share	No. in rural	Rural % share	No. in national
New construction	385	0.5	70,261	99.5	70,646
Rehabilitation	101	0.4	24,362	99.6	24463
Study design	909	100	-	0.0	909

Source: MDGs- Need Assessment Report, 2005

When we see the number of latrine required up to 2015, the Need Assessment Report said that around 6,020,964 total latrines in needed in Ethiopia to half sanitation problem. Out of these latrines, 87.1 percent allocated for rural area and 12.9 percent urban area. The distribution of new construction and rehabilitation of an infrastructure are more biased toward rural area than urban area. More than 99 percent of these interventions will be undertaken in the rural area. It is because of low coverage and poor infrastructure of the rural area that in force the government to give more attention in this area.

9.3 Types of rural water supply infrastructure

As it is said above more than 99 percent of new infrastructure constructions and rehabilitation will be take place in the rural area. Less than one percent of new construction and rehabilitation goes to the urban area. To understand in detail about rural new infrastructure construction and rehabilitation of infrastructure schemes, let us see the types of new constructions and rehabilitation from 2005 to 2015. There are four types of schemes that will be expected to provide water supply in rural area. The water schemes are known as: spring development, Hand Dung well, shallow drill well and deep well drill. The hand dug take the high share of new construction of the scheme. It takes around 52 percent of total construction. The other schemes, spring development, shallow drill and deep well drilling take 8 percent, 19 percent and 11 percent respectively in the coming 8 years.

The lowest share is taken by the deep drill. This scheme requires more technology and equipment as compared to other types of schemes. Directly or indirectly its cost will be higher than other schemes and this reduce the sustainability of water supply in the rural area. The other which takes the lowest share following deep drill is the spring development. This scheme is less costly but the quality of water provision by this scheme not secure as compared to other schemes. It is highly open for various types of water pollution. The scheme that takes the high share of new construction of water infrastructure is hand dung drill. It is better than all other scheme in terms of providing sustainability water supply in the rural area. Hand dung well is preferred source of water supply because it is relatively less expensive and provides a good basic service. That is why it takes more than half of total new construction in the country for the coming ten years. The disadvantage of this scheme is that it is subjected to going dry in dry season.

Table 9: Types of rural water supply schemes (new infrastructure construction) that will be constructed in the coming ten years

Types of New construction	2005	2010	2015	total	Total % share
Spring Development	603	793	1865	12669	18
Hand Dung well	1681	2216	1866	36424	52
Shallow drilled well	650	824	1867	13727	19
Deep will drilling	349	460	1868	7441	11
Total	6559	8113	10459	70261	100

Source: MDGs-NAR, 2005

In addition to the above infrastructure construction, in order to meet the propos target, there are a number of goods and service needed to realize the Millennium Development Goals of water supply and sanitation. Goods refer to different kinds of equipment and tools required for the provision of water supply. Service refers to the provision of various training and other facility for human capacity development in parallel to the construction of water supply. The number of new scheme construction highly increase in the second five years of the development plan. As you can see in the Table 9 above, it was 6559 scheme at the beginning of the plan year (2005), but it would increase to 10,459 at the end of the plan year (2015). That means in the second five years (2010-2015) around 2346 new construction of infrastructure would be undertaken as compared to 1554 new construction infrastructure in the first five years period (2005-2010).

9.4 Water supply and sanitation cost and source of finance

One of the important factors that facilitate the success of MDGs water supply and sanitation is the financial capacity of individual country. Especially for developing countries whose per capital income vary low, financing water supply and sanitation is highly challenging or the major constrain to realize their objectives. We must know the amount of finance required and the source of financing for smooth implementation of MDGs in the country. As you can see in the table below the cost required for water supply is around 2.6 billion USD. 1.6 billion USD allocated for rural area and 0.9 billion USD allocated for urban water supply. The remaining 0.1 billion USD allocated for federal level intervention. Federal level intervention includes ground water assessment in the country and other research and development activities. As you can see in the table below, the high share taken by rural water supply, that is 60 percent of total cost allocated for water supply 39 percent of the total cost allocated for urban water supply.

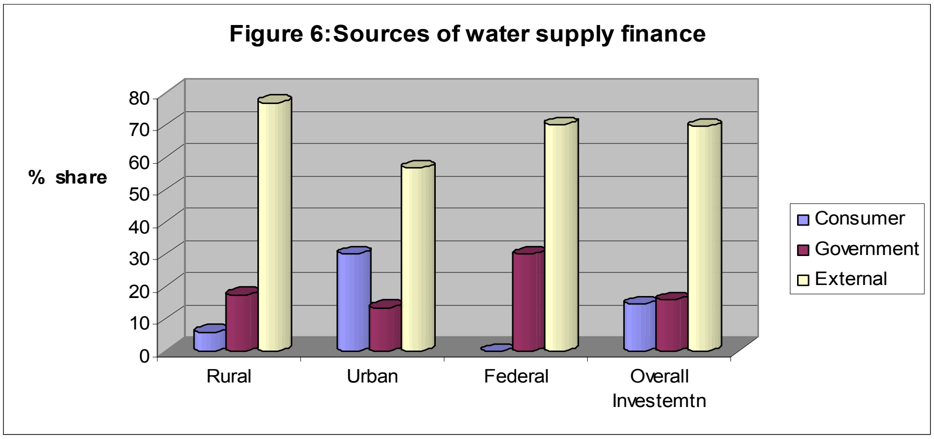
Table 10: Summary cost of water supply and sanitation ‘000,000 $

Description	Water supply		Sanitation	
	Total cost	**% share**	**Total cost ‘in mil.**	**% share**
Rural water supply	1.6	61.5	0.1	3.1
Urban water supply	0.9	34.6	3.1	96.9
Federal level intervention	0.1	3.9	-	-
Grand total	2.6	100	3.2	100

Source: MDGs-NAR, 2005

In terms of sanitation also, the total cost required is 3.2 billion USD. Around 96.9 percent is for urban sanitation provision and the smallest percentage share that is 3.1 percent for provision of rural sanitation service provision. After determining the amount of cost required for water supply and sanitation to meet the millennium development goal, the next challenge is to know the source of finance for the stated cost. In general we have three source of finance. The first one is government budget that depend on the treasury capacity of the country. The second one is the consumer finance. This is based on the willingness of the consumers to pay for the service they received from government or any provider agent. The last one is the external source of finance. In this case the source of finance came from multilateral or bilateral institution. These sources of finance may come through aid or loan. When we see the water supply finance in Ethiopia, around 69.43 percent of the finance came from the external source. The remains share of 15.97 percent and 14.61 percent came from government and consumer respectively. These sources of finance distribution indicate that Ethiopia water finance is more dependent on external aid who may affect the smooth implementation of the water supply project.

Regarding sanitation, around 78.8 percent of the total cost covered by the private finance. 21.2 percent taken by government or donors. When we compare each source of water supply and sanitation finance, the share of government finance is very low in sanitation provision. In other side in the rural area around 86.3 percent of the finance covered by the private household as compared to 77.1 percent in urban area that covered by household. In the same way government covered 22.9 percent in urban area and 13.7 percent in rural area by government. The source of financing that was prepared by the government in the need assessment completely in contrast to the national water supply and sanitation financing strategy.



Source: MDGs-NAR, 2005

A number of time government policy document stetted that the level of government finance will be minimal in urban area than in the rural area. Because it is believed that the ability to pay in urban area is much more than the rural area in the country. In the urban are the government provide credit facility than direct finance. But in the rural area due to lower capacity of the rural people, in addition to providing the credit, the government cover most parts of sanitation facility. Especially the hygiene promotion full covered in the rural area. The good side of this source of financing is the level of private involvement is very high that may promote sustainability of sanitation provision.

Table11: The source of fiancé for sanitation provision up to the end of MDGs

Source of finance	rural	% share	Urban	% share	Total	% share
Private	6,511	86.3	25,254	77.1	31,765	78.8
GOE/Donors	1,032	13.7	7,491	22.9	8,523	21.2
Total	7,543	100	32,745	100	40,288	100

Source: MDGs-NAR 2005

10. Challenges to meet the MDGs water supply and sanitation

The world leaders including the private sector and NGOs focus to implements the reduction of water supply and sanitation problem by halve in the coming ten years. Ethiopia is one of the countries who currently performing a number of activities to realize these water supply and sanitation target of MDGs. The success of the country to achieve these goals may encounter a number of challenges. Sustainability of water supply and sanitation project, lack of financial and material resource, more dependency on foreign resource (aid or loan), lack of the necessary skilled personnel and lack of awareness regarding the government rule and regulation on water supply and sanitation are the major challenges that would faces the country to realized its millennium development targets of water supply and sanitation.

The symptom of Sustainability of water supply and sanitation is seen by the non functional of water supply project or scheme in the country. Based on the survey conducted in 1996, by the Ministry of Water Resource, the average non functionality of water supply was 26 percent. When we look the emerging region where the coverage of water supply is low, the percentage of non functionality was 67 percent (Benishangul Gumuz). That means in this region half of the work that will be performed in the coming years will be out of work. The other challenge is the lack of financial and material resource. The study revealed that the country source of finance more dominated by external source (especially for water supply).Due to delay in disbursement of external fund and other absorptive capacity problem we may not use all aid and loan that we would get. This highly affects the progress of water supply and sanitation.

In regard to material resource, the government reiterated to use local material, but the problem is which local material, who is responsible for providing these material and what will be the technology level of the material application not specified clearly. In addition to this all the expected material may not available everywhere in the country. The place where the materials are not available, the implementation of water supply and sanitation can not be conducted, which may highly affect the national progress.

Not at the woreda level, even at the federal level, the level of manpower shortage is vary high in Ethiopia. Only 826 positions filled at the federal level out of the 1234 total position. That means around 411 positions is vacant (33% percent of total position).In the some way at wereda and zonal level we may get the woreds/zones which do not have single water professional. Water resource office in Hitosa woreda has one part time staff member, when it should have 11 staff. In Arsi Zone, there are no staffs as they have all been sent to woreda level (WtaerAid Ethiopia,-national water sector assessment). This shortage of skilled person or professional may affect the smooth performance of the water supply and sanitation target. The other one is the lack awareness regarding the rule and regulation of recent water supply and sanitation. We should not invite private sector and NGOs for policy preparation only. We have to use them also in awareness creation for the new implemented policy. Water storage capacity also other problem that may hamper the success of the water supply and sanitation in the country. Water storage capacity per person is often cited as a proxy to water security and measures of large and small scale water infrastructure development.

11 Conclusion and Recommendations

11.1 Conclusion

Ethiopia is the country which has lower level of water supply and sanitation. In 2004 the water supply and sanitation coverage was 39.4 and 11.5 percent, which is the lowest even as compared to the average of SSA water supply (56%) and sanitation (37%) coverage. The source of water supply is highly dominated by unprotected source of water supply that is 63.9 percent in 2004.Protcted source of water supply took only 35.9 percent. In the same way most people use field/forest for sanitation facility (69%). Only 31 percent of the people who use pit latrine and flush toilet. The government could not provide enough water supply and sanitation during the last decade.

In order to bring the country at least with equal feet of other developing country water supply and sanitation coverage, the government of Ethiopia accepted the Millennium Development Goals and also incorporated it in its national development strategy (APSDEP). In addition to this, the MDGs need assessment has been completed in 2005 for water supply and sanitation. In the coming ten years, the water supply and sanitation coverage will increased to 70 percent and 56 percent respectively. In terms of number of people, around 36 million people they will get water supply and around 45 million people also they will get the sanitation service. About 70,646 new water supply schemes and 6 million latrines will be constructed to achieve the millennium development goals of water supply and sanitation. In addition to these around 24,463 number of water supply scheme would be rehabilitated. Around 2.6 billion USD and 3.2 billion USD required for water supply and sanitation target.

Regarding the source of water supply finance, 15.97%, 14.61% and 69.9% came from the government, consumers and external source. In the case sanitation also the source of finance came from government/external and consumer. The former source of finance takes only 21.2 percent and the latter take 78.8 percent.

Sustainability of water supply and sanitation project, lack of financial and material resource, more dependency on foreign resource (aid or loan), poor absorptive capacity, lack of the necessary skilled personnel and lack of awareness regarding the government rule and regulation on water supply and sanitation are the major challenge that will faces the country to realized its Millennium Development target of water supply and sanitation.

As a result it is very hard to achieve the MDGs in the country in the area of water supply and sanitation. It is mentioned before that we need quite breakthrough efforts to solve the above stated problems. In addition to this currently the government use its own new version of water supply and sanitation program (Universal Access Plan) which highly affects the targets of MDGs water supply and sanitation.[8] But in this regard the government official belief that the new Universal Access Plan is much better than the MDGs. However this plan is more ambition. For instance still we have coordination, preparation and implementation of water supply and sanitation project .Especially the absence of sustainable and demand driven water supply and sanitation technology highly hinder the expected performance of the government plan.

11.2 Recommendation

The first and the most important thing is the government should conduct or facilitate an intensive advocacy regarding the importance of water supply and sanitation for the livelihood of the people. In the same way the government should announce what are the new policy introduced to realise the provision of the water supply and sanitation. Once people are aware about the need for water supply and the government commitment in providing the transparent rule, regulation and policy strategy, it will be simple to achieve the target stated by the MDGs regarding water supply and sanitation.

[8] Ethiopia Universal Access Plan use completely different ways of defining of water supply coverage/access and the amount of water should be available for individual people per day. It is the matter of the argument that considered as a best option to solve water supply problem in the country.

The other problem is sustainability of water supply and sanitation. The government and NGOs should apply the local personal for the constriction of water supply and sanitation. The local people should involve from the beginning of the work. In that case they feel ownerships of the project. In addition to this the maintenance and operation cost should be covered by beneficiary. NGOs or government can facilitate the pricing and auditing skill for those woreda water committee members. Through these measures we have to promote the sustainability of water supply and sanitation scheme in the coming ten years.

The government should rely more on the internal source of finance. It is clear that the financial capacity of the country is vary low as compared to the problem we have in the country. The problem is to set up proper and strong institution that is responsible to mobilize water and sanitation fund. This can be done by putting proper pricing policy for rural and urban area. Even we have some rural area where people are willing to pay high price in order to save their time. Such kind of resource mobilization for water supply and sanitation enable the government to finance it project in the remote area. In addition to this there should be an effective utilization of the loan and aid we received from donor countries. Because our future aid or loan depend on our current absorptive capacity.

The other problem is lack of skilled personnel. In this regard the government should strength the current vocational training in the area of water supply and sanitation. This training will solve the shortage of water professional at the woreda or zonal level. In addition to this there would be an intensive training for regional or woreds water bureau workers regarding monitoring and evaluation techniques. Here the government should set performance based management which recognize and reward those people who works effectively. The last but not least is the government should promote the involvement of NGOs and donor organization in preparation and implementation of water supply and sanitation policy. This measure at least reduces the shorted of skilled personnel that we have in the sub sector.

References

Alan MacDonald (2005). Developing Groundwater, a fide for rural water supply, Ashford Colour press Limited, Gosport, Hants, U.K

Roberto Lenton (2005): Water and sanitation for the unserved poor.

_______ (2004): UNICEF Ethiopia newsletter, Vol.6. No.3

David Prodfoot et. al (2005): "Tackling the root of poverty" changing an NGO'S WATSAN programme to meet productive water need, Zimbabwe

______ (2006): People's Republic of china: Safe drinking water and sanitation for the rural poor Technical assistance consultant's report, Asia development bank, project number 36594, Metchalf and Eddy Ltd.

R. A. Hope et al (2003):The role of improved domestic water supply in livelihood and poverty reduction in Limpopo province, South Africa, International Symposium on water, poverty and productive use of water at the household level,21-23 January 2003,Muldersdrift,South Africa.

______ (2006) Unning Dry: The humanitarian impact of the global water crisis, IRIN, United nation

______ (2006):Draft paper of Financing strategy for water supply and sanitation sector, EU water initiative.

______ (2004): National water development report for Ethiopia, United nation educational, scientific and cultural Organization World Water Assessment program, Addis Ababa, Ethiopia.

______ (2006): Sector review report of Water supply, sanitation and hygiene Ethiopia, prepared for presentation to the first Multi Stockholder form 9th-13th October 2006.

Deassalgne Rahmato (1999): Water resource development in Ethiopia: Issues of Sustainability and participation, Forum for social studies, Addis Ababa, Ethiopia

______ (2005): making every drop count, Financing water sanitation and hygiene in Ethiopia, Water Sanitation and Hygiene for All, Addis Ababa, Ethiopia

Getachew Abdi (2006): The road towards achieving goal 7 of the MDGs in Ethiopia rural water supply and sanitation department, ministry of water resource, Addis Ababa, Ethiopia.

Joan Soussan (2003) poverty, water security and household use of water, International Symposium on Water, Poverty and Productive uses of Water at the Household Level, 21-23 January 2003, Muldersdrift, South Africa

Federal Democratic republic of Ethiopia (2005): Rural water supply and sanitation service, Universal Access program from 2006-2010, Ministry of Water Resource.

Federal Democratic Republic of Ethiopia (2005): Urban water supply and sanitation service, Universal Access program from 2006-2010, Ministry of Water Resource, A.A, Ethiopia

Federal Democratic Republic of Ethiopia (2005):Ethiopia MDGs Need Assessment Final Report on Water supply, Addis Ababa, Ethiopia

Federal Democratic Republic of Ethiopia (2005): Sanitation Millennium Development Goals Needs Assessment final report, , Addis Ababa, Ethiopia

______ (2005): WaterAid Ethiopia,-national water sector assessment

______ (2003): Draft white paper, department of Correctional Services, South Africa.

______ (2004): Final National Water Development Report for Ethiopia, United Nations Educational, Scientific, and Cultural Organization, Addis Ababa, Ethiopia.

AN APPRAISAL OF THE NILE BASIN INITIATIVE IN THE ALLEVIATION OF ETHIOPIA'S FOOD INSECURITY AND ENVIRONMENTAL DEGRADATION

Wondwosen Michago[1]

Abstract

The paper starts with the premises that the Nile River is the major economic promoter of the riparian states that are trying to cater the demands of the growing population and to secure food security. The Nile Basin Initiative, NBI, was established to eradicate poverty and promote economic integration. However, food insecurity and environmental degradation in the Ethiopian portion of the Nile Basin is at a critical condition both in its extent and severity. The picture is gloomier in the central and northern parts of the country where the Tekeze and Abbay River Basins are found. Hence, there is an urgent need to assess the NBI and its projects. The main reason is because the NBI investment projects are rapidly being prepared and they will be implemented in full swing soon. This will bring to the benefit of understanding ENSAP's role and actual prospects of promoting and achieving poverty alleviation, economic growth and the amelioration of environmental degradation in Ethiopia.

The main objectives of this study are to critically assess the present status of the Eastern Nile Subsidiary Action Programs (ENSAP) projects, particularly those projects that are directed to solve the problems of food insecurity and environmental degradation and also tries to examine the Nile Basin Initiative (NBI) and its contribution in addressing these problems and to make some prognosis about its future status. This paper has used both secondary and primary sources of data. Semi-structured and unstructured interviews with key informants, concerned persons and pertinent organizations are held.

The study also attempts to examine the correlation between food insecurity and environmental degradation. Alongside, it tries to see, in a nutshell, the dilemmas of different views that are engulfing the NBI's capacity and credibility in achieving food security and economic integration. The study found out that there are many positive

[1] Researcher, (MA in Development Studies), Ethiopian Nile Basin Dialogue Forum (EtNBDF), Email: wondpr@yahoo.com , Tel: 0911-452102

developments with some challenges. The ENSAP projects have immense potential to alleviate Ethiopia's food insecurity and environmental degradation, if implemented timely and properly. To date, there is a high spirit of cooperation among the Eastern Nile countries to implement ENSAP projects on the ground through fas- track approach, even if the projects are behind schedule and their expected outputs are yet to be realized.

1. Introduction

The Nile River runs through jungles, deserts and gorges providing life to more than 300 million people. It is the longest river in Africa and the second longest in the world, next to the Mississippi River. The Nile Basin covers the whole of Uganda, almost the entire cultivated and settlement areas of Egypt, one-third of Ethiopia, a substantial portion of the Sudan, and parts of Kenya, Tanzania, Democratic Republic of Congo, Rwanda, Burundi and Eritrea (Ibrahim, 1984). The basin area envelops one-tenth of the total area of Africa. It also covers one-third of the part of the ten Nile riparian countries that are inhabited by approximately half of population of Africa. The Nile has two main branches; namely, the White and the Blue Nile. It is a product of tropical environment, which flows northward into the Mediterranean Sea, its mouth, stretching over Lake Victoria and Lake Tana. It covers areas exhibiting varieties of topography, climate, vegetation and people over its diversified range of latitude and altitude (Ibid.).

The Nile River has been utilized to develop irrigation, power generation, water supply, fishing, tourism, flood control and water transportation (Naden, 1973). A basin wide cooperative endeavor on the Nile River has been undertaken for the last five decades. There were bilateral, multilateral and basin-wide collaboration attempts to form a community of co-riparian states (Okidi, 1979 cited in Waterbury, 1987). Waterbury (1987: 99) stated that the assumption behind the cooperation is that the "river basin constitute an economic and geographic whole, whatever the nature of state boundaries within it." Since 1960s, the Nile river has been the target of development planners and the downstream countries particularly Egypt has utilized the waters tremendously (Yacob, 1997).

It is known that water, the environment and food production are highly interrelated at the local, basin, regional and global level. Today, the Nile basin is a home of the world's most food insecure people. Its natural resources are also under a serious threat. As a result, the future of water availability for food production is highly uncertain (Rosegrant et al. 2002). The rate of environmental degradation is also frightening in the Nile Basin. The basin is facing annual rate of erosion ranging from five to twenty meters, and the area lost vary from few hectares to several hundreds of hectares (El Monished et al,1997 quoted in Ayenew, 2004).

The common vulnerability to environmental degradation and its resultant food insecurity has created interdependence among the basin people. Hence, to address the present and looming regional problems such as food insecurity and environmental threats, the NBI formulated environmental and irrigation projects. Therefore, to date much of the success of the NBI falls on its subsidiary programs of the regions, namely East Nile Subsidary Action Program (hereafter ENSAP) projects (Nicol, 2003).

There are lots of studies on the Nile River. However, only few are directly related to the NBI and its projects. Of these, most of the literature only focus on the simple descriptive aspect of the Shared Vision Programe, (hereafter SVP) and Subsidiary Action Program, (hereafter SAP). Many scholars wrote different books and articles regarding the hydropolitics, economic significance, geographic, social and civilization aspect of the Nile River. These studies are different in their approaches, emphasis, nature and scale of analysis. A number of authors also wrote on the NBI. But only a few researchers wrote on the NBI's projects, as they are recently launched programs. Besides, some of the projects are under preparations while others are under revisions. For this reason, almost nothing has done so far regarding the role the NBI/ENSAP project could play in alleviating food insecurity and environmental degradation in Ethiopia. This study, therefore, would like to fill this gap.

The main objectives of this paper are: to critically assess the present status of ENSAP projects, particularly those projects that are directed to solve the problems of food insecurity and environmental degradation in Ethiopia and to analyse the practicality or implementation aspects of NBI/ENSAP in addressing these issues and make some prognosis about its future status. Hence, much of the emphasis in this paper dwells on the Ethiopian portion of the Nile River basin. Besides, this will bring to the benefit of understanding ENSAP's role and actual prospects of promoting and achieving poverty alleviation, economic growth and the amelioration of environmental degradation in Ethiopia.

Figure 1: The Nile Basin

Source: NBI/NTEAP cited in NTEAP: 2005

This study predominantly depends on secondary sources as supplemented by primary ones. Semi-structured and unstructured interviews with key informants, concerned persons and pertinent organizations have been held[2]. The author held in-depth interviews with almost all ENSAP Regional Project Coordinators, particularly with those coordinators who are engaged in irrigation and environmental projects in Eastern Nile Regional Technical Office, (hereafter ENTRO). Attempts have also been made to enrich the data and information by interviewing the Egyptians and Sudanese who are working in the SVP project. All the three methods of open-ended interview, namely: standardized open-ended interview, general interview guide approach and

[2] However, it should be noted that there was over-reliance on the accessible Ethiopian informants due to the time, budget and location constraints.

informal conversational interview are used interchangeably. Whenever necessary, two or three of them at a time are also used depending on the type of data required and the importance of respondents. Besides, information drawn from library sources, the internet and the like has been used to fill in some gaps. Finally, the gathered qualitative data have been critically appraised, analyzed, elaborated by using descriptive methods.

The paper is organized into five sections. The second part deals about the portion of the Nile basin within Ethiopia, as this gives a background for the main part of the study. It then proceeds by reviewing the literature on the Nile, food security and environmental degradation. Section four critically appraise ENSAP projects and forward the findings. The last section winds up by making concluding remarks and plausible recommendations.

2. Background of the study area

2.1. Description of the Portion of the Nile Basin within Ethiopia

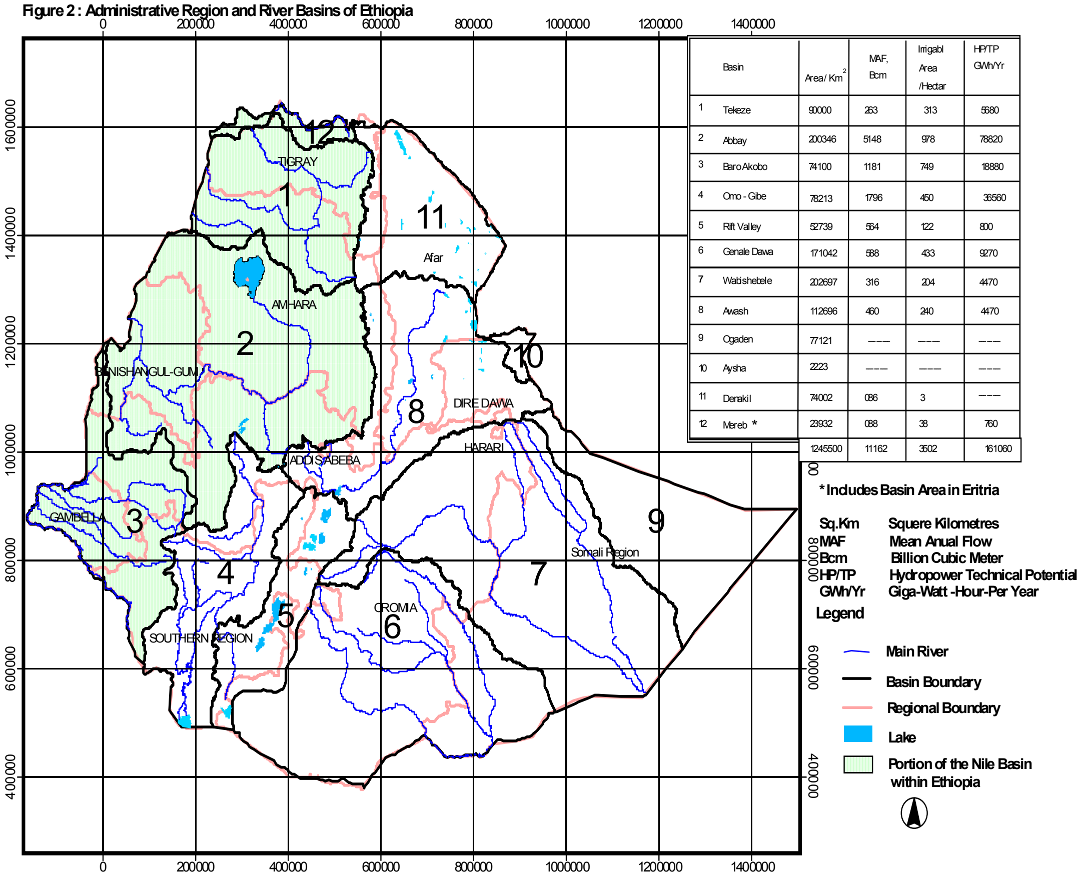
The Ethiopian portion of the Nile Basin consists of three major rivers, *viz*. the Abbay, Tekeze and Baro-Akobo, which originate from the central highlands, north-western and south-western of the country respectively, see the figure below. They cover a total area of about 358,889 km^2, which accounts to nearly 34% of the total geographic area of the country. They also serve as homes to about 40% of the country's population.

The total annual surface runoff of the three rivers is estimated at 80.83 billion cubic meters (hereafter bcm) per year, which amounts to nearly 74% of Ethiopia's 12 river basins. Besides, the three river basins have tremendous development potentials, including the development of irrigation agriculture (over 2 Million hectares) and hydropower generation (about 98,831 GWH/yr). They account for over 58% and 73% of the country's overall potentials in irrigation and hydropower developments respectively (NBI/ NTEAP, 2005).

These three major river basins cover six Regional States of Ethiopia, namely; Amhara, Tigray, Oromiya, Nations Nationalities and Peoples (hereafter SNNP), Gambella, and Benshangul-Gumuz with varying proportions. As it can be seen from Table 1, the Nile Basin within Ethiopia covers 38% of the total land area in Amhara, 24% of Oromiya, 15% of Benishangul-Gumuz, 11% of Tigray, 7% of Gambella and 5% SNNP Regional State (Ibid). Among the Regional States, Gambela and

Benishangul-Gumuz regions are entirely located within the basin, while considerable parts of the other regions fall under the basin[3].

Figure 2 : Administrative Region and River Basins of Ethiopia



	Basin	Area/ Km²	MAF, Bcm	Irrigabl Area /Hectar	HP/TP GWh/Yr
1	Tekeze	90000	263	313	5680
2	Abbay	200346	5148	978	78820
3	Baro Akobo	74100	1181	749	18880
4	Omo - Gibe	78213	1796	450	36560
5	Rift Valley	52739	564	122	800
6	Genale Dawa	171042	588	433	9270
7	Wabishebele	202697	316	204	4470
8	Awash	112696	460	240	4470
9	Ogaden	77121	----	----	----
10	Aysha	2223	----	----	----
11	Denakil	74002	086	3	----
12	Mereb *	23932	088	38	760
		1245500	11162	3502	161060

Source: Nile Transboundary Micro-grants Program, National Action Plan for Ethiopia, 2006

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[3] For instance, 93 out of 107 (87%) Weredas of the Amhara Regional State are covered by the Nile Basin; as are 31 out of 35 Weredas (89%) in Tigray Regional State (NBI/NTEAP, 2005).

Table -1: Areal distribution and relative proportions of the Nile Basin within Ethiopia

Regional States	Baro-Akobo Basin		Abbay Basin		Tekeze Basin		Total *(Nile in Ethiopia)*	
	Area (km^2)	% (Basin)	Area (km^2)	% Basin	Area (km^2)	% (Basin)	Area (km^2)	%
Gambella	26,062	34	-	-	-	-	26,062	7%
SNNPR	18,668	25	-	-	-	-	18,668	5%
Benshangul -Gumuz	7,412	10	44,699	22.37	-	-	52,111	15%
Oromiya,	23,770	31	62,474	31.27	-	-	86,244	24%
Amhara	-	-	92,639	46.36	45,237	54.39	137,876	38%
Tigray	-	-	-	-	37,928	45.61	37,928	11%
Total	**75,912**	**100**	**199,812**	**100**	**83,165**	**100**	**358,889**	**100%**

Sources: MoWR Master Plan: Abbay, 1999; Tekeze, 1998 and Baro-Akobo, 1997 and NBI/ NTEAP, 2005.

The following sections give a very brief description of the three rivers that flow within Ethiopia.

2.1.1 Tekeze Basin

Tekeze river basin is situated in the north-western part of Ethiopia and forms the northern most part of the Nile Basin within Ethiopia. It consists of three main rivers, as shown in Table 2, Tekeze itself, Angereb and Goange. These river basins join in the Sudan and form the Atbara River. Tekeze rises at an altitude of about 3,500 meter above sea level (hereafter m.a.s.l.) from *Meket* mountain range near Lalibela and flows north until it turns westward along the Ethio-Eritrean border and covers a whole distance of 600 km until it crosses the Ethio-Sudan border near Humera at an altitude of 550 m.a.s.l. It covers a total area of 82,350 km^2 within Ethiopia (exclusively in the Amhara and Tigray Regional States)[4]. About 70 % of the Tekeze basin lies in the highland part of Ethiopia, with a slope ranging from 1.5 to 3 % (MoWR Master Plan: Tekeze, 1998 and NBI/ NTEAP, 2005).

4 About 4,160 km^2 area of the Tekeze Basin is situated in Eritrea.

2.1.2 Abbay Basin

The Abbay river basin is situated in the north-central and western parts of Ethiopia. It forms a generally rectangular shape and extends for about 400 km from north to south and for about 550 km from east to west. It covers a total area of 199,812 km^2 within Ethiopia and has an average annual discharge of about 49.4 BCM (measured at Sudan border). The Dabus and Didessa that spring in Ethiopia are the largest tributaries of the Abbay River accounting for about 10 % and 8.5% of the total flow at the border respectively (see Table 2). The Abay basin originates from the centre of its own catchment around Lake Tana in the north. It develops its course in a clockwise spiral collecting its tributaries all along its nearly 1,000 km length from its source, to the south of Lake Tana up until the Ethio-Sudan border (MoWR Master Plan: Abbay, 1999 and NBI/ NTEAP, 2005).

2.1.3 Baro-Akobo Basin

The Baro-Akobo river basin originates in the western highlands at altitudes ranging from 2,000- 3,500 m.a.s.l. situated along the eastern part of the area and fall to the Gambella plain (450 m.a.s.l.) to the west. It covers a total catchment area of nearly 76,000 km^2 within Ethiopia. It accounts for an annual runoff of 23.24 bcm (about 21% of the country's total annual surface flow). It also has huge potentials for irrigation and hydropower. As it can be seen from the table below, the Baro-Akobo basin consists of four major rivers, namely Baro, Alwero, Gilo and Akobo. It runs through the Benishangul-Gumuz, Gambela, Oromiya and SNNP Regional States. The Baro-Akobo, also called Sobat after crossing the southern Sudan border, makes a confluence with other two rivers flowing from further south namely Albert River (Bahr El Jebel) and Bahr El Ghazal near Malakal in Sudan to form the White Nile collectively (MoWR Master Plan: Baro-Akobo, 1997 and NBI/ NTEAP, 2005).

Table 2: Major river basin and drainage basins/sub-basins of the Nile basin in Ethiopia

No.	Major river basin their drainage basins	Catchment Area (km^2)	Mean Annual Runoff (Bm3)	Remarks
1	Tekeze River basin (Total within Ethiopia only):	82,350		23% catch. area & 10.13% runoff of the Nile Basin in Ethiopia
1.1	Tekeze	63,376[a]	5.88	[a] 4,070 km^2 in Eritrea
1.2	Angereb	13,327	1.45	
1.3	Goang	6,694	0.86	
1.4	'*Feral*' Storm drainage into Sudan	3,113[a]	N.A	[a] 90 km^2 in Eritrea
2	Abbay River basin (Total)	199,812	49.40	55.8% catch. area & 61.12% runoff of the Nile Basin in Ethiopia
2.1	Anger	7,901	NA	
2.2	Beles	14,200	NA	
2.3	Beshilo	13,242	NA	
2.4	Dabus	21,032	NA	
2.5	Didessa	19,630	NA	
2.6	Dinder	14,891	NA	
2.7	Finchaa	4,089	NA	
2.8	Guder	7,011	NA	
2.9	Jemma	15,782	NA	
2.x	Lake Tana	15,054	NA	
2.11	Muger	8,188	NA	
2.12	North Gojam	14,389	NA	
2.13	Rahad	8,269	NA	
2.14	South Gojam	16,762	NA	
2.15	Welaka	6,415	NA	
2.16	Wombera	12,957	NA	
3	Baro - Akobo River basin (Total)	75,910	23.24	28.75% catch. area & 21.2% runoff of the Nile Basin in Ethiopia
3.1	Baro	30,004	12.78	
3.2	Akobo Upper	6,036	1.77	
3.3	Akobo Lower	7,209	2.12	
3.4	Gilo	12,815	3.22	
3.5	Alwero	8,019	1.38	
3.6	Serkole	7,702	1.32	
3.7	Tirmatid	2,690	0.42	
3.8	Pibor	1,435	0.22	
TOTAL (Nile Basin in Ethiopia)		**358,072**	**80.83**	

Sources: NBI/ NTEAP, 2005.
NA: Not Available

3. The problem of food insecurity and environmental degradation in Ethiopia

The following section attempts to discuss the status of food insecurity and environmental degradation in Ethiopia with particular emphasis in the Ethiopian portion of the Nile basin. Before getting into the discussion, it is appropriate to have a common understanding of food environmental problem by briefly discussing the concept and definition of food security and environmental degradation

3.1 Definitions and concepts

3.1.1 Food security

There are many definitions of food security without much change in the basic concept. Different scholars and organizations defined food security in various forms and levels. For instance, Maxwell and Frankerberger (1992) noted that there are about 200 definitions of the concept of food security (cited in Kifle and Yoseph, 1999). The World Bank defines food security as "access by all people at all times to sufficient food for an active healthy life" (World Bank, 1986 quoted in Kifle and Yoseph, 1999: 61). This definition is accepted by many organizations that are working in food related activities in Ethiopia (Kifle and Yoseph, 1999). The World Bank definition's basic components are the availability of food and the ability to acquire it (Wolde-Selassie, 2001). The United Nations (1990) also defined food security "as the ability of family members to guarantee themselves to a sufficient and quality of food for their active and healthy lives" (cited in Kifle and Yoseph, 1999).

Degefa (2005) noted that the concept of food security emerged in the early 1970s when famine and malnutrition were common phenomena throughout human history. Originally, stated the same author, the food security used to be understood from a supply point of view. Currently, food security as a concept has been addressed at the global, regional, sub-regional, national, community, household and individual levels. As a result, understandings differ depending on the level that one tries to address (Kifle and Yoseph, 1999). Kifle and Yoseph (1999) described three different components of food security. The first is *availability,* which refers to the capacity of producing food; the second one is *accessibility* to produced food and the purchasing capacity of the nation or the individual; while the third one deals with the essential *nutritional* requirement of the food for body growth and healthy life.

Here, it has to be noted that the concept of food self-sufficiency is different form food security. The former refers to an aggregate global, regional, sub-regional, national and local food production which is sufficient to feed the population. A country can be food self-sufficient but this does not mean that the country is food secure. The best example is India, a country which is able to produce sufficient food to feed its bourgeoning population and yet a significant number of its population remain food insecure. Today, much of the emphasis is on the household and individual level of food security (Kifle and Yoseph, 1999).

On the other side of the scale, we have food insecurity which refers to the deprivation of food. According to the World Bank, it can be defined as "lack of access by all people at all times to sufficient food for an active and healthy life" (Kifle and Yoseph, 1999). Theoretically, food insecurity could be categorized as transitory and chronic[5]. Transitory food insecurity is a temporary decline in a household's access to enough food. It is usually triggered by seasonal instability in food supply and production, fluctuation in prices and household incomes. In its worst form, it could lead to famine (Ibid). Chronic food insecurity, on the other hand, is a continuously inadequate diet caused by inability to acquire food. It often affects households that persistently lack the ability to either produce their own food or buy enough food (Ibid).

Ethiopia experienced, and is experiencing, both chronic and transitory food insecurity. The northern parts of Ethiopia which are usually known for their chronic food insecurity are mainly taken as synonymous with poverty. Besides, Desalgn (1998) noted that most rural people fail to meet their food requirements unless they produce their own food. In this case, food security is almost the same as food self sufficiency in rural Ethiopia.

3.1.2 Environmental degradation

It is known that different literature forwarded different conceptual definitions and terminologies in an attempt to understand environmental degradation. A wide range of definitions are used in different disciplines. In other words, different branches of science approach the subject from different angle and at times this leads to the misinterpretation of term. Having this in mind, the author tries to define some key terms and select those definitions which are relevant to this study.

[5] There are linkages between acute and chronic food insecurity. This is because unpredictable shocks do not suddenly lead to acute food insecurity unless people are already very poor and are chronically food insecure. Thus, chronically food insecure people are also represented in the acute category (FDRE Food Security Strategy, March 2002).

Conceptually, environmental degradation is defined as a depletion of environmental resources and their adverse effect on the natural support system of the living things especially the livelihood of mankind. It is also defined as the long term decline of productivity of the environmental resources. Stated differently, it is a deterioration both in quality and quantity of the environment in supporting floras and faunas. That is to say environmental degradation upsets the whole edifice of man-nature relationships. And this might lead to regional environmental insecurity among the riparian countries (Barber, 1984; Bennet, 1991and Renner et al., 1991 cited in Ayenew, 2004).

Land degradation is defined as a process that describes human and nature induced phenomena which reduces the actual and potential productivity of the land to support human life. Soil degradation[6] is also defined as a process of losing the current and/or potential productivity of the soil due to both human and nature-induced causes. Besides, in agricultural sense, soil degradation includes the declining of soil depth due to loss of fertile by erosion, loss of organic matter, collapse of soil structure, reduced infiltration, leaching of nutrients and reduction of biological activities in the soil (Blaikie and Brookfield, 1994; Oldeman, 1988; Stroosrijdr and Eppink, 1993 quoted in NBI/ NTEAP, 2005: 32-33). Soil erosion is a process of detachment and transportation of soil materials by geological[7] (natural) or human-induced (accelerated) actions. The human induced soil erosion such as loss of soil by runoff and causing on-site and off-site damages by forming gullies and filling of reservoirs with sediments (Hurni, 1985 and 1993; Lal, 1994; Stroosrijdr and Eppink, 1993 & Thomas et al, 1997 cited in NBI/ NTEAP, 2005)

While defining these terms, one can easily notice their superficial similarity though they are distinctively different concepts. In many literature, for instance, '*land degradation* and *soil degradation'* and *'soil degradation* and *soil erosion'* are taken as synonymous. In reality, however, land degradation refers to the broader system hierarchy than degradation of the soil, which constitutes only an aspect of the land degradation. On the other hand, soil degradation constitutes a higher meaning which encompasses more features than implied by soil erosion. In short, soil erosion is a subset of soil degradation, which is also a subset of land degradation.

[6] It may take six different forms: erosion by water (is a dominant cause of soil degradation in Ethiopian highland and in Ethiopian portion of the Nile Basin), erosion by wind, salination &alkalization, chemical degradation, physical degradation and biological degradation (Riquier, 1982 cited in NBI/ETEAP, 2005).

[7] The geological processes occur over a long time with the rate ranging between 0.1 to 1 mm/year almost without depleting soil productivity (Hurni, 1985 and 1993; Lal, 1994; StroosrijDr. and Eppink, 1993 & Thomas et al., 1997 cited in NBI/ NTEAP, 2005).

As it has been discussed above, the concept of food security is still debatable and seeks further study. The term food insecurity is also defined and used in many different ways in the literature, sometimes referring to food accessibility, availability and at the other times to its nutritional content. The specific definition of food insecurity that will be employed in this paper, unless otherwise stated, is the "availability concept of food at the national level." Similarly, in the context of this paper whenever the term environmental degradation is employed, it refers to land degradation (deterioration of landscape, overgrazing, deforestation, sediment deposition), soil degradation (in agricultural context) and soil erosion (accelerated water erosion), unless stated otherwise. Besides, though they are conceptually different theses three terms can be used interchangeably in this study. This is simply because of the complementarity nature of the words, their previous usage in many literature and the nature of this study, meaning the study focuses on how these problems are going to be addressed by NBI/ENSAP.

3.2. Food Insecurity in Ethiopia

Ethiopia's history has been marred by famine and drought. Both chronic and transitory food insecurity have been the hallmark of the country. Ethiopia faced more than three major famines at different times. These include the 1888/92, 1964/66, 1974, 1984/85 and 1994 famines (Kifle and Yoseph, 1999). Since the occurrence of the strongest famine in 1984, Ethiopia has been suffering from structural as well as transitory food deficits, requiring substantial food aid both in non-drought and drought years (Devereux, 2000). According to the government of Ethiopia, " food insecurity is one of the defining features of rural poverty, particularly in the moisture deficit northeast highland plateaus and some pastoral areas" (The FDRE Food Security Strategy, 2002). The reasons for the concentration of famine in the central and northeastern highland zones, which are mostly found in the Nile Basin, are three interrelated factors: population pressure[8], ecological degradation and climate change (Kloos and Zein 1988, Gutu, Lambert, and Maxwell 1990, quoted in Webb et al, 1992).

Although the causes of food insecurity both in greater Ethiopia and in particular the Ethiopian portion of the Nile Basin are said to be similar, it has to be noted that there is no general consensus on the causes of food insecurity. Different authors forwarded

[8] The highland areas, which are homes to more than 88 percent of the population, have a population density in excess of 200 persons per square kilometer while the average density ratio at the national level was only 40 persons per square kilometer according to the 1989 estimation (Gryseels and Anderson 1983; and Hurni 1988, cited in Webb et al, 1992).

different causes of food insecurity[9]. However, it can be concluded that the root causes of food insecurity in Ethiopia in general and in the Nile Basin portion in particular are both man-made and natural factors.

It is argued that the unutilized water resources of the country's major river basins constitute the main reason for Ethiopia's food insecurity. For centuries, the agricultural sector showed a very low growth rate due to its high dependence on rain-fed agriculture. For example, Von Braun (1991) estimated that a 10% decline in rainfall below its long-term average reduces national food production by 4.4% (cited in Devereux, 2000: 4). It is believed that the immense potential of the Ethiopian Nile is enough to feed not only Ethiopia but also the Horn of Africa. Ethiopia, however, failed to use its water resources due to internal and external factors. While civil war, lack of finance, poor policy, and others account for the internal factors, the transboundary nature of the river, the Cold War politics and Egyptian influence are some of the external factors (Wondimeneh, 1997 ; Gebretsadik, 2000; Yosef, 2004 and Yacob, 1997).

3.3 Food Insecurity in the Portion of the Nile Basin in Ethiopia

Food insecurity is a common feature in the portion of the Nile Basin in Ethiopia. The Tekeze River Basin Integrated Development Master Plan Project of 1998 reported that 10% of the people in Tekeze Basin are considered rich[10], while 30% are middle-income and the rest 60% are poor or very poor (MoWR Master Plan, Tekeze, 1998). The report showed that food shortage affects all poor households as well as middle-income households, albeit in different degrees. Due to the similarities in socio-economic conditions in the Abbay river basin with that of the Tekeze river basin, the food insecurity situations in both sub-basins is believed to be similar, especially in the Amhara and Oromiya regions. A recent wealth ranking that has been conducted

[9] Food security analysts divided the cause of food insecurity in Ethiopia into tow major groups: the 'physical ecology cluster' and the 'political economy cluster'. The first one focuses on the adverse changes in climate and environment, population growth, drought, while the latter emphasizes on the policy-related as well as program implementation problems including inappropriate government policies, limited infrastructure and off-farm employment, weak market and institutional failures, the lack of political will and economical feasibility, inappropriate national water resources planning and implementation (Devereux, 2000).

[10] Applications of the degree of these classifications for stratification usually vary from place to place. A household is usually considered 'rich' if it can feed a family year-round and the household owns oxen and livestock. An average (middle-income) household can feed itself for most part of the year with 2-4 months' deficit, owns an ox or two and a few cattle or small ruminants. A poor household experiences 6-8 months' food deficit and manages the rest by reducing the number of meals per day, owns neither oxen nor livestock (MoWR Master Plan: Tekeze, 1998).

based on the local standards for 6 Weredas in Benishangul-Gumuz Regional State, which is entirely located in the Baro-Akobo and Abbay river basins, showed that 50-75% of the community members are food insecure (FDRE/MoWR, 1998, Benishangul-Gumuz Regional State, 2004 cited in NBI/NTEAP, 2005).

The number of food insecure people and the areal coverage of food insecure areas are always expanding. For instance, the Baro-Akobo river basin, which used to be considered better off than the other sub-basins, is reported to be equally experiencing food insecurity due to declining soil fertility, erratic rainfall, civil unrest, and other factors. Unfortunately, the continued expansion of farmlands through denudation of natural forests could not sufficiently feed the growing human population. As a result, the February 2005 Benishangul-Gumuz Food Security Program showed that the people in the Region suffered from food deficiency for a significant part of the year. The baseline survey of the same study result indicated that the towns of Sherkole, Kurmuk and Guba experienced food gaps of -59%, -50% and -33% respectively (NBI/NTEAP, 2005).

The above facts clearly show the degree to which the Ethiopian portion of the Nile Basin finds itself in chronic food shortage. Last year, a joint government and humanitarian partners appeal made it clear that 52% of the Nile Basin people are food insecure. Given this, they appealed for 55% of relief food requirement (refer to Table 3).

Table 3: Food Aid Beneficiaries and Requirements in 2005 by Region

No.	Region	Beneficiaries	Food Requirement (MT)
1.	Tigray	702,922	101,233
2.	Amhara	114,610	15,560
3.	Oromiya	682,755	90,409
4.	Gambela	49,500	5,502
5.	SNNPR	426,667	44,571
Sub-Total (1-5)		**1,976,454**	**257,275**
% of Total (1-5)		**52%**	**55%**
6.	Harari	6,605	736
7.	Somali	1,240,806	137,916
8.	Afar	544,478	63,471
9.	Dire Dawa	38,454	4,987
	Total	**3,806,797**	**464,385**

Source: A Joint Government and Humanitarian Partners Appeal, May 4, 2005, The Reporter, Vol. IX, No. 456, June 4, 2005, Addis Ababa, Ethiopia.

In short, due to high fluctuation of rainfall and other factors, domestic production in the country is difficult to feed its burgeoning population and we are having an average of more than five million people suffering annually. This fact clearly shows the scale of food insecurity problem in the country. This reminds Ethiopia to utilize its water resources if it wishes to remain food secure.

3.4 Environmental degradation in Ethiopia

The ecological crisis in Ethiopia is deepening from time to time. The highland part, which is severely degraded, constitutes about 45% of the total land area and supports about 85 % and 75 % of human and animal populations respectively. It produces nearly all of the staple and cash crops of the country. The Abbay, Tekeze and Baro-Akobo River Basins are found in the north, central and south-western highland parts of Ethiopia. The environmental degradation in these parts of the country is the concern of this paper. As is well known, the status of the environment in the Ethiopian portion of the Nile Basin is at a critical condition both in its extent and severity. Moreover, today, the rate of environmental degradation is reaching an unpredictable stage (Mortimore, 1998 and Shibru, 2000). For instance, the speed of deforestation, soil erosion and land degradation in Ethiopia is very high though its estimate is varying from region to region (Ayenew, 2004). According to Markos (1997: 79) quoted in Ayenew (2004), the estimated rate of deforestation[11] is “about 8,000 hectares per annum in the closed forest and 80,000 hectares per annum in the open forest.”

On the contrary, the afforestation rate in the 1980s was only 13,000 hectares per year, which was very low as compared to the rate of deforestation (Tesfaye, 2001 cited in Ayenew, 2004). If the rate of deforestation remains unabated, it might turn Ethiopia into a bare land that is devoid of natural forest. For instance, BBC warned that by 2020 Ethiopia could be the first country with no natural forest at all (cited in Ayenew, 2004). It is also noted that the remaining natural forest is found in the less populated regions of western and southern Ethiopia. On the other hand, stated the same author, the upper reaches of Tekeze and Abbaye basins, areas which are found in the central and highlands parts of the country, are completely deforested (Tesfaye, 2001 cited in Ayenew, 2004).

[11] It was estimated by different researchers and institutions that at the beginning of the previous century 40% of the highlands were covered by forests, but at the end of the 20th century only less than 3% are covered. It is also estimated that between 150,000-200,000 hectares per year are deforested in the natural forest (The Conservation Strategy of Ethiopia, 1997).

When we come to soil erosion,[12] the figure is also frightening. This is mainly due to the high slopes that range between 20 to 30 percent, which lead to accelerated soil erosion. For example, highland Ethiopia losses at the rate of 1.9 to 3.5 billion tons of top soil every year (The Conservation Strategy of Ethiopia, 1997). Constale (1984: XV) estimated that cropped areas lose on average 100 tons of soil per hectare annually and further noted that those poor croplands which are covered by less than 10 centimetre deep soil will increase five-fold by the year 2020 (cited in Ayenew, 2004:69). The Ethiopian Highland Reclamation Study made it clear that about 270,000km^2 of area, which is equivalent to half of the highland area are already significantly eroded. Of these, about 140,000 km^2 are severely eroded.

Furthermore, the study reported that around 20,000km^2 of agricultural land may not sustain any farming at all (cited in Ayenew 2004:80). In economic terms, the annual loss of soil erosion was estimated to be 10 to 30,000 millions of Ethiopian Birr (1Birr=8.7 $US at the time of study) while the depletion of nutrient was 600 to 8,000 Million Birr (Bojo and Cassells cited in The Nile Transboundary Environmental Action Project Micro-Grant programme, 2005:12). Likewise, the Conservation Strategy of Ethiopia stated that in 1990 Ethiopia lost 40 million Birr, which was approximately equal to 17 percent of the potential agricultural GDP, due to soil erosion (The Conservation Strategy of Ethiopia, 1997).

The major causes of environmental degradation both in Ethiopia in general and in the Ethiopian portion of the Nile areas are, among others, population growth, overgrazing, deforestation, poor agricultural practice, rural peoples' dependence on fuel wood, drought, and desertification. This can be easily grouped as manmade and natural factors, which are both a cause and effect of environmental degradation in the country (Tesfaye, 2001 and Ayenew, 2004).

3.5. Environmental Problems in the Ethiopian Portion of the Nile Basin

The situation of the environment in Ethiopia in general and the area where the Nile Basin portion is found in particular are the same. However, the picture is gloomier in the central and northern parts of the country where the Tekeze and Abbay Basins are found. The rate of deforestation, however, is relatively lower in the sparsely populated southern and western areas where the Baro-Akobo Basin is located. What is so

[12] It is estimated that in the highland part of Ethiopia about 35.4 percent of land has less than 35cm of soil depth while 18 percent only has less than 10cm depth (The Conservation Strategy of Ethiopia, 1997).

alarming in the Tekeze and Abbay Basins is not only the extent and severity of the soil erosion but also the rate at which environmental degradation is taking place. The large proportion of shallow soils is mainly found in the old agricultural settlement area of these basins (Ayenew, 2004 and Mateos, 1997).

As mentioned above, the causes of environmental degradation in the Ethiopian portion of the Nile Basin are related to natural, socio-economic and other factors. However, it can be said that the major cause and effect of this crisis is poverty, which, in turn, is related to population growth and environmental degradation. This interrelation, therefore, falls prey to the Malthusian theory. To date, the Abbay and Tekeze basins are typical examples of the causal link of population growth, poverty and land degradation.

In 2005, the number of people found in the Ethiopian portion of the Nile Basin was estimated to be 26,893,442[13] (FDRE/MoWR, 1997; 1998a; 1999 cited in NBI/ NTEAP, 2005: 29). As seen from the table below, the relative distribution of population in the Abbay, Tekeze and Baro-Akobo basins is estimated at 17,681,818 (66% percent of the population in the Ethiopian Nile Basin), 6,462,124 (24%) and 2,749,500 (10%) respectively (Ibid.) respectively. The table also shows the distribution of population in the six regions that are found in the study area, with the bulk of them (about 55%) concentrated in the Amhara Regional State, followed by the Oromiya (28%) and Tigray (11%) (Ibid).

Table 3 Estimated population distribution by regions and major river basins for 2005

Regional States	Major River Basins in the Nile Basin Parts of Ethiopia			Total Population	%age Pop$^{\underline{n}}$ by Regional State
	Baro-Akobo	Abbay	Tekeze		
Amhara	-	1,1316,364	3424926	14,741,289	55
Benshangul-Gumuz	302,445	530,454	-	832,900	3
Gambela	219,960		-	219,960	1
Oromia	1,649,700	5,835,000	-	7,484,700	28
SNNP	577,395	-	-	577,395	2
Tigray	-	-	3,037,198	3,037,198	11
Total	**2,749,500**	**17,681,818**	**6,462,124**	**26,893,442**	**100**

Source: FDRE/MoWR, 1997; 1998; 1999 cited in Nile Basin Initiative, Nile Transboundary Micro-grants Program, National Action Plan for Ethiopia (NBI/ NTEAP), 2005.

[13] The population size provided here refers only to the population within the hydrographical boundaries of the river basins, but not to the economic river basin areas as a whole (FDRE/MoWR, 1997; 1998a; 1999 cited in NBI/ NTEAP, 2005: 29).

The population density of the area is one of the highest in Ethiopia. For example, the 1990s study showed that the population densities in the lowland parts along the western sides of all the river basins was as low as 15 persons/km^2 while the central and eastern highland parts of the Abbay and Tekeze basins reached as high as 200 persons/ km^2 (Ibid:30). What is so alarming is the ever increasing figure of the population form time to time. This can be seen if one looks into the density of the area through time. The study also estimated that there will be 674,387 additional people (with average growth rate of 2.51%) for the coming ten years starting from 2005 and this will rise to 829,887 during the following twenty years and about 797,956 during the last ten years to the year 2045 (Ibid). For instance, in 1995 the population density was only 61persons/km^2, in 2005 it rose to about 76 persons per km^2 and in 2015, 2035 and 2045, it is estimated to rise to 95, 141 and 164 respectively (FDRE/MoWR, 1997; 1998a; 1999 cited in NBI/ NTEAP, 2005: 30). In short, the population in the basin will increase by 216% over the next forty years (Ibid). This will definitely worsen the environmental and food problems in the area unless some integrated water resource management measures are taken soon.

As it has been discussed above, the concept of food security is still debatable and seeks further study. The term food insecurity is also defined and used in many different ways in the literature, sometimes referring to food accessibility and availability and at the other times to its nutritional content. The specific definition of food insecurity that will be employed in this paper, unless otherwise stated, is the "availability concept of food at the national level." Similarly, in the context of this paper whenever the term environmental degradation is employed, it refers to land degradation (deterioration of landscape, overgrazing, deforestation and sediment deposition), soil degradation (in agricultural context) and soil erosion (the accelerated water erosion). Though they are conceptually different theses three terms can be used interchangeably in this study. This is simply because of the complementarity nature of the words.

4. An Appraisal of the NBI/ ENSAP

4.1 An Overview

The Nile Basin countries established the Nile Basin Initiative, NBI, in February 1999 in common pursuit of the sustainable development and management of the Nile waters. For the first time, all the Nile basin counties, with the exception of Eritrea, have become members of the NBI[14]. Its main aim, among others, has been to achieve a regional cooperative framework acceptable to all basin countries in order to promote basin wide cooperation in integrated water resource planning and to target poverty eradication. The NBI has a Strategic Action Program that comprises two complementary sub-programs, namely the Shared Vision Program (hereafter SVP) and the Subsidiary Action Program (hereafter SAP).

The Shared Vision Program aims to "achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources" (cited in http://www.nilebasin/org/). It was designed to create an "enabling environment" for investments and action on the ground at basin-wide level. The SVP project portfolio consists of eight projects, of which the first four are thematic and the rest facilitative: (a) Nile transboundary environmental action; (b) Nile basin regional power trade; (c) efficient water use for agricultural production; (d) water resource planning and management; (e) confidence building and stakeholder involvement; (f) applied training, and (g) socio economic development and benefit sharing (Ibid.).

The SAP comprises actual development projects at the sub-basin level, involving two or more countries, to move from planning to action. It has two working group of countries: the Eastern Nile Subsidiary Action Program[15], ENSAP that embraces the Abbay Sub-basin countries, viz. Egypt, Ethiopia and the Sudan and the Nile Equatorial Lakes Subsidiary Action Program (hereafter NELSAP) that comprises the equatorial co-basin states of Burundi, Kenya, Rwanda, Tanzania, Uganda and the Democratic Republic of Congo and also includes Egypt and the Sudan, as downstream riparians. Currently, SAP has fifteen major projects on water supply and sanitation, river regulation and flood management, irrigation and drainage, fisheries, hydropower, water hyacinth and weeds control. It is stated that national governments would identify what needs to be done at local and national levels, while the subsidiary program would address development opportunities with transnational implications. In other words, action on the ground will take pace at local, national and sub-basin level

[14] The emphasis on sustainability is what makes the NBI different and promising than the previous initiatives, which failed after more than four decades of attempts and seventy meetings (Tesfaye, 2001).

[15] It is led by the Eastern Nile Council of Ministers (ENCOM) that comprises of the Water Ministers in the three Eastern Nile countries, and an ENSAP Team (hereafter ENSAPT) formed of three technical country teams namely Egypt, Ethiopia and the Sudan (cited in http://www.nilebasin/org/entro, accessed in December 2005).

and this, in turn, will integrate itself upward to form a basin wide development (ENSAP, PID 2001:22).

As stated in the ENSAP Project Identification Document, the long-term program objectives of ENSAP are to: (a) Ensure efficient water management and optimal use of the resources through equitable utilization and no significant harm; (b) Ensure cooperation and joint action between the Eastern Nile countries seeking win-win goals; (c) Target poverty eradication and promote economic integration and (d) Ensure that ENSAP results in a move from planning to action (ENSAP, PID, 2001). It is an investment-oriented program that is designed to develop the water resources of the Eastern Nile Basin in a sustainable and equitable manner and to enhance food production and protect the environment, among others. The Integrated Development Program of the Eastern Nile (hereafter IDEN) project, which is also referred as the first ENSAP project, comprises the following major subprojects: (i). Irrigation and Drainage subproject (hereafter I&D) (ii). Watershed Management (hereafter WSM) (iii). Baro-Akobo-Sobat Multipurpose Water Resources Development subproject (iv). Eastern Nile Power Trade Investment Program (v) Ethio-Sudan Transmission Interconnection subproject (vi) Eastern Nile Planning Model subproject (hereafter ENPM) (vii). Flood Preparedness and Early Warning subproject (hereafter FPEW) (viii) Eastern Nile Joint Multipurpose Program (hereafter ENJM).

In what follows, the SVP and ENSAP projects, specifically those projects which have direct relationship with environment and food security, will be discussed thoroughly. Although all of the projects build upon each other to form a coordinated effort to achieve sustainable development in the basin in general and in Ethiopia in particular, each project is different in its focus and scope. Hence, among the NBI's Strategic Action Programs, the two SVP projects, namely the *Nile Transboundary Environmental Action* and *the Efficient Water Use for Agricultural Production* and the three ENSAP sub-projects, namely the *Baro-Akobo-Sobat Multi Purpose Water Resource Development,* I*rrigation and Drainage* and *Watershed Management,* are geared towards mitigating the food insecurity and environmental degradation problems in Ethiopia.

4.1.1 Shared Vision Program projects

(a) Efficient Water Use for Agriculture Project

The main objective of this project is to "increase the availability and efficient use of water for agricultural production in support of sustainable socio-economic development of the Nile Basin countries" (NILE-COM Project Document, 20001:1). Its aim also includes forming a forum to assist stakeholders at all levels to address issues related to efficient use of water for agricultural production. Additionally, the forum is designed to foster intensive dialogue, experience sharing and training to build trust and cooperation for the sustainable utilization of Nile Waters. Its slogan is encapsulated by the phrase ‘more crop per drop’ (Ibid: 2). The project has become operational starting from September 2006 and is located in Nairobi, Kenya. The Netherlands government is its sole donor. This project has a potential to address Ethiopia’s food insecurity problem by designing and employing efficient water utilization approach. However, the delay to launch and the relatively meager amount of money allocated to it (only 4.9 Million USD) and its reliance on a single donor (the Netherlands government) might reduce the efficiency of the project.

(b) Nile Transboundary Environmental Action Project

The Nile Transboundary Environmental Action Project (hereafter NTEAP) focuses in areas like irrigation in a regional context; integrated water resources management/watershed management; water use efficiency improvement, flood and drought management; sustainable management and conservation of lakes and linked wetlands, environmental education and awareness and pollution control (NBI/NTEAP, 2006). The project is the first SVP project to be launched demonstrating a move from planning to action. It is one of the projects that currently enjoy a relatively high amount of fund, i.e. around 39.1USD, with no funding gap. Its main donors are Global Environmental Facility, GEF, World Bank, WB, United Nation Development Programe, UNDP, Canada and the Netherlands. This project might address the environmental problems of Ethiopia. It is noted that there are ongoing studies in each member basin countries. In Ethiopia, for example, the recent study of ‘Soil Erosion Assessment’ in the Ethiopian portion of the Nile, which was conducted by an Ethiopian consultant, assesses the Nile Basin parts in Ethiopia and tries to come up with some mitigating measurers. Even if this project is at a better position as compared to the other projects, it fails to move at its own stated schedule. As a result, currently environmental degradations are by far exceeding the mitigation process.

4.1.2. Eastern Nile Subsidiary Action Program projects

(a) Irrigation and Drainage

The Irrigation and Drainage, I&D Project of ENSAP aims at increasing food production for the growing population of the Eastern Nile region. This can be achieved through the expansion of cultivated area or from agricultural intensification. The long term objective of the sub-project is to “increase agricultural productivity through irrigation development, create rural employment opportunities, and improve rural livelihoods and incomes" (ENSAP, IDN, 2001:35). The project will also "contribute to food security, reduce rural poverty and reduce population pressures in the region, with associated beneficial effects on the environment" (Ibid). The immediate objective of the project is "to support the development and expansion of irrigated agriculture as well as to improve the productivity of small- and large-scale agriculture through improved agricultural water use" (Ibid).

In Ethiopia, the unpredictable seasonal and spatial distribution of rainfall is a major reason for poor agricultural productivity and its resultant effect on food insecurity. Hence, when the proposed project is realized, it will hopefully enhance the development of irrigation and intensification of existing agriculture to alleviate food insecurity and improve livelihoods. As stated in the ENSAP Project Identification Document Summary (hereafter IDEN) (2001:35), one of the expected output of the I&D project is to: "reduce poverty and improve food security through higher production levels of food crops; implement sustainable agriculture by reducing land degradation and erosion." This objective is in line with Ethiopia's top priority that is achieving food self-sufficiency as stated in the Agriculture Development Lead Industrialization (ADLI) document. At the beginning, the I & D project was not fast track in its preparation[16]. It was only in October 2004 that Eastern Nile Council of Ministers (hereafter ENCOM) decided to fast-track it. The Council agreed to carry out feasibility studies for 100,000ha and investment for initial development of irrigation of around 20000-50,000ha in each of the EN country. In order to achieve its stated objectives at the sub-basin level, the preparation approach focuses on diagnosis of proposed sites and the selection of up to 20,000ha for feasibility study in Ethiopia and Sudan.

(b) Integrated Watershed Management

The major regional benefit of this project is "erosion control leading to decreased siltation and sedimentation in downstream river/reservoir reaches, which will increase reservoir life, improve hydropower production and irrigation efficiency, as well as protect critical aquatic habitats" (ENSAP, IDN, 2001:39). It also aims at improving the land productivity of Ethiopia so as to increase agricultural outputs, enhance food security and alleviate poverty. Furthermore, it has the objective of establishing a sustainable framework for the management of selected watersheds on the Tekeze, Atbara, Mereb, Abbay and Baro-Akobo/Sobat rivers (Ethiopia and Sudan) to improve the livelihood of the people, enhance agricultural productivity, avoid environmental degradation, reduce sediment transport and siltation of infrastructure, and prepare for sustainable development oriented investments (Ibid).

[16] It is an accelerated preparation and appraisal to launch the implementation process within 24 months to show early results on the ground and tangible benefits from cooperation (ENSAP: Overview, March 2006).

The project has national and trans-national components, due to the transboundary nature of the problem. Currently, all pre-project preparation activities are finalized and implementation completion reports are already submitted to the funding agency. Selection of sites for the national level programs is already completed and detailed preparation is expected to be completed in May 2007 (ENTRO Annual Report, 2006).

(c) The Baro-Akobo-Sobat Multipurpose Project

The Baro-Akobo-Sobat Basin is located in southwestern Ethiopia on the Ethiopia-Sudan border and aims to provide a multipurpose water resources project which may provide win-win benefits to the Eastern Nile countries. Several studies in Ethiopia have concluded that there is good potential for developing multipurpose projects that will be built around hydropower, irrigation and watershed. Ethiopia would, for example, benefit

from increased electricity supply and irrigation[17]. The greater proportion of electricity would be supplied to meet the projected power demand in Egypt and the Sudan, while the latter would also gain substantial benefits from flood damage reduction and irrigation. Crucially, a regional multipurpose project would also serve as a tangible step in achieving regional integration and development. Currently, the project is under revision due to its multifarious problem and discussion is going on with African Development Bank (ADB) to secure fund (ENTRO Annual Report, 2006). At the moment, there are no national coordinators at all. It can be said that the project is in its infancy stage. Besides, the project preparation is not yet functional unlike the other ENSAP projects.

The table below shows that the Baro-Akobo-Sobat project status is not yet known. The I&D project's fast-track implementation started in 2007 by the Ethiopian government. According to the IDEN project status report, the assumed irrigation field is 10,000 ha and the cost of its development is estimated at 5,000 USD per ha (ENTRO Annual Report, 2006). The same table shows that the watershed management project's fast-track implementation started at the beginning of 2007 by the Ethiopian government and ENTRO. The implementation process is expected to be finished over a period of 3-5 years. These projects are mainly financed by the World Bank and African Development Bank, ADB. It is also noted that the I&D project will be prepared and implemented in full coordination with Ethiopia's Watershed sub-

[17] It is planned to conduct a feasibility studies of hydropower generation of up to 793MW, irrigation of about 10,000 hectares in the Gambela plains, and river regulation for conservation, sediment and flood control through the construction of three dams (Tams, Gambela and Itang) on the Baro River (ENTRO Annual Report, April 2006).

project. The implementation process of the Eastern Nile Planning Model and the Flood Preparedness and Early Warning project started in 2006. The Ethio-Sudan Transmission Interconnectedness project has shown promising progresses and is expected to be fully finalized by the year 2007. On the other hand, the Easter Nile Regional Power Trade Investment Program is a little bit late and its implementation started in the middle of 2007. The Eastern Nile Joint Multipurpose Project[18] is a recently launched basin-wide project with the aim of bringing the three countries under one project to achieve regional integration and cooperation.

Table 5. The Preparation and Implementation schedule of ENSAP projects

Projects	2005	2006	2007	2008	2009	2010
EN Planning Model	PPPIIIIIII		IIIIIIIII	II		
Watershed Management	pPPPPPPPP		PP IIIII	IIIIIIIIIII	IIIIIIIIII	IIIII
Flood Preparedness and Early Warning	PPPPIIIII		IIIIIIIII	IIIIIIIIIII	IIIIIIIIII	IIIII
Irrigation and Drainage		PPPP	IIIIIIIII	IIIIIIIIIII	IIIIIIIIII	IIIII
Ethio-Sudan Transmission interconnectedness	PPIIIIIIIIII		IIIIIII			
EN Regional Power Trade Investment		PPPPP	PPPIIII	IIIIIIIIIII	IIIIIIIIII	IIII
Baro-Akobo Sobat Multipurpose Development	**					
Eastern Nile Joint Multipurpose Project	PPPPPPP		PPPPPP	PPPPPPP	PPPPIII	III

Source: ENSAP: Overview, March 2006.

** Status unknown **P**-Preparation **I**-Implementation

Generally, the aforementioned projects are designed to address the problem of food insecurity and environmental degradation in the Eastern Nile countries in general and in Ethiopia in particular. Today, the process of establishing sustainable watershed areas in the Eastern Nile basin is under preparation. For instance, around 150 thousand hectares of land is already identified in these countries and implementation process will be started soon. In line with this activity, there are attempts to identify suitable area to start irrigated agriculture in Ethiopia and the Sudan. It is noted that around 15 thousand hectares of land are going to be irrigated with the financial

[18] The Eastern Nile Council of Ministers (ENCOM) at its 19th meeting in Alexandria, Egypt, on Feb 15th, 2005 and its 20th meeting in Rwanda, Kigali, on March, 17th, 2005 agreed to launch the first phase of identification of a major program of multipurpose development of the Eastern Nile. The JMP approaches the development of the Eastern Nile as "one river system" shared by the three countries. Taking a "Three-country , One system " approach to the development of the Nile is essential of this complex river system is to bring maximum benefits of he people of Egypt, Ethiopia, Sudan and their future generations (http://www.nilebasin.org/entro, accessed in May 2006).

support of the ADB and the World Bank. Additional 20 thousand hectares of land is also about to be irrigated with the help of the World Bank (ENTRO Annual Report, 2006).

4.2 An Appraisal of ENSAP Projects

With regard to the role of ENSAP project in alleviating Ethiopia's food insecurity and environmental degradation, it is believed that the projects have the potential to address both problems. However, there are divergent views regarding the realization of their objectives. All the projects will in one way or another address Ethiopia's problems with some delays in implementation. It should be noted that the environmental and food insecurity problems in the Ethiopian portion of the Nile basin are so deep rooted and its extent is very alarming. Hence, the role of ENSAP project might be insignificant if one compares it with the severity and intensity of the problems.

There are also delays in some projects, for instance the Baro-Akob-Sobat multipurpose project. There are many reasons for the delay of the Baro-Akobo-Sobat project. One reason for this is the location of the project. This multipurpose project was designed to benefit Ethiopia and the Sudan on their common border. In the part of Southern Sudan, there was a civil war that impeded the project preparation process. Even now, there are no means of communication to carry out discussions with the community members and stakeholders in Southern Sudan. Currently, this is creating a problem in the preparation process of the project. Though there is peace agreement between the Sudanese People Liberation Army/Movement (SPLA/M) and the central government in Khartoum, at the moment, southern Sudan is not yet ready to make the 'water issue' at the top of its agenda as there are many other more pressing political and economic issues at hand.

Further, the area is full of mines. There is hardly any infrastructure in the region. Beyond the political and infrastructural problems, there was and still is a suspicion in the south about any development project which is proposed by the central government of Sudan. To this, the Jongli Canal Project is the best example. Due to the above mentioned facts and other reasons the project is under revision in many aspects and the preparation process is delayed for an indefinite time. The ENTRO should do a better job to propel the Baro-Akob-Sobat project. Ethiopia has a very fertile soil, less degraded and large hectares of land in the basin. This area therefore could have been a backbone for an increased food production. However, nothing has been done so far.

When we come to the Irrigation and Drainage project, it is going well, albeit with some delay. Since the pilot project areas are already selected in Ethiopia, the implementation process will start in one year time. In view of the authors, the exclusion of the project from the first phase of 'fast-track' preparation process may have a negative consequence in the preparation and realization of the project in the future[19]. In this regard, are to shoulder the blame for failing to make this project part of the fast-track group from the very beginning. Had it been included in the first phase fast-track package, it could have been in a better position or at least it would have stood at an equal footing with the Eastern Nile Planning Model (ENPM) and Flood Preparedness and Early Warning (FPEW) projects[20].

These instances show the benefits of being fast-tracked. Partially, this might be attributed to Egyptian influence in prioritizing the projects. Though it's very difficult to label one project as Egyptian and the other one as Ethiopian, one can easily see that those projects which are designed to address flood problem and to generate hydrological data are emphasized by the lower riparians, particularly by Egyptians. On the contrary, irrigation and watershed management projects, which are directed to Ethiopia's benefit, are lagging behind schedule.

Additionally, the past experience of the Nile Basin in implementing projects is very poor. A close examination reveals that most of the projects failed in the past failed to be realized. For instance, the Jongeli canal project failed to be implemented due to the conflicts in Southern Sudan and the alienation of the southern people from the preparation and implementation phase, among others. Similarly, the same mistakes are enveloping the Baro-Akobo-Sobat project. This project, just like the Jongeli project, is partially located in south Sudan and shares most of its problems at the moment. The project also failed to take on-board the southern Sudanese people during preparation and it is now very difficult to consult them after the whole *project identification* process is finished. At the moment, both the Jongeli and the Baro-Akobo-Sobat Projects are duckling.

In the past Egypt either controlled or influenced any basin-wide or bilateral water projects. Typical examples for this include the Hydromet and the Owen Fall projects between Uganda and Egypt. While the Hydromet project phased out without attaining its objectives; the Owen Fall is still functioning under the close supervision of the

[19] The I & D project in the beginning was not a fast-track project, it is only in 2004 that it became a fast track project

[20] These two projects were fast-tracked at the initial phase and now are ahead of all the other IDEN projects, except the Ethiopia-Sudan Transmission Interconnection project.

Egyptians. To this, one may add the relatively advanced Egyptian-oriented ENSAP projects. Hence, the present projects might fall in this trap unless genuine attempts are made by other riparian countries, like Ethiopia.

Similarly, as we have seen the Irrigation and Drainage, and the Watershed Development projects are going to be implemented by the Ethiopian government. In Ethiopia, the government is known for its much-criticized syndrome: “it is not the policy/project that is the problem but rather its implementation.” It should be remembered that it is only what is on the ground that could salvage our people from starvation. If we see the past experience, for example, four costly dams (e.g. the Tana-Beles project) that were constructed in the 1980s had to be abandoned, and several irrigation schemes became out of use because of the poor planning and the Derg’s authoritarian approach to policy formulation and implementation (MoWR 1997 cited in Desalgn, 1999).

In the following sections, an attempt will be made to enrich the aforementioned discussions by briefly discussing the constraints that ENSAP projects might face. There are both internal and external factors which facilitate or delay the proper preparation and implementation of these projects. These factors, among others, include the activities of NBI and ENTRO, implementation problems, the irreconcilable national water policies, the unilateral water resources development, financial constraints, social and environmental challenges, and others.

4.2.1 The Eastern Nile Technical Regional Office

ENTRO was initially headed by ‘representative type of management,’ i.e. the three states represented by three managers. At that time the atmosphere was so tense and the working environment was affected by suspicion and mistrust. In every minor routine work, ENCOM was forced to take part and intervene. This made ENTRO almost dysfunctional. Consequently, ENTRO was restructured by ENCOM in 2004/2005 and changed the management system to a competitive and merit based one instead of representative. Hence, the performance of ENTRO can be seen starting from the restructuring date and not the date of its inception. In spite of the restructuring, the role of ENTRO in the implementation phase is not yet clear. The mandate of ENTRO is limited to preparation phase only. Currently, its mandate is “evolving”, i.e. it is under revision. This might also create a problem to the implementation of the fast-track project unless measures are taken soon.

To date, ENTRO is highly understaffed[21]. This is because of the meager financial status of the Office. This might be one factor for the delay in the realization of ENSAP projects. What is worth mentioning here is the good working environment which instills in one a positive impression about ENTRO in particular and the NBI in general. It can be said that the NBI will have a bright future, if the politicians listen to the technical experts in ENTRO. The personal communication between the Ethiopians, Egyptian and the Sudanese is friendly[22]. This kind of working environment enlivens and enriches the working atmosphere and inevitably will have a positive impact on ENSAP projects. It seems that they are "one", though there are many issues yet to be resolved and solved among them.

Regarding the financial aspect of the project, it is noted that there is a promising financial backing from the donor communities. At the moment, there is sufficient fund for the preparation of ENSAP projects. However, there will be a financial constraint during the implementation phase unless the donors commit themselves in financing these mega projects in the future. Recently, the donor countries made it clear that the progresses and finalization of the Cooperative Framework is a pre-condition to get any additional financial support in the future. In other words, the Cooperative Framework or the D3[23] project is critical in determining the mandates and mobilization of the funds of the investment projects. Hence, the result of the D3 project is very crucial for the success of the Subsidiary Action Program, which, in turn, is expected to improve the livelihood of the Basin people as a whole and the Ethiopian people in particular.

[21] Currently, Dr. Solomon Abate is the Regional Project Coordinator of three projects: the Irrigation and Drainage Project, the Watershed Development Project and the Baro-Akobo-Sobat Project; Dr. Abdulkarim H. Seid is the Regional Project Coordinator of Eastern Nile Planning Model and Flood Preparedness and Early warning Projects and Dr. Fatma Moustafa is Project Coordinator Unit Manager of the Ethiopia-Sudan Transmission Interconnection project and the Eastern Nile Regional Power Trade Investment Program. This might be one factor for the delay in the realization of ENSAP projects. It's very difficult to run two or three basin-wide projects under one person.

[22] During a tea break, you can easily see how they are intimate and sociable. Here it is good to cite one question that was raised by a Sudanese guy at tea break, which took all of us by surprise "How many of you will re-marry the same wife if you are given a second chance?" This question made all to burst into laughter and an Egyptian mockingly answered by saying "no body will make the same mistake!"

[23] The major objective of the Cooperative Framework or D3 project which is financed by UNDP is to " enable the Nile River basin countries to determine equitable entitlements for each riparian country for the consumptive and non-consumptive use of the Nile waters [and] for optimum sustainable socio-economic benefits of the inhabitants of the basin" (Nile-COM, 1999 cited in Tesfaye, 2001b).

4.2.2 The Nile Basin Initiative

There are divergent views regarding the NBI in all riparian countries. As Mason (2004) noted in all the riparian countries there are groups that support and oppose the NBI. It is also believed that the major issues which might bring the NBI in general and ENSAP projects in particular to a controversy are the claimed validity of existing agreements and the ever increasing unilateral developments in the basin. As recently as March 30-31, 2006, the Nile-COM held its extra-ordinary meeting here in Addis Ababa to discuss the report of the Negotiating Committee for the Nile River basin Cooperative Framework. In his opening statement, Prof. Bikoro Munyanganizi, Nile-COM Chair and Minster of State for Water and Mines in Rwanda, noted that the riparian countries have entered the ninth year of Cooperative Framework Development and the third year of the formal negotiations. While this length may not seem very long, given the seriousness and complexity of the legacy of the Nile basin, our people cannot wait any longer for its conclusion.

In this extra-ordinary meeting the Nile-COM agreed to sideline the very contentious issues as “pending issues, annexed to the agreement, in order to move the NBI into a permanent institution soon[24]. However, a few of the Nile-COM members expressed their concerns and wanted to know the implication of these “pending issues.” In order to clear this doubt, the Legal Advisor of the D3 Project has been given an assignment to study whether such a method had been successfully used elsewhere. It was also learnt that the Nile-COM agreed on more than 95% of the issues. Even if the number of articles they agreed upon are many, weight has to be given on the substance than simply counting them. Crucial issues like water allocation are not yet agreed upon and there is no improvement in this aspect of the project.

Though this progress is a good sign, it is difficult to believe that Egypt will sign a new agreement any time soon, if there is any at all. Considering the plans of the Egyptians that aim at diverting the Nile waters beyond the drainage area, it is difficult to see any light at the end of the tunnel. What makes things starker is the fact that Ethiopia’s position of negotiation is not showing any progress. Rather the lack of clear and well thought-out national water policy, the incompetence of negotiators, political instability

[24] If one is willing to come out with a fair and equitable distribution of the Nile waters, the agenda of the Cooperative Framework and other similar Nile meetings should gravitate away from science, technology and data towards the redistribution of the Nile water. The other items become meaningful and effective if and only if one could be in a position to put the horse before the cart and not the other way round, as it has been the case so far (Tesfaye, 2001b: 580).

and economic constraints will certainly contribute in delaying the conclusion of the matter.

To date, the fate of the NBI is highly dependent on the performance of the D3 project. Unfortunately, nothing is known for sure about what will happen next. Today's "pending issues" might turn themselves to "backpedaling issues" in the NBI. A real cooperation in the Nile Basin is only ten years old and the difference between the lower and upper riparian countries regarding the existing treaties is still unresolved. As a result, a move from "a polarized position to a harmonized position" has not yet been concretized. Therefore, unless a genuine attempt is made to solve the present "pending issues" and transform the NBI into a permanent legal institution, the success of the NBI and ENSAP projects would be in danger.

It should be remembered that NBI and its projects are highly interrelated. The good performance of the former contributes to the success of the latter and vice versa. In other words, the conclusion of the D3 project would facilitate the implementation of SAP and SVP projects. In the mean time, the NILE-COM should speed up the Cooperative Framework negotiation to form a permanent legal framework. If the NBI countries failed to back their Shared Vision and Subsidiary Action Programs with sustainable actions and development, things would remain the same, if not worse, in the Nile Basin. In short, one can say that it is incumbent among all stakeholders in the Nile Basin and beyond to bring a lasting solution to the intricacies of the Nile questions.

4.2.3 The Impact of Unilateral Developments on ENSAP projects

The Nile Basin Initiative reserves all the riparian countries right to implement any project in the Nile Basin unilaterally. Thus, it is worth discussing the possible impacts of unilateral developments on ENSAP projects in addressing environmental degradation and food insecurity problems. The Efficient Water Use for Agricultural project, one of the SVP projects, has the aim of increasing the availability and efficient use of water for agricultural production to improve the livelihood of the people of the Nile Basin. However, at the moment, almost all the riparian countries, especially Egypt, are engaged in unilateral schemes.

For instance, Egypt is already planning to use what is going to be gained through recycling and technological efficiency to its unilateral mega projects[25]. Mason (2004) noted that Egyptian mega projects are aimed at getting water from what Egypt is going to collect from efficiency increase. For instance, 50% of the water of the Toshak project is planned to come from water recycling in the future, while the rest 50% will be from the 1959 Nile Waters Agreement[26]. This clearly shows the determination of the Egyptians to use any additional water for their own mega projects only. This, in turn, shows that there will be no water reserved for other riparian countries out of the Egyptians water efficiency programme. This will create additional problem to the Eastern Nile Countries in general and to Ethiopia in particular (Boubaker, 1991).

Almost all the ground water and any drop of water which is going to be obtained from the efficiency project in the Egyptian land is going to be used for Egyptians and Egyptians only. This will pose an obstacle in the implementation of ENSAP projects in one way or another. Confirming this fact, Mason (2004) states that Egyptians are not yet even ready to abandon the cultural rice production, which consumes too much water, by simply giving a reason that it is a long practice of its people. Besides, these unilateral mega projects are too big and they will consume much of the Egyptian economy and attention which could be used for regional cooperation. Mason succinctly describes the unilateral development of Egypt by saying: “the general debate in concerning such projects, however, is not if they should be undertaken, but how they should be undertaken” (2004:149). Unfortunately, Egypt is determined to continue on its unilateral programme and this for sure will have an adverse effect on the future water allocation, SVP/ENSAP project implementations and financial contribution to the projects activities.

The authors of this paper believe that these mega projects, which are planned to be finished in 20 years time, are aimed at improving the food availability, hydropower demand, and the water supply of Egypt. Hence, it is small wonder to know that the Egyptian interest is more on the environmental and other technical aspect of ENSAP

[25] Strengthening this argument, Mason (2004) states that Egypt will have sufficient water supply until 2017 by shifting its policy from green revolution to blue revolution, i.e. by increasing the productivity of the water per drop or employing the ‘more crop per drop’ approach. According to Egyptian estimation, around 20.9 km^3 /year additional water could be available through recycling and by improving the efficiency of agriculture. To achieve this objective, Egypt would continue to implement its water resource development under the auspices of its recently introduced national water plan which focuses on three pillars: working with upstream states on both the Blue and White Nile to develop new water resources; protecting water quality and severely rationalizing the usage of Egypt’s share on the Nile (Folds, 2002).

[26] The New Valley Project requires water that could be used to reach a new Nile waters Agreement that accommodated the upstream riparians (Waterbury and Whittington, 1998).

projects than with others. Emphasis and interest on unilateral projects might make Egypt less committed to regional projects like ENSAP, as they are less profitable to it compared to its own projects. In short, ENSAP projects in the Easter Nile countries and the Unilateral Projects in Egypt can not move in tandem. They are rather irreconcilable. Thus, one can not expect Egypt to be as committed as Ethiopia to ENSAP projects, which is craving to get much out of ENSAP projects due to its disadvantageous position in the past.

On the other hand, Sudan has a water policy which aims at increasing production, enhancing irrigated agriculture, improving efficiency of existing schemes, and forecasting and preventing flood (Mason, 2004). To achieve these objectives, the Sudanese government plans to build two new dams and heighten an existing dam with the aims of tripling hydroelectric production in the country, enhancing food production and other similar benefits. Some say that Sudan does not clearly state whether it will use hydropower or oil as a source of energy for its national development plan in the future (Ibid).

In the opinion of the authors, this ambivalence might play a crucial role in affecting the Sudanese government's commitment to the ENSAP in general and to the power development projects in particular; viz. the Eastern Nile Power Trade and Ethio-Sudan Interconnection projects. It would also affect, directly or indirectly, the development of the Baro-Akobo-Sobat project. Furthermore, the authors believe that the current crisis in Darfur, will affect the Sudanese role in the NBI as a whole and ENSAP projects in particular. Besides, the southern Sudan problem is not yet totally solved. Unless these and other problems are addressed, Sudan could become a passive member of ENTRO and may lose its economical and political commitment in the realization of ENSAP projects.

When one comes to Ethiopia, its national water utilization program in the coming 15 years aims at developing 120, 000 ha of large-scale irrigation and 120,000 ha of small-scale irrigation out of the 2.3 million ha of irrigable land it possesses (Yacob, 2004 cited in Mason, 2004). This plan would require about 1.2 bcm or 1.6 % of the 74 bcm in the 1959 agreement water allocation. If the whole 2.3 million ha of land is irrigated, 11.5 bcm or 15% of the water that Egypt and the Sudan use at the moment would be utilized (Waterbury and Whittington 1998:158 cited in Mason, 2004: 160). At the moment, there are a few unilateral projects under implementation including the micro-dams strategies in the highlands of Ethiopia, the Tekeze and Lake Tana sub-Basin projects (e.g. the Gumera, Gilgle Abay 1&2, Jema, Ribb and Megech) Fincha and other multi purpose projects.

Nevertheless, though Ethiopia has a water policy, it gives no clear picture regarding the country's water resource utilization priority. For instance, some Ethiopians believe that the comparative advantage of Ethiopia is in hydroelectric power. This argument is also shared by the lower riparian countries especially by Egypt. Contrary to this belief, it is argued that Ethiopia should give priority to irrigation agriculture to alleviate poverty and minimize food insecurity. Mason (2004) also noted that there is no national consensus among Ethiopians regarding the comparative advantage. Additionally, there is no agreement among the irrigation advocates when it comes to prioritizing between large-scale and small-scale irrigation projects. At the moment, this debate is still going on. Therefore, in the authors' opinion, the ambiguity in what should be prioritized in Ethiopia's water policy may have a negative consequence both on the unilateral water resource development and ENSAP projects and also on the D3 negotiation process.

As discussed above, the national water policies of the three countries are irreconcilable and this might result in incompatible desire and disagreement in the realization of ENSAP projects which, in turn, would force them to engage themselves in unilateral development. The latter may result in grabbing a big chunk from the Nile River at the expense of the vision of the NBI. This process certainly will have a negative effect on ENSAP projects and aggravate environmental and food insecurity problems of the basin and Ethiopia.

5. Conclusions and Recommendation

5.1 Conclusions

The NBI is at a crucial point in its life time. There are many positive developments with some challenges. At present, it is very difficult to assess the performance of ENSAP projects due to the following two main reasons: First, it is "too early to be assessed" and second it is difficult to evaluate "on-going and basin-wide mega projects," which are at their preparation phase. However, it is not totally impossible to assess the progresses that are made against the projects expected output and time schedule. With respect to this, no one denies that all the projects are behind schedule and their clearly expected outputs in the IDEN summary document are yet to be realized. Besides, no one knows for sure when the ENSAP projects are going to be implemented. Everybody in ENTRO says "soon," but no one for sure determines the exact dates. The latter is becoming a blanket word for all the questions. For a country like Ethiopia where environmental degradation is heading at an alarming rate, the population pressure is increasing alarmingly, and more than five million people are famished every single year, the mere word "soon" seems a mirage in the desert.

As a result, given the progress of ENSAP projects so far toward attaining its goals, it seems that the future is unclear. At the moment not a single ENSAP project is on the ground. There are many 'ifs' and 'perhaps' than exact predictions and deeds as far as the project implementation is concerned. If this trend continues, the Eastern Nile people will be tired of waiting and the projects contribution will be "too little too late" in the face of overwhelming environmental degradation, booming population growth and chronic food insecurity. Thus, unless ENSAP projects are implemented on the ground and bear fruit, millions of Ethiopians will continue to pay the cost with their lives.

In spit of the aforementioned drawbacks, however, ENSAP projects are showing considerable improvement especially after the restructuring of ENTRO. Today, more than ever before, there is a high spirit of cooperation among the Eastern Nile countries. Besides, there is a genuine attempt to implement ENSAP projects on the ground through fast track approach. It should also be noted that basin-wide projects like the ones we have under ENSAP requires much efforts and need long years of confidence building steps. Hence, the high spirit of commitment among the riparian states, particularly the Eastern Nile countries should be encouraged. Moreover, given the hydro politics and complexity of the legacy of the Nile Basin, the progresses that are made still now by the NBI are promising, though it is not satisfactory. The situations have changed by which decades ago not all the Nile riparians were members to a basin-wide organization; today all are members. Besides, all the Nile Council of Ministers are meeting regularly to expedite the transformation of the NBI to a permanent and legal institutional framework. If the ENSAP projects, particularly the Irrigation and Drainage, the Watershed Management and the Baro-Akobo-Sobat projects, implemented timely and properly, they have immense potential to address Ethiopia's food insecurity and environmental degradation problems. Thus, it is believed that the proposed projects will hopefully protect the environment and enhance the development of irrigation to alleviate food insecurity and improve livelihoods.

Considering the above challenges and opportunities, it is therefore, very hard at this moment to come up with a clear picture of the projects. Thus, it is too soon and very difficult to label the NBI/ENSAP either as a stimulus or deterrent to Ethiopia's food insecurity and environmental degradation alleviation process.

5.2 Recommendation

The authors would like to conclude the paper by proposing the following recommendations:

Though it is good to start some of the projects by using the fast-track implementation strategy, care should be taken not to spoil the first opportunity by simply running out of expedience to meet the desire of the basin people without doing detailed studies. There is a need to show some early results on the ground as early success of the fast-track projects will build confidence among people living in the basin states. However, this ambition should be done more in vigilance than in hurry. Otherwise, the implementation of the fast-track's "first impression" might leave a scar of "first depression" in the Nile Basin peoples mind and all the next efforts will be an exercise in futility.

The three Eastern Nile Countries should also know that they are a "tripod animal," i.e. if one fails other will fail as well. Sensing this Nile River interdependence,' they should work for the sustainable utilization of the waters rather than greedily harness the fragile ecology to unilateral development. Besides, Egypt needs to be more committed to ENSAP projects. Sudan, on the other hand, must have a clear picture of what it is looking for from ENSAP project. Ethiopia should also make an attempt to exploit the opportunity that the ENSAP projects might bring in.

Likewise, ENTRO should build its capacity to facilitate the preparation and implementation (of the fast-track) process of ENSAP projects. To do this, ENCOM should clearly define the 'mandate of the ENTRO' regarding the role it will play when it comes to the implementation phase. In addition, ENTRO should recruit other qualified staff to accelerate its work.

The Nile basin countries should be cautious not to be influenced or inclined to the interest of one or another member of the NBI or ENSAP countries, as this might paralyze the whole NBI and ENSAP projects. If Egypt, just like in the past imitative attempts, tries to influence SVP and ENSAP projects, it might change the credo of the NBI from a "shared vision" to an "unshared vision." Furthermore, the Cooperative Framework should come up with some plausible agreement sooner than later. Otherwise, we will be forced to remember the famous medical maxim: "the operation was successful, but the patient died"

Finally, the international community also needs to continue its financial and technical support. At the same time, they need to pull their strings whenever necessary for the development and conclusion of the D3 project. Therefore, the donor community should use the carrot and stick approach to force the Nile-COM to come up with a basin-wide new Nile Water Agreement soon.

References

Ayenew Tessera (2004) "The Imperative Need for Watershed Management in the eastern Nile Basin," pp.67-154. In Mulegeta Feseha and Tesfaye Tafesse (eds.) *Proceeding of the Conference on Management of Water Resources* in Ethiopia organized by Institute for Development Research, Addis Ababa University Graduate School Auditorium on May 14-15,2004.

Ba, Boubaker (1991) "The Nile: Lifeblood or Bloodshed." In Olivia Bennett (ed.) *Green War: Environment and Conflict*, pp96-100, Panos Publication Ltd, London.

Degefa Tolossa (2005) *Rural Livelihoods, Poverty and Food Insecurity in Ethiopia: A case Study at Erenssa and Garbi Communities in Oromiya Zone, Amhara National regional State,* Doctoral Thesis, Norwegisn University of Science and Technology, Faculty of Social science and technology Management, department of Geography, Norway.

Desalgn Rahmeto (1998) "Food Security Long Term Objectives," Paper presented to *Food Security Indicator Development* Workshop Organized by International Institute of Rural Reconstruction (IRRR), Ethiopia.

Devereux, Stephen (2000) "Food Insecurity in Ethiopia." A *Discussion Paper* of DFID, Institute of Development Studies, Sussex, UK.

Eastern Nile Technical Regional Office (2006) Eastern Nile Subsidiary Action Program Status Report, April 2006, (Unpublished).

Federal Democratic Republic of Ethiopia, FDRE, (1997) The Conservation Strategy of Ethiopia. Executive Summary, Addis Ababa.

Federal Democratic Republic of Ethiopia, FDRE, (2002) Food Security Strategy, Addis Ababa.

Foulds E., Kimberly (2002) "The Nile Basin Initiative: Challenges to Implementation." Paper was presented at the *Managing Shared Waters* Conference, Hamilton, Ontario, Canada, 23-28 June 2002.

GebreTsadik Degfu (2004) "What Benefits Will Ethiopia Gain from Membership of the Nile Basin Initative?" *Addis Tribun,* 25 June 2004. Accessed on December 2005, the Nile Basin Society-http://www.nilebasindiscourse.org/

Ibrahim, A.M. (1984) "Development of the Nile River System." In Mohamed O.Beshir (ed.) *The Nile Valley Countries: Continuity and Change*, vol. 1 Khartoum: Fal Advertising and Printing Press Ltd.

Kifle lemma & Yosef Gebrehiwot (1999) "The Food Security Situation in Ethiopia" In Taye Assefa (ed.) *Proceedings of the First Workshop of NOVIB Partners Forum on Sustainable Land Use-Food Security through Sustainable Land Use: Policy on Institutional, Land Tenure, and Extension Issues in Ethiopia*, pp 60-77, Addis Ababa, January 14, 1999.

Mason, Simon A. (2004) *From Conflict to Cooperation in the Nile Basin*, Center for Security Studies, Swiss Federal Institute of Technology, Zurich.

Mateos Mekiso (1997) "Environmental Consideration in the Nile Basin Water Resources Development Programme." Paper presented at *the 5th Nile 2002 Conference*, pp 403-413Addis Ababa, February 24-28, 1997.

Ministry of Water Resources (1999) Abbay River Basin Integrated Development Master Plan Project, Executive Summary, FDRE, MoWR, Addis Ababa.

Ministry of Water Resources (1997) Baro-Akobo River Basin Integrated Development Master Plan Project, Executive Summary, FDRE, MoWR, Addis Ababa.

Ministry of Water Resources (1998) Tekeze River Basin Integrated Development Master Plan Project. Executive Summary, FDRE, MoWR, Addis Ababa.

Mortimore, Michael (1998) *Roots in the African Dust: Sustaining the Sub-Saharan Drylands*, Cambridge University Press.

Naden, Corinne J. (1973) *The River Nile*. Bas printer Ltd. London.

Nile Basin Initiative (2001) Shared Vision Program, Efficient Eater Use for Agricultural Production, Project Document, Council of Ministers, Nile-COM.

Nile Basin Initiative (2001) Shared Vision Program, Nile Transboundary Environmental Action Project, Project Document, Council of Ministers, Nile-COM.

Nile Basin Initiative (2001) Eastern Nile Subsidiary Action Program: Integrated development of the Eastern Nile (IDEN), Project identification document (PID), Summary, Eastern Nile Concil of Minsters (ENCOM), May 2001.

Nile Basin Initiative (2005) Nile Transboundary Micro-grants Program, National Action Plan for Ethiopia, (NBI/NTEAP). Prepared by the Local Micro Grant Coordination Office, Addis Ababa, Ethiopia,

Nile Basin Initiative (2006) Eastern Nile Subsidiary Action Program: Overview, March 2006, (Unpublished).

Nile Basin Initiative (2006) The Shared vision program: An Overview and Status, the first Water Resource Planning Management Project Steering Committee Meeting January 19, 2006 (Unpublished).

Nile Transboundary Micro-grants Program (2006) National Action Plan for Ethiopia, (NBI/NTEAP), Ethiopia.

Nicol, Alan (2003) "The Nile: Moving Beyond Cooperation," UNESCO-Green *Cross International Project*, World Water Assessment Programme.

Rosegrant, M., Cai, X. and Cline, A. (2002) *World Water and Food to 2025: Dealing with Scarcity,* IFPRI, Washington DC.

Shibru Tedla (2000) "Poverty and Environment." Paper presented on the International Conference on *Poverty Reduction Alleviation Policy and Strategies in Ethiopia*, organized by the Ethiopian International Institute for Peace and Development, May 15-18, 2000, UN-ECA, Addis Ababa, Ethiopia, Unpublished.

Tesfaye Tafesse (2001a) *The Nile Question: Hydrpolitics, Legal Wrangling, Modus Vivendi and Perspective*, Lit Verlag Munster-Haburg-London

_______ (2001b) "An Appraisal of Shared Water Dispute Resolution Mechanisms in the Nile Basin." Ethiopian Development Forum Bulletin of the Institute for Development Research, pp1-26, Addis Ababa University.

The Eastern Nile Subsidiary Action Program (2001), Integrated Development of the Easter Nile Project Identification Document, Summary. Adopted at the 8th ENCOM metting, Cairo, Egypt, May 17-18, 2001.

The Reporter, Vol. IX, No. 456, June 4, 2005 : "Humanitarian conditions and the response of nine regions". *The Reporter*, Vol. IX, No. 456, Page 8, Saturday June 4, 2005, Addis

Ababa, Ethiopia. (Based on "A joint government and humanitarian partners appeal - May 4, 2005".

Waterbury, John (1987) "Legal and Institutional Arrangements for Managing Water Resources in the Nile Basin," *Water Resources Development* V 3 No 2, Butterworth and Co Publishing Ltd.

Waterbury, J. and Whittington, D. (1998) "Playing Chikens on the Nile ? The Implication of Microdam Development in the Ethiopian Highlands and Egypt's New Valley Project." Paper Presented for *the 5th Nile 2002 Conference*, Addis Ababa February 24 -28 ,1997

Webb, P., Braun, J and Yisehac Yohannes (1992) "Famine in Ethiopia: Policy Implications of Coping Failure at National and Household Levels." *Research Report* 92, IFPRI, Washington , DC.

Wolde-Selassie Abbute (2001) "Rural Local Institutions and Livelihood Security: The Case of Relocated Peasant in Belese Valley, North Western Ethiopia.". In Yared Amare (ed.) *Food Security and sustainable Livelihood in Ethiopia, Proceeding of the Symposium of the Forum for Social Studies*, pp 76-204 Addis Ababa, 10-11 March 2000.

Wondeimeneh Thilahun, (1997) *Egypt's Imperial Aspiration over Lake Tana and the Abbay*. Addis Ababa, United Printers Ltd.

Yacob Arsano (1997) "Toward Conflict Prevention in the Nile Basin." Paper presented at *the 5th Nile 2002 Conference*, Addis Ababa, February 24 -28, 1997.

Yosef Yacob (2004) "From *UNDUGU* to the Nile Basin Initiative: An Enduring Exercise in Futility." *Addis Tribune*, January 30, 2004.

Internet Sources

-The Nile Basin Initiative-http://www.nilebasin/org/

-The Eastern Nile Technical Regional Office-http://www.nilebasin/org/entro

VALUING WATER SUPPLY SERVICE IMPROVEMENTS IN ADDIS ABABA

Kinfe G.Egziabher[1] and Berhanu Adnew[2]

Abstract

Using the contingent valuation method (CVM), the study sets out to analyze determinants of households' willingness to pay (WTP), estimate total WTP, and derive aggregate demand and aggregate benefit for improved water supply service. The study used cross-sectional data collected from 240 households in Addis Ababa, the capital city of Ethiopia through closed-ended value elicitation format with open-ended follow up questions. The empirical models adopted by this study are probit and tobit models. The tobit model is used to identify socio-economic factors that affects the WTP of households and to estimate aggregate demand and aggregate benefits for the proposed improvement in water supply service. The probit model is used to calculate the mean WTP for the closed-ended format.

The tobit model shows that there are several explanatory variables that affect the WTP value. Income of the household, sex of the respondent dummy (female = 1), education (both secondary and tertiary level), households' year of stay, households not using tank as a storage, wealth of a household, employment status of the respondent dummy (employed = 1), households satisfaction with the existing service, and location of the study site (Addis Ketema) have positive and significant effects on willingness to pay. Family size has negative and significant effect on willingness to pay.

The mean WTP values are 15.34 and 20.20 cents per Baldi (a 20 liter bucket) for the improved water supply service as calculated from the tobit and probit model, respectively. The total WTP amount from the sample of 126,108 households in Addis Ababa sub-cities was found to be Birr 154, 198.26 per day.

The area under the demand curve represents the gross value of consumers' surplus which is Birr 181,935.36 per day if water is considered as a free good. But water is an economic good and if a new tariff rate of the authority proposes to be 8 cents per Baldi the consumers' surplus will be reduced to Birr 94,397.85 per day. The rest of the benefit is distributed to the water authority (AAWSA) Birr 80,364.96 in the form of revenue and Birr 7,172.55 as a dead weight loss per day.

Key words: water, supply, improvement, CVM, WTP, AAWSA

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[1] Admas University College, E-mail: kinfeg@yahoo.com
[2] EEPRI, Agriculture and Rural Development Division Head

List of Acronym

AACG	Addis Ababa City Government
AAWSA	Addis Ababa Water and Sewerage Authority
BoFED	Bureau of Finance and Economic Development
CSA	Central Statistical Authority
CVM	Contingent Valuation Method
EEPRI	Ethiopian Economic Policy and Research Institute
MoWR	Ministry of Water Resources
NGO	Non -government Organization
WTP	Willingness to Pay
WTA	Willingness to Accept

1. Introduction

Water supply service in Ethiopia is found far below the required level. According to CSA (2000) cited by MoWR (2003) states that for all the water development activities achieved so far, the average access to safe water supply is 28% of the total population of Ethiopia. The average per-capita consumption in urban areas is close to15 liter per capita per day. This can be taken as an example of a very low supply and coverage level.

Lack of adequate and safe water supply and sanitation remain two of the main transmitters of disease in Ethiopia such as diarrhea, cholera and dysentery, which are potential causes of loss of life especially in the case of children. Moreover, water and sanitation inadequacies hinder economic and social development that constitutes a major impediment to poverty alleviation.

Recently, Addis Ababa has been undergoing rapid changes in terms of its size and importance. In relation to this, it was forecasted that its water demand would substantially increase in the subsequent decades. The root causes of the problems of the existing water supply system in this city includes: rapid growing of population, fast expansion of metropolitan area, financial constraints, high rate of water wastage, and administrative constraints.

In relation to this, to improve water supply service in Ethiopia, the government has implemented integrated short and long-term plans. These phenomena call for immediate efforts to improve the existing water supply and promote the construction of new supplies so as to cope up with the increasing demand for water.

Nevertheless, most previous studies made on the city water supply system focus on the development of supply-oriented approach to deal with the water supply service problems. But along this, to attain an improved water service to residents of the city, an assessment on effective demands of the majority of the households is also imperative. According to Whittington et al. (1990) a new vision based on the demand-oriented approach has emerged. This new approach asserts that water utility bodies need to understand actual household water use behavior and the observed ability and willingness to pay for improved water services.

Hence, this information gap on the household water demand behavior needs to be investigated and reconsidered. The purpose of this paper is, therefore, to examine the household's willingness to pay for improved water supply service. More specifically it attempts to identify factors that affect households WTP and determine aggregate benefit for improved water supply services. Along this, the study tries to evaluate the demand for improved water service by inhabitants of the city based on their WTP.

In general, the supply and demand side constraints are relevant for informed policy decisions. With this premise to assess the household's willingness to pay for improved water supply service, the study employs a CVM. This method involves obtaining direct information from individual households about their willingness to pay for improvement in water services.

1.1 Objectives of the Study

The objectives of this study include the following:

1. Examine the status of water supply services in Addis Ababa.
2. Estimate household’s willingness to pay for improved water supply service.
3. Identify factors determining willingness to pay, and.
4. Use the willingness to pay responses to calculate aggregate benefits.

The remaining part of the paper is structured as follows: section two deals with review of literature. The third section gives the data, elicitation method and models. In the fourth section, description of variables, descriptive analysis, econometric results and discussion is presented. The last chapter deals with the summary and conclusion of the study.

2. Review of Literature

2.1 Theoretical Literature Review:

This section deals with ways in which how economists attach values to the resources provided by the natural environment. In relation to this, we deal with the theoretical foundations for the techniques that economists have developed for environmental valuation in connection with the resources. The economic approach to the valuation of resources is based on the contribution of the resources to human welfare. Whether the good or services is marketed or non-marketed, its unit economic value is determined by the welfare contributions that it makes to humans. Consequently, the need to demonstrate the importance of environmental policy is the ultimate objective of the valuation.

2.1.1 Measures of Welfare Changes

The change in utility due to change in prices, quantities or both leads to a change in welfare of the society. Changes in welfare are measured in terms of each individual's personal assessment of changes in well-being. For traded commodities, the demand curve depicts the marginal willingness to pay (WTP) for the good or service. The household will consume all units of the commodity where the marginal WTP exceeds the market price. The consumer enjoys a consumer surplus for all points where the marginal WTP is higher than the market price. The welfare change associated with a change in the price of a marketed commodity is often measured using the change in consumer's surplus, derived from the Marshallian demand curve with a constant level of income.

For non market ecosystem service, the maximum WTP for an improvement in quantity or quality is the area between the initial and new levels of the resource under the demand (marginal benefit) curve. Value estimation then involves determining directly or indirectly the shapes of these marginal WTP curves for the ecosystem services (Shiferaw et.al., 2005).

According to Shiferaw et al. (2005) a given household maximizes its welfare (U) from consumption of a vector of marketed goods (c), ecosystem goods and services (q) and has a fixed budget y, such that:

$$\text{Max } U = U(c,q) + \mu(\mu - p'c) \qquad \textbf{(2.1)}$$

The standard utility-maximizing solution to this problem will give the Marshallian demand function for the tradable commodity:

$$c^* = c\,(p,q,y) \qquad \textbf{(2.2)}$$

which is a function of a vector of market prices (p), the disposable income (y) and the ecosystem services (q) considered to be a public good. If this is substituted in to the utility function it could be derived:

$$v\,(p,q,y) = U\,(c(p,q,y),\, q) \qquad \textbf{(2.3)}$$

The marginal effect of the change in the level of the public good q_i on household welfare can be derived as:

$$\frac{\partial v(p,q,y)}{\partial q} = \frac{\partial U\big(c(p,q,y),q\big)}{\partial q} \text{-} \qquad \textbf{(2.4)}$$

This is equal to the marginal valuation of the environmental good. For a given change in q from q^o to q^1, the welfare effect on household **h** can be estimated as

$$\Delta U^h = v^h(p,q^1 y) - v^h(p,q^0,y) = \int_{q^0}^{q^1}\left[\frac{\partial v^h(p,q,y)}{\partial q}\right] \qquad \textbf{(2.5)}$$

The total welfare effect (WTP) summed over all the affected households (h) can be calculated as:

$$\sum_h \Delta U^h = \sum_h \int_{q^0}^{q^1}\left[\frac{\partial v^h(p,q,y)}{\partial q}\right] \qquad \textbf{(2.6)}$$

The compensating surplus (CS) and equivalent surplus (ES) measures (analogous to the compensated variation (CV) and equivalent variation (EV) for price changes) can also be directly derived from the indirect utility function. For an improvements in q from q^o to q^1 the compensating surplus (CS) and equivalent surplus (ES) measures can be computed as:

$$v\,(p,q^1{}_{,}\, y - CS) = v(p,\, q^0,\, y) \qquad \textbf{(2.7)}$$

$$(p,\, q^1,\, y) = v(p,\, q^0,\, y + ES) \qquad \textbf{(2.8)}$$

The expenditure function for household h is given by e^h (p, q). The aggregate welfare change measures for a change in q from q^o to q^1 for compensating surplus (CS) can be

$$CS = \sum_h (e^h(p,q^0,u^0) - e^h(p,q^1,u^0) = \sum_h \int_{q^0}^{q^1} \left[\frac{\partial v^h(p,q,u^0)}{dq} \right] dq \qquad \textbf{(2.9)}$$

The aggregate equivalent surplus (ES) measure for a change in q from q^o to q^1 can be given as:

$$ES = \sum_h (e^h(p,q^0,u^1) - e^h(p,q^1,u^1) = \sum_h \int_{q^0}^{q^1} \left[\frac{\partial v^h(p,q,u^1)}{dq} \right] dq \qquad \textbf{(2.10)}$$

The compensating surplus (CS) is the maximum amount of money that the individual is willing to pay (WTP) to secure an increased provision of the public good q. The equivalent surplus (ES) measures the minimum sum of money that must be given to individuals (WTA) before the change to make them as well-off as they would have been following an increase in q. This forms the basis for valuation of non- marketed ecosystem services.

The measure of welfare change can be either positive (a welfare gain) or negative (a welfare loss). For a proposed welfare gain the compensated variation measures tell us how much money income the individual would be willing to pay (WTP) to ensure that the change occurs; while the equivalent variation measure tell us how much extra money income would have to be given to an individual (WTA) for the person to attain the final improved utility level in the absence of provision change occurring.

2.1.2 Methods for valuing environmental resources

Economics literature indicates that the total economic value of an environmental good is composed of two types: use value and non-use value. The total economic value of water can be broadly defined as the maximum amount the user would be willing to pay for the use of water.

In relation to this, various valuation methods are available to attach economic values to non-marketed environmental resources. According to Callan and Thomas (1996), these methods can be discussed under two categories: indirect (revealed) method and direct (stated preference) methods.

The Indirect Method

Economists use indirect methods to make inferences about markets that are linked to the environmental good under investigation. Although there are many indirect estimation methods, in this study, the two common valuation methods are: the travel cost method (TCM) and the hedonic price method (HPM).

The travel cost method (TCM) depends on information about the amount of money and time people spent getting in to a site to infer a value for that site. According to Callan and Thomas (1996) the travel cost method (TCM) has a primary advantage of measuring environmental benefits based on actual behavior, but it ignores non-use value. Furthermore, this method focuses on recreational use, making it ineffective for estimating any incremental benefits that might be accrued to commercial users of a resource.

The hedonic price method (HPM) is based on the theory that a good or service is valued for the attributes or characteristics it possesses. This perception of value suggests that implicit or hedonic price exist for individual product attributes, and these can be determined from the explicit price of the product. According to Carson (2000), however, this method does not capture non-use values that are very important when we deal with environment and hence underestimate the total economic value.

The Direct Method

The direct method estimates environmental benefits according to responses or observed behaviors directly tied to the environmental quality. The common method in this approach is CVM.

When market data are unavailable or unreliable, economists can use alternative estimation methods that rely on hypothetical market conditions. Such methods typically use surveys to inquire about individuals' WTP for some environmental policy initiative. This survey approaches to benefit estimation is known as the CVM because the results are dependent up on the hypothetical market devised. CVM is based on classical economic theory using Hicksian technique, that is, either compensation variation (WTP) for improved environmental services or equivalent variation (WTA) compensation for environmental deterioration.

The CVM first came into use in the early 1960s by Economist Robert K. Davis in 1963 when he used questionnaire to estimate the benefits of outdoor recreation in a Marine backwoods USA. Since then, the contingent valuation (CV) technique has been utilized by various economists to measure the benefits of a variety of goods including recreation, hunting, water quality and toxic waste dumps (Mitchell and Carson, 1989).

In general, CVM helps researchers to capture the total value of the good: both use and non-use values and its flexibility facilitate valuation of a wide range of non-marketed goods. As a result, this method is becoming the most preferred valuation at present. Thus, based on the reasons mentioned above CVM is employed for this study.

Critiques on CVM

Although a number of researchers have employed the CVM, using such survey method has some basic problems in the sense that survey respondents could give biased information. Five major potential types of bias have been identified as follows (Callan and Thomas, 1996).

Strategic bias-an individual may have an incentive not to reveal his/her true preferences about an environmental good when responding to questions WTP. This bias may arise from free-rider ship problem typically associated with public good. Individuals may be tempted to understate their true WTP for public goods in the hope of a "free ride" while others pay for the provision of the good or service. Alternatively, if the price to be charged for the public good is not tied to an individual's WTP response, the respondent may over-report WTP in order to ensure the provision of the good. To reduce this bias, the questionnaire for this study is designed to the respondents with some how detail description of the proposed improvement of the scenario.

Hypothetical bias- because the market is a hypothetical one, the respondent may view the questions as not believable or unrealistic, and respond with an equally unrealistic estimate of WTP. If respondents are not familiar with the scenario presented, their response can not be taken as their real WTP. However, this type of bias is not likely significant for water supply service in the study area. Because, in Addis Ababa different water systems have already been built; our respondents are all familiar with public fountains, shared tap connection and private water connections and already understood the possibility that the community will receive improved water supply services. In general, this bias has been tried to minimize in this study by a careful description of the good under consideration for the respondents.

Interviewer bias- the respondent's answer may be influenced by the enumerator who is employed to administer the interview. To minimize this problem, the enumerators were given two days of training and then conducted supervision of the main survey.

Starting point bias- This is mostly associated with bidding games. The choice of a low (high) starting point leads to a low (high) mean WTP. The starting bids used in this study were obtained from the pilot survey so as to minimize this problem.

Information bias- if there is insufficient information about the commodity being valued; the individuals' WTP response may not be equivalent to their actual WTP. In this study to minimize such bias the survey design was administer carefully and gave training to the interviewers.

In general, CVM is widely applicable and applied monetary valuation method despite its limitations. It has potential application to a wider range of environmental goods than any other valuation techniques. It has strong theoretical basis with unique advantage that it estimates income compensating welfare measures. When surveys are properly planned and executed, most of the CVM problems can be eliminated and it would be one of the best methods for estimating environmental benefits. In this study, the value of improved water supply service in Addis Ababa city is estimated by using CVM to measure WTP. Domestic water consumers' were asked questions on their willingness to pay for improved water services.

3. The Data, Elicitation Method and Models

3.1 The Data

In order to fulfil the above mentioned objectives, the study was designed to gather information and necessary data from various sources. The study uses a combination of primary and secondary data. The data used in this study are mainly primary and cross sectional for the year 2006/07 from Addis Ababa. The secondary data was collected from AAWSA, MoWR, CSA, BoFED and other various published sources including journals, development reports, research articles and websites.

The main data source is a contingent valuation (CV) survey conducted in Addis Ababa city. The study employed CVM to solicit the respondents' WTP for improved water services. The contingent valuation (CV) survey questionnaire used in this study was designed to include hypothetical description of the good being valued, socio-economic and demographic characteristics of household, existing water supply situation, water usage and general perception questions. The sample for the study was drawn from three out of ten administrative sub-cities in Addis Ababa, covering a total of six kebeles[3] and a stratified proportional random sample of 240 households were used in the survey, out of which 235 of them were found usable.

A stratified two-stage sample design was adopted. At the first stage 3 sub-cities based on CSA (2004a) study of the economic establishment standards were selected which called Primary Sampling Units (PSUs). Accordingly, Addis-Ketema, Nefas-Silk Lafto, and Bole were selected from lower, medium and higher economic standards, respectively. The household in each sub-city was selected proportionally. From the total 126,108 households, Addis Ketema, Nefas-Silk Lafto and Bole were selected 44,921 (35.6%), 42,978 (34.1%), and 38,209 (30.3%) households, respectively. Accordingly, from the sample of 240 households 85, 84 and 71 were from Addis-Ketema, Nefas-Silk Lafto and Bole, respectively.

Table 1: Summary of sample households (HHs) from each sub-city and kebele

Sub-cities	Total No. of HHs	% of HHs from total	No. of HHs in the sample	Sampled Kebele based on water services	water supply situations (hrs/week)	Total No. of HHs in each kebele	No. of sampled HHs in each kebele
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Addis ketema	44921	35.60	85	14 19	7-16hrs/day 17-24hrs/day	1287 1670	37 48
Nefas-Silk Lafto	42978	34.10	84	03 05	7-16hrs/day 1-6hrs/day	2228 2631	35 49
Bole	38209	30.30	71	05 14	7-16hrs/day Least of all	2232 6220	19 52
Total	**126108**	**100**	**240**			**16268**	**240**

Source: Own survey, 2006

[3] Kebele is the smallest administrative unit in the city. The city is divided in to sub-cities which in turn divided in to kebeles. According to BoFED (2004) there are 10 sub-cities and 203 kebeles in Addis Ababa city.situation (Zerihun, 2005), (Table1 column 6), which is the Second Stage Unit (SSU). AAWSA map indicates that each kebele of the city is segregated to the respective water supply situations. Hence, from Addis-Ketema, kebele 14 and 19 were selected based on water supply situation of 7-16 and 17-24 hrs/day, respectively. Moreover, out of the total 16,268 households of the six kebele, 1,287 and 1,670 households were drawn from kebele 14 and 19, respectively. Finally, from a sample of 85 households in Addis-Ketema, 37 and 48 households were drawn from kebele 14 and 19 on the base of stratified proportionate random sampling, respectively (Table1).The sampling procedure for both Nefas-Silk Lafto and Bole sub-cities were similar steps to that of Addis-Ketema sub-city.

At the second stage, 2 kebeles were selected from each sub-city based on the water supply

To select the respondent from every kebele, the kebele itself was chosen as a starting (reference) point during the survey. After the stratified two-stage sample design, the first household was selected around the kebele based on random method. After the selection of the first household, the remaining households were selected on equal paced interval (every 15th) based on spatial distribution till the households in each kebele were drawn totally.

3.2 Contingent Valuation Elicitation Method

In this study, among various elicitation formats, the single-bounded dichotomous choice format with a follow up question was chosen to obtain a household's willingness to pay for a proposed scenario. Green et al. (1995) indicated that the main reason for using this format is to provide far more information on WTP and information on plausibility of responses than other alternatives.

The scenario assumes that households who do not have private tap water will have connection. Note that households that are going to connect private tap water may not be required to pay initially the costs of connection to the new scheme. Instead, the authority will cover the costs of connection with insignificant increase in the monthly tariff rate. And every household will have improved water supply service. By an improved provision of water, we mean good quality of water which is safe for health and good quantity of water which is available for 24 hours per day.

Before implementing the final survey we conducted the pilot survey using open-ended elicitation format to set up starting bids. The total sample households were randomly divided in to three groups of equal size and each contained 80 households and the three different starting bids (5, 10 and 15 cents[4] per bucket of water) were assigned to households in the different groups

3.3 Empirical Models

3.3.1 The Tobit Model

The tobit model is a censored regression model. Observations on the Latent variable **Y** are missing (or censored) if **Y*** is below a certain threshold level. One of the

[4] The exchange rate at the time of survey was 1USD = Birr 8.38 and 1Birr = 100 cents.

applications of the tobit model is when the dependent variable (for our case maximum WTP) is zero for some individuals in the sample (Maddala, 2002).

The tobit model is used to identify factors that affect the willingness to pay (WTP) of households for the proposed improvements in water supply services. In addition to this, in the tobit model our interest is in finding out the amount of money a respondent spends on improved water services in relation to socio-economic and demographic variables. According to Greene (1997), the general formula of the tobit model is given as follows

$$\mathbf{Yi^* = \beta' X_i + u_i} \qquad \mathbf{(3.1)}$$

Suppose **Y*** is observed if **Yi*** > 0 and is not observed if $\mathbf{Yi^* \leq 0}$.

Then the observed Yi* will be defined as

$$\mathbf{Yi = Yi^* = \beta' X_i + u_i} \quad \text{if} \quad \mathbf{Yi^* > 0}$$

$$\mathbf{=0} \quad \text{if} \quad \mathbf{Yi^* \leq 0} \qquad \mathbf{(3.2)}$$

Where

β' = A vector of coefficients ,

$\mathbf{X_i}$ = A vector of explanatory variables ,

$\mathbf{u_i}$ = The error terms that are independently and normally distributed with mean zero and a common variance δ^2 .

Estimation of the tobit model is similar to that of truncated regression. Following Greene (1997) the log likelihood for the censored regression model is

$$LnL = \sum_{yi>0} -\frac{1}{2}\left(\ln(2\pi) + \ln\delta^2 + \frac{(yi - B^1 xi)^2}{\delta^2} \right) + \sum_{yi=0} \ln\left[1 - \phi\frac{(B^1 x_i)}{\delta} \right] \quad (3.3)$$

The two parts correspond to the classical regression for the non limit (continuous) observations and the relevant probabilities for the limit (zero) observations, respectively.

Based on the above behavior of the model, tobit analysis is appropriate for this study. The equation in this tobit model is indicated as follows.

$$\begin{aligned} \mathbf{MWTP_i^*} = {} & B_0 + B_1 INCH + B_2 SIZF + B_3 WEAH + B_4 SEXR + B_5\,AGER + B_6\,EMPR + \\ & B_7\,ATTR + B_8 LOC_{AK} + B_9\,TANK + B_{10}\,STAT + B_{11}\,INFO + B_{12}\,IB + \\ & B_{13}\,STAY + B_{14}\,STAT + B_{15}\,SATI + B_{16} EDUC_1 + B_{17}\,EDUC_2 + B_{18}\,EDUC_3 \\ & + B_{19}\,LOC_{BO,} + U_i \quad \text{-(3.4)} \end{aligned}$$

$MWTP_i^*$ = maximum willingness to pay for improved water services. And MWTP* is a latent variable which is not observed when it is less than or equal to zero but is observed if it is greater than zero.

$B_{0,}$ $B_{1,}$ ----- = are coefficients, i = 1, 2, 3, -------

The description of all variables of the above regression are given in Appendix1

3.3.2 The Probit Model

In the probit model of single bounded dichotomous format, households are given initial bid which they may accept or reject. The basic model for analyzing dichotomous contingent valuation (CV) responses is the random utility model. A study by Hanemann (1984) indicates that he had constructed the basic model. The central theme of this theory is that although an individual knows his/her utility certainly, it has some components which are unobservable from the view point of the researcher. As a result, the researcher can only make probability statement about respondent's 'yes' or 'no' responses to the proposed scenario.

The indirect utility function for the j^{th} respondent can be specified as follows:

$$U_{ij} = U_i\,(Y_{j,}\, X_j,\, \varepsilon_{ij}\,) \qquad \textbf{-(3.5)}$$

Where Y_j= j^{th} respondent's income

i=1 denotes the final state and i=0 the status quo (the initial state)

X_j= vector of household characteristics and attributes of a given choice

ε_{ij}= random component of the given indirect utility

If a payment (the initial bid, β_i^*) is introduced due to improvement in water supply service, the household accepts the proposed bid only if the utility with the contingent valuation (CV) program , net of the required payment, exceeds utility of the status quo.

$$U_1\,(Y_j - \beta_i^*, X_j,\, \varepsilon_{1j}\,) > U_0\,(Y_{j,}\, X_j,\, \varepsilon_{0j}\,) \text{-} \qquad \textbf{(3.6)}$$

For the researcher, however, the random components of preferences cannot be known and s/he can only make probability statement of 'yes' or 'no' responses. Thus, the probability that the respondent says 'yes' is the probability that s/he thinks that s/he is better off in the proposed program. For individual j, the probability is:

$$\Pr(Yes_j) = \Pr(U_1(Y_j - \beta_i^*, X_j, \varepsilon_{1j}) > U_0(Y_j, X_j, \varepsilon_{0j})) \qquad \textbf{(3.7)}$$

This probability statement provides an intuitive basis to analyse binary responses. Assuming the utility function is additively separable in deterministic and stochastic preferences:

$$U_i(Y_j, X_j, \varepsilon_{ij}) = U_i(Y_j, X_j) + \varepsilon_{ij} \qquad \textbf{(3.8)}$$

with the additive specification of equation (3.8), the probability statement for respondent j becomes:

$$\Pr(Yes_j) = \Pr[U_1(Y_j - \beta_i^*, X_j) + \varepsilon_{1j} > U_0(Y_j, X_j) + \varepsilon_{0j}] \qquad \textbf{(3.9)}$$

The goal of estimating econometric (or parametric) models from dichotomous choice of contingent valuation (CV) responses is to calculate mean WTP for the services described. In addition, parametric models allow for the incorporation of respondent characteristics in to the willingness to pay functions (Haab and McConnell, 2002). In this study we discuss the effect of socio-economic and demographic factors of the respondent on WTP with the help of tobit model. In connection to this, the probit model in this study is used to calculate mean willingness to pay for the closed -ended format.

The Probit model can be defined as:

$$Ti^* = \boldsymbol{\beta' X_i + u_i}$$

Where

β' = Vector of the parameter of the model coefficients

$\mathbf{X_i}$ = Vector of explanatory variables

$\mathbf{u_i}$ = The error term assumed to have normal distribution with zero mean and a common variance δ^2 (Greene,1997)

Ti*= Unobservable households' actual WTP for improved water supply services. Ti*is simply a latent variable. What we observe is a dummy variable $\mathbf{WTP_i}$, which is defined as: $\mathbf{WTP_i} = 1$ if $Ti^* \geq \boldsymbol{\beta_i}^*$ $\mathbf{WTP_i} = 0$ if $Ti^* < \boldsymbol{\beta_i}^*$.

In the single bounded elicitation format, the i^{th} respondent is asked if s/he would be willing to pay the initial "bid", **($\boldsymbol{\beta_i}$*)** to get improved water supply services.

4. Description of variables, Descriptive Analysis, Econometric Results and Discussion

4.1 Description of Explanatory Variables

The hypothesis that is being tested in this analysis indicates how households' socio economic and demographic factors affect the household's decisions on WTP for improved water services. This study collected several households' demographic and socioeconomic factors as well as current status of water services. Therefore, those variables are considered to determine the willingness to pay and willingness to connect to the new improved water supply services are given in Annex1.

4.2 Summary of Descriptive Analysis of the CVM Survey

A total of 240 sample households were interviewed in the survey. Out of this total sample, only 235 were analyzed and the remaining 5 were removed due to protest zero. Thus, from the total of 235 sample respondents, 140 (59.6%) are head of the households and the rest 95 (40.4%) are not. Out of total respondents, 167 (71%) are female and the rest 68 (29%) are male. The average family size of the total sample household is 4.79 and ranges from 1 to 10. Their level of education ranges from none to higher education graduates. Out of the total respondents, 52 (22.1%) were categorized under illiterate group. Those with formal education of grade 1 to 6 grades (primary education) constitute 57 (24.3%) of the total respondents. Those with formal education from grade 7 to 12 grade are 81 (34.4%) and grouped under secondary school. Only 45 (19.1%) of the respondents have attained formal education above grade 12 of higher education (tertiary school).

The average monthly income of the sampled household was Birr 1339.33 ranging from the minimum of Birr 110 to the maximum of Birr 8,500 per month. The mean household consumption of water was 9 *Baldi* or 180 litters per day. Based on this information, the average households' water consumption per month was 5,400 liters (which is 5.4 m^3/month). For the year 2006/07, the minimum water consumption block tariff rate of AAWSA for less than 7 m^3 is birr 1.75/m^3. Thus, on average, the household's water consumption expenditure is Birr 9.45 per month.

As compared to the mean monthly income of the households (that is, Birr 1339.33), households in the sampled area spend only 0.71% (excluding meter fees) of their income on water. Though, this is with in the range of the World Bank's recommendation, which states a household should not spend more than 5% of his monthly income on water, it is far below the recommended level. This suggests that the households in the sampled area can spend for improved and reliable water supply services.

The other finding of the study showed the mean per capita consumption of the sample household was around 37.6 liters per day. However, according to Gleick (2001) the absolute minimum per capita per day of water is 50 liters based on the United Nation's target. The amount in the study area is below this minimum requirement.

Data for the wealth of the households, which was proxy by whether the household owns house or not, showed that 99 (42.2%) live in rented houses from individuals, kebeles and government while 136 (57.8%) of the interviewed households live in their own houses. Among those who live in their own houses 65 (47.79%), 45 (33.08%) and 26 (19.135) were from higher, medium and lower economic standard groups, respectively.

The study also tried to look whether the household uses tank as storage of water or not. The survey finding indicated that out of total households in the survey area, 71 (30.21%) of the respondents said they own tanks for water storage to cope with low water pressure and water outage. Out of those households who have tanks as a storage of water 42 (59.15%) of the respondents said the storage allow them continuous water supply while the remaining 29(40.85%) of the respondent said the storage does not allow them continuous water supply.

Out of those households who know tariff rate increment, 73(39.89%) said AWSAA'S tariff rate increment is high, 99(54.09%) said AAWSA'S tariff rate increment is medium, the remaining 11(6.01%) of the households said the tariff rate increment is low. With regard to households' water consumption due to increase in tariff rate, 148(80.88%) of the household responded that no change in their consumption, 35(19.12%) said their consumption decrease. This implies that the majority of households' water consumption would not be affected by tariff rate increment. Hence, if AAWSA revised a new tariff rate for cost recovery system, the households' water consumption may not be affected and, hence, might be affordable by the majority of the residents.

The mean willingness to pay for the whole sample is 15.34 cents (ranging from 0 to 50cents) per bucket of water, which implies that the sample sub-cities were willing to pay more than the current tariff rate which is 3.50 cents per bucket of water for the lowest consumption block and 7.60 cents per bucket for the highest consumption block.

Of the three clusters, it was found that the highest mean WTP of 18.96 cents per bucket in area with higher economic standard. The mean WTP from the medium economic standard and lower economic standard groups were 12.33 and 15.34 cents per bucket, respectively. The result showed that households from the low economic standard group were willing to pay more than households in the medium economic standard group. The reason is out of the total public taps in the sample, 81.85 % of the public tap users were in the low economic standard group. Thus, these households are more willing to pay for improved water service to avoid long queue.

The other finding of the survey indicated that, out of the total observations 91 (38.72%) of the households have no private pipe lines, out of which 11(12.09%), 27(29.67%) and 53 (58.24%) are from higher, medium and lower economic standard groups, respectively. Where as the remaining 144 (61.28%) of the households have private pipe lines, out of which 61 (42.36%), 56 (38.89%) and 27 (18.75%) were from higher, medium and lower economic standard groups, respectively.

The other observation from the study result indicated that households' with no access to private pipe line were more willing to pay than households' with access to private pipe lines. The reason is probably households who don't have private pipe line spend a lot of time to fetch water from outside source. Moreover, these households may buy water from vendors at relatively higher price than the authority's tariff rate. Hence, households with no access to private pipe lines show more preference to the improved service than the counter part. The summary of descriptive statistics for the variables used in the multivariate regression analysis is given in appendix 2.

4.3 Econometric Results and Discussions

In this section, results obtained from regression estimation of willingness to pay equation are presented. As mentioned above, two maximum likelihood estimates are made.

According to the rule of thumb if the pair wise or zero order correlation coefficient between two regressors is high, say, in excess of 0.8, then multicollinearity is a serious problem. However, a test was made to check whether or not the problem existed is severe or not. The result indicated multicollinearity is not a serious problem as the correlation matrix results are less than 0.8.

A test for the presence of heteroscedasticity problem in the model was also done. The test result shows that the null hypothesis of homoscedasticity is rejected implying that there is heteroscedasticity problem in the model, which is expected from survey of the cross sectional data (Appendix 3). Because of this problem the study can not use a simple tobit model but a hetroscedastic tobit model (results corrected for hetroscedasticity) using LIMDEP Version 7.0.

A test for measures of model goodness of fit was also done with model chi-squared statistic (LR_{Model}). The LR chi-squared measures the overall significance of the model with the null hypothesis that all parameters associated with covariates are zero is rejected at 1% significance level. Thus, the model is statistically acceptable. It implies that the model is acceptable to explain the relation between willingness to pay and its explanatory variables.

To check for the existence of starting price bias, the starting bid is used in the model as an explanatory variable. To check whether or not asking representatives of the households rather than the heads affects the willingness to pay responses, a dummy variable (status of the respondent) taking 1 if the head is the respondent; 0 otherwise is included in the model. To capture the effect of stratification, the location of the study area LOC_{Bo} is dummy variable taking 1 if it is Bole sub-city, 0 otherwise. LOC_{AK} is dummy variable taking 1 if it is Addis-Ketema sub-city, 0 otherwise are included in the model.

4.3.1 Tobit Model: Results and Discussion

The Tobit results obtained using a Limdep Version 7.0 are given in Table 2.

Income of the Household

The variable consistent with a priori expectations is monthly income of the household. It is significant at 1% and has the expected positive sign. This result confirms with economic theory, which states that an individual's demand for a particular commodity depends on his/her income, and that income and quantity demanded are positively related, except in the case of inferior goods. The result of the survey shows higher income group are more willing to pay for an improved water supply service than lower income group. Hence, the income of the households needs to be considered to introduce a new tariff rate structure which will help to cover the financial costs of the proposed improvements.

Education Level of the Respondent

From the four categories of educational level, the illiterate group is taken as a bench mark group to avoid a dummy variable trap. The other three educational dummies show positive effect on willingness to pay amount as compared to the bench mark group. The primary education dummy is not significant at 10% level of significance.

The secondary and tertiary education dummies are significant at 10% level of significance. This may be due to the fact that as compared to the bench mark group the households of secondary and tertiary education groups are more aware about health and sanitation benefits of the improved water services.

Employment status of the Respondent

The variable employment status of the respondent is found to be positive and significant at 10%, as expected. The result is consistent with the idea that those respondents who are employed in government organization, private organization, NGO's, own business and other related areas are more willing to pay than unemployed respondents. This is because the exposure of household that is working in different sectors is expected to understand the benefits of improved water services and their effect on human being than the other group.

Table 2: Tobit estimates for the determinants of WTP for improved water supply services (Heteroscedastic Tobit)

Variable	Coefficient	Std. Er	b/St.Er.	P-Values	Mean of X
CONST	4.449472436	2.2901043	1.943*	.0520	
INCH	.0001715432	.0000533710	3.214***	.0013	1339.3285
SEXR	.2582252614	.14324646	1.803*	.0714	.71063830
AGER	-.0022208961	.0059684669	-.372	.7098	34.974468
FAMS	-.0845664581	.036997020	-2.286**	.0223	4.7872340
EDUC1	.2114814859	.18721616	1.130	.2586	.24255319
EDUC2	.3564540480	.21652342	1.646*	.0997	.34468085
EDUC3	.4393207847	.22956193	1.914*	.0557	.19148936
STAY	.01643804708	.0056196780	2.925***	.0034	19.952837
TANK	.5254671750	.16506017	3.183***	.0015	.69787234
ATTR	-.1906904134	.14743595	-1.293	.1959	.78297872
WEAL	.5896728854	.16945571	3.480***	.0005	.57872340
EMPR	.2621695535	.15043565	1.743*	.0814	.37446809
INFO	.1029382746	.16798658	.613	.5400	.77446809
SATI	.3998056983	.17182031	2.327**	.0200	.83829787
IB	.02389464906	.015496762	1.542	.1231	9.9787234
STAT	.1276074785	.16764284	.761	.4465	.59574468
LOC_{AK}	.6530232215	.18891336	3.457***	.0005	.34042553
LOC_{BO}	.1933452929	.17510182	1.104	.2695	.30638298

No of Observations = 235

Log likelihood=-773.2196 Restricted log likelihood =-836.6690

Source: Own survey result, 2006

***, **, * indicate significance at 1%, 5%, and 10% levels respectively.

Wealth of Respondent
In this study ownership of house is used as a proxy to wealth. As expected, this variable is found positive and highly significant at 1% level of significance. That is, those households living in their own houses are more willing to pay for the proposed improvements than those living in rented houses. This may be the fact that households who own private houses are concerned more to pass the improved water services to their children (bequest value) than those households who do not own private houses..

Sex of Respondent
This variable has a positive sign as expected and is significant at 10% level of significance. This shows that female respondents are more willing to pay to connect improved water services than male. This result really tells us the experience of most developing countries with regard to gender. It indicates that female headed households are primarily responsible for the task of fetching water and hence greater preferences for improved water services by paying more as compared to their counter male headed households.

Family Size of the Household
Family size of the household variable was found to be significant at 5 % with a negative parameter estimates. This suggests willingness to pay for improved water services decreases as family size of the household increases. The reason could be large family size of households' increase their water consumption which could discourage the family due to high bill charge services and hence willing to pay less for the proposed improvements than small size households.

Household Use of Tank for Water Storage
Households who do not use tank as storage for water was another variable found to be significant at 1% level of significance. Since the parameter estimate is positive, it implies that households who don't use tank as storage for water tend to be willing to pay more as compared to households who own tank. This indicate that households who do not use tank as a storage for water frequently suffer from low water pressure and water tap interruptions than households who use tank as a storage. These households are forced to buy water from vendors at higher price than the AAWSA tariff rate.

Household Year of Stay in the House
The variable household's year of stay in the house is positive and it is significant at 1% level of significance. That is, those households who have been stayed in a

particular house for long year are more willing to pay for the proposed improvements than their counter parts. The possible reason could be those households that are staying for a long year in that house are mostly in the older quarter of the city. The majority of the houses in this old quarter of the city are poor in terms of infrastructure and social facilities. A related problem especially in the old quarter of the city is that un-planned houses and overlapping lots contribute to a high rate of unaccounted for water (UFW) due to leakage and illegal connection. The replacement and maintenance services due to old age of pipe for the household in the old settlement is poor since AAWSA at this time focuses on expanding service for un-served households. The above mentioned reasons exacerbate the existing water supply problem in the old quarter of the city and thus the households that are staying long in that area are more willing to pay for improved water services as compared to short stayed households.

Location of the Study Sites

Addis Ketema site dummy was positive and significant at 1% level of significance, suggesting that household in this site is willing to pay more than the bench mark (Nefas-Silk Lafto) site , keeping all other things constant. The possible reason could be that considerable part of the households in the former sub-city use public tap and hence they incur high costs in terms of time and labour for fetching water from the existing water sources. Thus, households from Addis Ketema site are more willing to pay for the new improved water systems to avoid the high opportunity costs than the bench mark site.

Level of Satisfaction the Household with the Existing Water Services

The coefficient for the level of satisfaction the household with the existing water services has the expected sign and statistically significant at 5% level of significance. One possible reason could be those households who are dissatisfied with the current water service due to poor quality, less quantity, unreliability and absence of own private pipe are likely to pay for improved water services than those households who are satisfied with the existing services.

4.3.2 The Probit Model: Calculating Mean WTP

In this study we have already discussed the effect of socio-economic and demographic factors of the respondent on WTP using the tobit model. Thus, the probit model in this study is used to calculate mean willingness to pay for the closed-ended format. According to Hanemann et al. (1991) one of the main objectives of estimating an empirical WTP model based on the contingent valuation (CV) survey responses is to derive a central value (mean) of the WTP distribution. Similarly, Carlsson et al. (2002) cited by Mahmud (2005/06) states that the main reason for estimating the probit model is to obtain an estimate of mean WTP. The result is obtained by regressing the willingness to pay variable on intercept and initial bid variable. The regression result shows the following values.

Table 3: The probit model to calculate mean WTP

Variable	Coefficient	Std. Er	b/St.Er.	P-Values	Mean of X
CONST	2.330989231	.34074517	6.841	.0000	
IB	-.1154249357	.027824861	-4.148	.0000	9.9787234
Dep. var. = yes/no (Y/N)	Mean =.8553191489		S.D.= .3525296318		

Source: Own survey result, 2006

Mean WTP (μ) using the model for the closed -ended format is defined as follows:

$$\mu = -\frac{\alpha_0}{\alpha_1}$$

Where:

$\alpha_0 =$ the constant term

$\alpha_1 =$ the bid coefficient

$$\mu = -\frac{2.330989231}{-.1154249357}$$

$$\mathbf{= 20.20}$$

Thus the mean WTP (μ) calculated from the closed-ended probit model is 20.20 cents per bucket of improved water services. However, the mean WTP is 15.34 cents per bucket of water from responses to the open-ended contingent valuation (CV) survey questions, which is a bit lower than the mean values obtained from the closed-ended probit model estimates. Thus, the finding of the study showed the respondents willingness to pay was in the range of 15.34 – 20.20 cents per Baldi for the proposed improvements of water supply services. The similarity of the mean WTP under the open-ended and closed-ended formats indicates the validity and reliability of the contingent valuation (CV) outcomes in the empirical analysis. Based on the mean WTP of open-ended format, the total values of water services have been estimated in the following section under the improved scenario.

4.3.3 Estimating Total Willingness to Pay and Total Revenue

In this section, the total willingness to pay and the total revenue at different prices that households in the three sub-cities of Addis Ababa are willing to pay is computed. The demand curve for improved water service has also been derived.

There were around 432,967 households and 2,211,552 residents in Addis Ababa in 2004 with an average family size of 5.1 (CSA, 2004b). In the study area, the three sub-cities (Bole, Nefas-Silk Lafto and Addis Ketema) were included with a total of 126,108 households (HHs) and 678,645 residents. The average family size of the study area was found 5.38, which is similar with the CSA result mentioned above. To make the aggregation, class boundaries for the maximum willingness to pay values have been utilized (Table 4).

Table 4: Total WTP and total revenue from improved water services

Class bound. of WTP (in cents)	Class mark of WTP (cents/ Baldi)	Sample Dist. of HHs		Total No. HHs	Total WTP (in cents)	Sample HHs WTP at least that amount (cumm.)		Total HHs WTP at least that amount (Cumm.)	Total Revenue (in cents)
(1)	**(2)**	**(3)No.**	**(4)%**	**(5)**	**(6)**	**(7)No**	**(8)%**	**(9)**	**(10)**
0-5	3	27	11.48	14,477	43,431	235	100	126,108	378,324
6-10	8	69	29.36	37,025	296,200	208	88.51	111,618	892,944
11-15	13	54	22.97	28,967	376,571	139	59.14	74,580	969,540
16-20	18	57	24.25	30,581	550,458	85	36.17	45,613	821,034
21-25	23	13	5.53	6,974	160,402	28	11.91	15,019	345,437
26-30	28	8	3.40	4,288	120,064	15	6.38	8,046	225,288
31-35*	33	0	0	0	0	7	2.97	3,745	123,585
36-40	38	3	1.27	1602	60,876	7	2.97	3,745	142,310
41-45**	43	0	0	0	0	4	1.70	2,144	92,192
46-50	48	4	1.74	2,194	105,312	4	1.70	2,144	102,912
Total		**235**	**100**	**126,108**	**1,713,314**				

Source: Computed based on own survey, 2006

* and ** indicate class boundary of WTP where there is no sample distribution of households.

From the class boundaries (intervals) for the willingness to pay amounts, the class marks (the mid willingness to pay amounts) have been calculated and the results are shown in the second column of Table 4. The third and the fourth columns show the number and the percentage of the sample households whose maximum willingness to pay amounts fall within the given intervals, respectively.

The total number of households in the three sub-cities of Addis Ababa has been multiplied by the proportion of sample households falling in each boundary to obtain the total number of households whose WTP amount lies in each boundary (column 5 of Table 4). Total willingness to pay (column 6 of the table) has been obtained by multiplying the mid willingness to pay amount by the total number of households willing to pay that amount.

Summation of the total WTP values in column 6 gives the grand total willingness to pay amount. Thus, 126,108 households in the three sub-cities of Addis Ababa are expected to pay 1,713,314 cents (Birr 17,133.14) if every household use only one Baldi. But survey data on 240 households indicate that the mean water consumption per household per day to be 9 Baldi. Based on this calculation the total willingness to pay is estimated to be Birr 154,198.26 per Day[55]. This is, on average, 13.59 cents per household per Baldi if the proposed improvement in water supply services is implemented. This result is almost similar with the average WTP of 15.34 cents per household per Baldi from the open-ended formats mentioned previously.

Columns 7 and 8 of Table 4 indicate the number and the proportion of sample households willing to pay at least the amount in each boundary and the figures continuously diminish as class mark for WTP amount increases (with the exception of * and ** in Table 4). Similarly, the total number of households who are willing to pay at least the amount in each interval (column 9) falls as the mid willingness to pay amount rises . This relationship can be easily depicted by deriving a demand curve for the improved water supply services.

Total revenue (10th column of the Table) has been obtained by multiplying the mid WTP amount (column 2) by the corresponding total number of households willing to pay at least that amount (column 9). As can be seen from the total revenue columns, total revenue initially increases as payment per Baldi increases and reaches a maximum of 969,540 cents per Baldi with the payment of 13 cents per Baldi per household. After that it decreases and reaches a minimum of 102,912 cents per Baldi at the highest service charge of 48 cent per Baldi per household due to relatively small number of households (only 2,144) willing to pay these amounts.

The revenue estimation in this study is very important since it allows water utility to determine how many households can afford the provision of improved water services on charge base. The administrative body can also undertake cost-benefit analysis of

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[5] $17{,}133.14 \times 9 =$ Birr 154,198.26 per day

a project which is meant to improve the water services in the city. From Table 4 there is a very wide room for cost recovery by improving the existing water supply services in the city.

4.3.4 Derivation of Aggregate demand and Estimation of Consumer Surplus for Improved Water Services

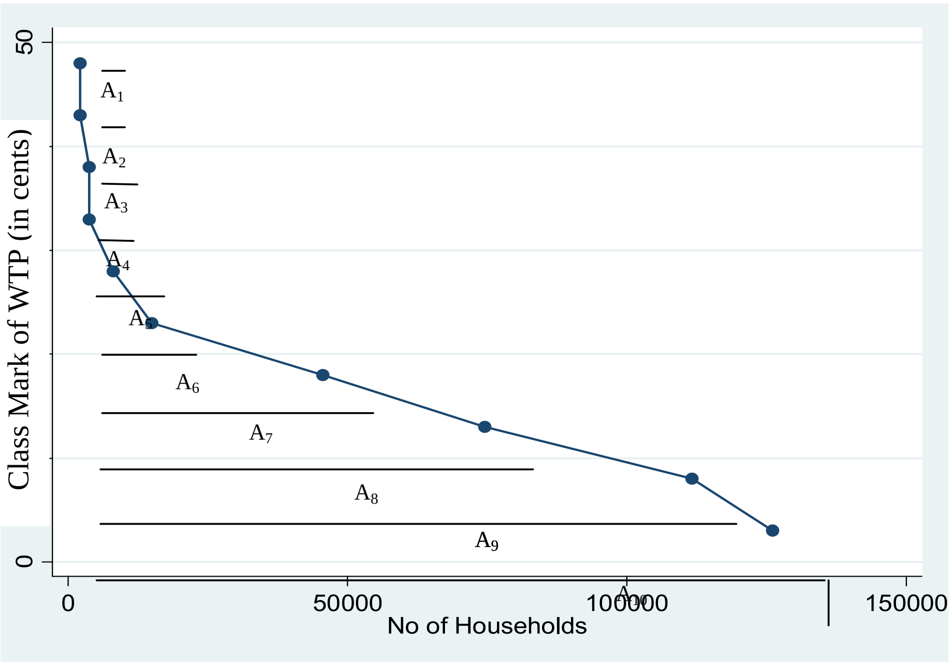
The aggregate demand for this study has been derived from the above WTP payment scenario. The aggregate demand curve is derived using the mid willingness to pay amount along the vertical axis and the number of households' willingness to pay at least that mid value per Baldi along the horizontal axis (Figure 1). The figure shows the aggregate demand curve for the improvements in water supply services using the observations in the study. Any point on the curve shows all the households that prefer the improved water service but do not bid more than the corresponding value on the mid WTP axis.

The demand schedule that has been obtained from our survey is basic information for policy makers. The information helps them to make sound water tariff decisions and investment. The information on the frequency distribution of WTP bids is also useful information in estimating the demand for improved water services in terms of the tariff versus number of households.

As shown in Figure1, the demand curve is negatively sloped indicating the fall of the demand for improved water supply service as user charges increase, like most other economic goods, other things remaining the same. If water is considered as a free resource to the society, the consumers' surplus would be the total area under the demand curve. The area under the demand curve represents the gross value of consumers' surplus if the tariff rate of the authority is zero. The sum of all the areas under the demand curve (A_1-A_{10}) is 2,021,504 cents per Baldi (Figure1). This shows the gross consumer surplus is estimated 2,021,504 cents or Birr 20,215.04 if every household is using only one Baldi per day for the improved water services, with supply left unrestricted (Appendix 4). But based on the survey data the gross consumer surplus has been estimated to be 18,193,536 cents or Birr 181,935.36 per day.

The study further analyses the allocation of the total benefits which has been derived from the service charge fees on each household per Baldi by improving water supply services. The current tariff rate of AAWSA is 3.50 cents per bucket of water for the lowest consumption block (which is less than 7 m^3 /month) and 7.60 cents per bucket for the highest consumption block (for more than 20 m^3 /month) that cover only operation and maintenance costs. But the current tariff policy of the water authority could not meet financial sustainability. Thus, if AAWSA proposes a new flat tariff rate for the improved water at 8 cents per Baldi (which is well below the mean WTP of own survey) with supply left unrestricted, it may help to cover the authority's costs (operation and maintenance costs plus capital investments). This will help to implement the proposed improved water supply service.

Figure 1: Estimated Demand Curve for Improved Water supply Service in Addis Ababa

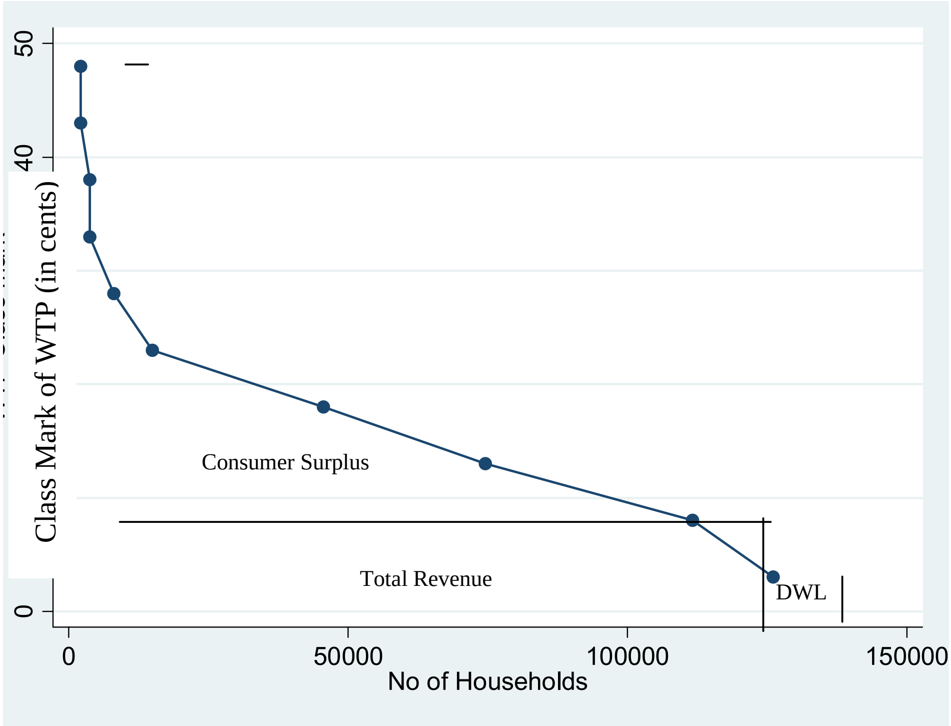


Source: Computation based on own survey, 2006

The finding indicated that out of the total 126,108 households in the study area, 111,618 (88.51%) of households are assumed willing to pay at least the new proposed tariff rate of 8 cents per Baldi for the improvement in water services. In relation to this, a rise in revenue of the authority is anticipated and a large increase in the consumers' surplus, in turn, will help for implementing an improved water project. The allocation of the total benefits of improved water services at the proposed tariff rate can be depicted using Figure 2.

The total benefits of the improved water supply services are the sum of expected revenue of AAWSA, consumer's surplus of the society, and the dead weight loss. If tariff is set for water supply services, the consumers' surplus discussed previously can be minimized by shifting consumer surplus partly to dead weight loss and partly to the revenue of AAWSA.

Figure 5.2: Estimated Total Benefit for Improved Water supply Service in Addis Ababa



Source: Computation based on own survey, 2006

As indicated in figure 2, if a new tariff rate of 8 cents per Baldi is implemented, the consumers' surplus (CS) decreases from 2,021,504 cents to 1,048,865 cents per Baldi or from Birr 181,935.36 to Birr 94,397.85 per day. The rest of the benefit is distributed to AAWSA, 892,944 cents in the form of revenue and 79,695 cents as a dead weight loss (DWL)[6] per Baldi, which is equivalent to Birr 80,364.96 in the form of revenue and Birr 7,172.55 as a dead weight loss (DWL) per day. The dead weight

[6] DWL- measures the value to the consumer of the lost output (Varian, 1992).

loss of the study result indicate that only 14,490 (11.49%) out of 126,108 households could not afford for the proposed new tariff rate. The dead weight loss (DWL) is part of the aggregate benefit of improved water service that belongs neither to the consumer surplus nor revenue to the service delivery authority. However, there is a possibility of cross subsidy to those households who are unable to pay by those who are willing to pay more.

In general, the results of the study in this unit open a room to any interested individuals or groups in the area of improving water supply services in the city. The aggregated WTP amounts shows that the authorities could collect sufficient resource for both service modernization and could also reduce existing subsidies.

5. Summary and Conclusion

In this study we have used a contingent valuation method (CVM) to analyze determinants of households' WTP, estimate total WTP, and derive aggregate demand and aggregate benefit for improved water supply service. CVM helps to estimate the value that households in Addis Ababa attach to the proposed improvement in water supply service. For this purpose, a total of two hundred forty (240) households were interviewed after stratifying sub-cities and kebeles based on economic standard and water supply situations, respectively. A closed-ended with open-ended follow-up elicitation technique was used.

The empirical analysis we conducted and its findings show that controlling for the other variables in the model, income of the household, sex of the respondent, education dummies (both secondary and tertiary education), households year of stay, households not using tank as a storage, wealth of a household, employment status of the respondent, households' satisfaction with the existing service, and location of the study site (Addis Ketema) affect the willingness to pay for improved water service positively. On the other hand, family size affects the willingness to pay negatively.

The total willingness to pay amount from the total of 126,108 households in the study area of Addis Ababa is Birr 17,133.14 per *Baldi* or Birr 154,198.26 per day at different service fees. The maximum total revenue that can be collected per Baldi is 969,540 cents when a service fee of 13 cents per Baldi is charged. The area under the demand curve represents the gross value of consumers' surplus which is Birr 20,215.04 per Baldi if water is considered as a free good (zero tariff rates for water). Based on the survey data of the mean water consumption per household per day the gross consumer surplus is estimated to be Birr 181,935.36 per day. But water is an economic good and if a new tariff rate of the authority is supposed to be 8 cents per Baldi the consumers' surplus will be reduced to Birr 94,397.85 per day. The rest of the benefit is distributed to the water authority Birr 80,364.96 in the form of revenue and 7,172.55 is a dead weight loss per day. This proposed new tariff rate can help the water authority to implement the proposed improvement of water supply service.

The mean willingness to pay value is 15.34 and 20.20 cents per bucket for the improved water supply service as calculated from the tobit and probit model, respectively. Hence, the mean willingness to pay value ranges between 15.34 and 20.20 cents. The similarity of the mean WTP under tobit and probit models indicate the validity and reliability of the contingent valuation (CV) outcomes in empirical analysis.

It may be safely recommended from this study that income and willingness to pay for the proposed improvement in water supply service is positively related, development policies should target at increasing income per household that address the low income members of the society. Income source diversification strategies and expansion of small scale enterprises which can employ households in the lower income strata are the possible areas of intervention

This study, however, lack the comprehensiveness as it has limited water supply service for domestic purpose only. Thus, further study needs to incorporate water supply for industrial, institutional and commercial purpose to have more real image on water supply service in Addis Ababa.

References

BoFED. (2004) .A Conceptual Back-Ground for Policy on Private-Public Partnership in the Provision of Municipal Services in Addis Ababa, unpublished, AACG.

Callan, Scott J and Thomas Janet M.(1996). Environmental Economics and Management: Theory, Policy and Applications. South Western College Publishing, 1st ed. Chicago, Irwin

Carlsson, F., H. Gunaltilake and Kohlin G. (2002). Willingness to pay for Solid Waste Management, Work in Progress.

Carson, R. (2000). Contingent Valuation: A User's Guide. Department of Economics, University of California, San Diego, California.

CSA (2004a). Information on Urban Economic Establishment Census, Unpublished data. Addis Ababa.

______(2004b). Welfare Monitoring Survey, Analytical Report. 339-A STATISTICAL BULLETIN 339-A Addis Ababa

Greene, W. H. (1997). Econometric Analysis. 3rd ed., New Jersey: Prentice- Hall, Inc.

Green, D., K. E. Jacowitz, D. Kahneman and D. McFadden (1995). Referendum Contingent Valuation, anchoring, and Willingness to Pay for Public Goods, A paper Presented at the August 1995 World Congress of the Econometric Society , Tokyo.

Habb, T.C., and McConnell, K.E. (2002).Valuing Environmental and Natural Resource: The Econometrics of Non-Market Valuation. New Horizons in Environmental Economics, Edward Elgar

Hanemann, M.W.(1984). Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses, American journal of Agricultural Economics, 66, 332-41

Hanemann, M.W., Loomis, J. and Kanninen, B. (1991). Statistical Efficiency of Double-Bounded Dichotomous Choice Contingent Valuation. American Journal of Agricultural Economics. 73(4): 1255-1263.

Maddala, G.S. (2002).Introduction to Econometrics. 3nd ed., John Wiley and Sons Ltd. Singapore.

Mahmud, M. Yesuf (2005/06). An Introduction to Limdep With Discrete Choice applications. A manual Prepared for an M.Sc Course on "Environmental Valuation and Policy" at Department of Economics, unpublished, Addis Ababa University.

Mitchell, R. C. and Carson, R. T. (1989). Using Surveys to Value Public Goods: The Contingent Valuation Method. Resources for the Future, Washington, D.C.

MoWR (2003).The Federal democratic Republic of Ethiopia. Environmental Support Project Component 3. National Water Supply and Sanitation, Master Plan Frame Work. Part A.

Shiferaw B.,H. A. Freeman and S. Navrud. "Valuation Methods and Approaches for Assessing Natural Resource Management Impacts" in Shiferaw B., H. A. Freeman and S.M. Swinton (eds.) Natural Resources Management in Agriculture. Methods for Assessing Economic and Environmental Impacts. Michigan State University, East Lansing, Michigan, USA,CAPI Publishing .

Varian, Hal R.(1992).Microeconomic Analysis, 3rd ed. university of Michigan.

Whittington, D., J. Briscoe, X. Mu and W. Barron. (1990).Estimating the Willingness to Pay for Water Services in Developing Countries: A Case Study of the Use of Contingent Valuation Surveys in Southern Haiti. Economic Development and Cultural Change, 38(2): 293–311

Zerihun, Amdemariam (2005). Addis Ababa Water and Sewerage Authority, Water Supply Situation Map. Engineering Services Department, GIS unit, Addis Ababa.

Appendix 1: Description of Explanatory Variables

Dummy Variables	Explanatory Variables
WEAH	Ownership of house- is a proxy for wealth. Wealthy households are more willing to pay and prefer to have a private connection to the improved water service. It is a dummy variable, 1 if the house is owned by the household, 0 otherwise (that is, if rented from individuals, kebeles or public agency. Thus a positive sign is expected.
SEXR	Sex of Respondent -fetching water primarily depends on women in most developing countries. Thus, it is hypothesized that women are more likely to pay for improved water supply than men. It is a dummy variable, 1 if the respondent is female, 0 other wise.
EMPR	Employment status of Respondent- This is a dummy variable, taking 1 if the respondent is employed in a government or private organization, NGO's, owns a business, and other related areas ; 0 otherwise (that is if not employed). The employed respondents are expected to be more willing to pay than their unemployed counter parts. This is because the exposure (the state of having the true facts) of those working in different sectors to the improved water service is more than the other group. Thus we expect a positive sign.
ATTR	Attitude of Respondent about the Responsibility of Water Supply- It is a dummy variable, and takes 1 if the respondent says the government should administer, 0 otherwise. We expect a negative sign. If the respondent says the government should administer (manage) the water service, it might be expected that the government will provide the service at lower price and thus less WTP.
LOC	Location of the Study Sites-LOC_{Bo} is dummy variable taking 1 if it is Bole sub-city, 0 otherwise. LOC_{AK} is dummy variable taking 1 if it is Addis-Ketema sub-city, 0 otherwise. It is expected that households in a sub-city with more problem of water supply are willing to pay more for improved water supply scheme than sub-city with less problem of water supply service.
EDUR	Education Level of the Respondent -WTP for improved water service is expected to have a positive relation with the level of education, since respondents with higher education have more awareness of the value of water services. $EDUC_1$ is a dummy variable taking 1 if the respondent's educational level is primary education; 0 otherwise. $EDUC_2$ is a dummy variable taking 1 if the respondent's educational level is secondary education; 0 otherwise. $EDUC_3$ is a dummy variable taking 1 if the respondent's educational level is tertiary education; 0 otherwise.
TANK	Household use of Tanks as Storage for Water -It is assumed that households with no tank as a storage for water may be willing to pay more for improved water services than households who use tank for water storage, since the severity of water supply disturbance is higher for the former. A dummy of 1 is specified for household with no tank as a storage for water; 0 otherwise. The coefficient is expected a positive sign.
STAT	Status of the Respondent- This variable helps to examine whether the representative of the household gives similar opinion with that of the head of the household on willingness to pay or not. It is a dummy variable taking 1 if the respondent is the head of household; 0 otherwise. We expect a negative sign since the head of the household is concerned more about the management of his /her limited finance that s/he could allocate, based on prioritized activities.

INFO	Respondent's Information about Tariff Increment on Domestic Water Consumption-Dummy variable 1 if the respondent has the information, 0 otherwise. We expect a positive sign. Households who know tariff increment are more responsible about cost sharing than their counter parts. Hence, respondents that have the information regarding tariff increment on domestic water consumption are more willing to pay for improved water service than respondents with no information.
SATI	Level of Satisfaction of the Household with the Existing Water Services- dummy variable 1 if the household is not satisfied with the existing water service; 0 other wise. It is expected with a positive sign. This is since households that are not satisfied with the existing water services show grater preference for improved services and more willing to pay to connect for improved water service.
Continuous variables	
INCH	Total monthly income of the household. The monthly income of the household includes the income of the head and all other members of the household from different sources. . Households with higher income have a greater ability to pay and have a grater preference for an improved water services. This is based on previous empirical studies and economic theory that shows quantity demanded and income are positively related for normal goods. So we expect a positive coefficient. We are looking at the household's disposable income (in birr).
FAMS	Family Size of the Household-two rationales are forwarded. The first indicate that as family size is higher, there will be a higher need for water in the family and hence more preference for an improved water provision, and WTP is higher. The second indicate that for large family size it is expected to increase their water consumption for improved water service which could discourage the family due to high bill charge services and hence willing to pay less for the proposed improvements than small size households. Thus we can not determine its sign a priori.
AGER	Age of Respondent- continuous variable in number of years. Older people who used to live with free water supply or less prices, may be reluctant to prefer new improved services and could be less willing to pay for it. Thus, a negative relationship is expected between the age of a respondent and WTP for new improved scheme.
IB	Initial Bid- this will help to examine whether the initial bid do have an impact on the respondent's WTP for improved water services or not. It is to be tested for initial bid bias.
STAY	Household Year of Stay in the House -continuous variable in a number of years. It is expected to be a positive coefficient. Those households who have stayed in the house for long year are mostly in the older quarter of the city where there is more serious problem of water supply service and thus are willing to pay more for improved water services than those households who have stayed short in the house.

Appendix 2: Summary of Descriptive Statistics of Variables

Dummy Variables	**Observ.**	**Mean**	**Std.Dev**	**Min**	**Max**
Primary education of the respondents ($EDUC_1$)	35	.24	.43	0	1
Secondary education of the respondents($EDUC_2$)	35	.34	.48	0	1
Tertiary education of the respondents($EDUC_3$)	235	.19	.39	0	1
Information about tariff (INFO)	235	.77	.42	0	1
Status of the respondents (STAT)	235	.59	.49	0	1
Wealth of the households (WEAH)	35	.58	.49	0	1
Employment status of the respondents (EMPR)	235	.37	.48	0	1
Attitude of the respondent (ATTR)	35	.78	.41	0	1
Yes/no (Y/N) to initial bid	235	.85	.35	0	1
Sex of respondents (SEXR)	235	.71	.45	0	1
Households use of tank as a storage of water (TANK)	235	.69	.46	0	1
Location of the study site Bole (LOC_{BO})	235	.31	.46	0	1
Location of the study site Addis-Ketema (LOC_{AK})	235	.34	.47	0	1
Location of the study site N. Silk Lafto (LOC_{NL})	235	.35	.48	0	1
Level of satisfaction to the existing water services (SATI)	235	.84	.37	0	1
Continuous Variables					
Income of the households (INCH)	235	1339.32	1481.21	110	8500
WTP	235	15.34	8.53	0	50
Initial bid (IB)	235	9.98	4.15	5	15
Age of respondents (AGER)	235	34.98	14.89	17	85
Family size of the households (FAMS)	235	4.79	1.89	1	10
Households year of stay in the house (STAY)	235	19.95	12.57	.75	60

Source: Own survey result, 2006

Appendix 3: Test of Heteroscedasticity

One of the important methods used to test the existence of hetroscedasticity in Tobit model is the log –likelihood ratio test (LR) test. The LR statistics of testing the null hypothesis of homoscedasticity assumption is obtained by

λ_{LR}=2[Log Lu-LogLr]; Where
log Lu is the value of unrestricted log-likelihood function and
log Lr is the value of restricted log –likelihood function

λ_{LR} has a $X^2(n)$ distribution with n degrees of freedom where n is the number of explanatory variables. If the data do not support the null hypothesis (homoscedasticity assumption), then the value of the test-statistic becomes large and null hypothesis is rejected; i.e, if $\lambda_{LR} \geq X^2$ (n). The result of the test for the model is shown below.

λ_{LR}=2[Log Lu-LogLr]
=2[-773.2196 – (-836.6690)]
=2[63.4494]
=126.8988

The critical value of the chi-square at 18 degree of freedom is 28.87 at 95% level. Comparison of the result (test statistic) with critical table value shows that the test statistic (computed value) is found to be larger than the critical table value. This implies that the null hypothesis of homoscedasticity is rejected, i.e. hetroscedasticity is the problem for the model.

Appendix 4: Estimating consumer's surplus using figure 5.1

Area	Computation	Value of consumer's surplus (in cents)*
A_1	2144×5	10,720
A_2	(2144×5) + ½(1601×5)	14,722.5
A_3	3745×5	18,725
A_4	(3745×5) + ½(4301×5)	29,477.5
A_5	8046×5 + ½(6973×5)	57,662.5
A_6	15019×5 + ½(30594×5)	151,580
A_7	(45613×5)+ ½(28967×5)	300,482.5
A_8	(74580×5) + ½(37038×5)	465,495
A_9	(111618×5) + ½(14490×5)	594,315
A_{10}	126108×3	378,324
Total		**2,021,504**

Source: Computed based on figure 1, 2006

APPLICATION OF NATURAL RESOURCE ACCOUNTING TO THE FOREST RESOURCES OF ETHIOPIA: CASE OF SHASHEMENE FOREST

Anteneh Kebede Gebremariam[1]

Abstract

One of the natural resources that does not receive proper treatment in the system of National Income Accounts (SNA) of Ethiopia and many other countries is the forest resource. By taking the case study of Shashemane forest in Ethiopia, this paper tries to show which parts of forest resources are missing from the national accounts, what would their magnitude look like, and how could they be integrated into the SNA framework. For this purpose the amenity, tangible non-timber forest products, timber and depreciation values of the forest are treated. The total value of the forest (for 2003/04) which only considers the above three components is estimated to be 163,705,524 ETB. Out of this, the non-timber forest product (NTFP) values take the lion's share. Since it is a plantation forest, we found appreciation rather than depreciation in this forest and the value of appreciation is found to be 3,245,524 ETB. In the Contingent Valuation Method (CVM) survey, age, income, fuel wood benefit, and acquaintance are found to be significant determinants of willingness to pay (WTP) for amenity benefits. The study also tries to see the interaction between the forest and the surrounding community, and results show that the lower 10 percent income group of the community depends more in the tangible NTFPs of the forest than the upper 10 percent income group.

Key words: Natural resource accounting, system of national accounts, Ethiopia, Shashemane forest, amenity value.

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[1] Mekelle University, antkeb@yahoo.com

1. Introduction

Ethiopia, a country of 67 million people (MOFED 2007), is one of the largest countries in Sub Saharan Africa. According to the Ethiopian forestry action program (EFAP) document (Ministry of Agriculture, 1994) the country has a land area of about 110 million hectares. This country has immense resource potential for development in terms of agriculture, biodiversity, mineral and other resources. However, this potential is being degraded due to increasing demand for and lack of proper management of these resources.

History tells us that around 42 percent of the total land in Ethiopia was once covered by natural high forests (Ministry of Agriculture, 1994). This coverage has dramatically been decreased in the early 1950s and reached around 19 million hectares or 16 percent of the total land area. According to Reusing (1998), between 1955 and 1979 Ethiopia has lost almost 77 percent of the forest stock it had in 1955. A recent estimate of Woody Biomass Inventory and Strategic Planning Project (WBISPP) shows that in 2002, the total area covered by forest is about 4.07 million hectares, which constitutes only 3.5 percent of the total area of the nation.

Different studies indicate that in most parts of the country, especially in rural areas, fuel wood is the major source of energy mainly for cooking purposes; energy sector is heavily dependent on traditional fuels although it has a negative effect on the environment. Forest resources are also basic inputs in house construction and for making of house furniture and equipment. According to the National report on Environment and Development (1992), 90 percent of the wood production is used for fuel wood, while the remaining 6 and 4 percent go to construction and furniture and industrial purposes respectively.

Due to the increase in population at an annual rate of 2.7 percent, and deterioration in land productivity, expansion of agricultural land is taking place at the expense of the forest resources of the country. It is estimated that the annual destruction of forest for agricultural expansion is around 59,000 hectare per year for the three regional states of Oromiya, Gambela and Southern Nations Nationalities and Peoples (SNNP) (WBISPP, 2002).

Let us briefly turn our attention to the classification and distribution of forest resources in Ethiopia. First, it is necessary to define what forest is. WBISPP, borrowing from Friis (1992) defines forest as “a relatively continuous cover of trees, which are ever green or semi-deciduous only being leafless for a short period, and then not simultaneously for all species. The canopy should preferably have more than one story". From now on it is mainly within this context that the word forest is used.

Ethiopian land cover contains various types of mountain and low land forests. In the high lands there are broadleaved, coniferous and mixed forests whereas the low lands have semi-evergreen forests (Reusing 1998). WBISPP classifies the Ethiopian forest into three, based on their crown cover namely: closed, dense and open. Out of the total forest cover of 4.07 million hectares around 95 percent is located in the three regional states of Oromiya, SNNP and Gambela regions. The following table shows forest distribution of Ethiopia.

Table 1: Forest coverage and its distribution

Region	Total (ha)	
Oromiya	2,547,632	63
SNNPR	775,393	19
Gambela	535,948	13
Dire Dawa	0	0
Harari	216	0
Benishangul	68,945	2
Afar	39,197	1
Somali	4,257	0
Amhara	92,744	2
Tigray	9,332	0
Total	4,073,213	100

Source: WBISPP, 2002

In the Oromiya region there are many protected and unprotected forestlands. Among the protected ones Shashemane forest is one.

After long years of economic decline during the socialist regime (1974-1991), Ethiopia is now showing a good rate of growth especially in the last one decade. There was a poor performance of the Ethiopian economy during the two decades of the Derg regime, which demonstrates itself through declining rates of economic growth. At this time " GDP growth fell to an average of around 2 percent per annum in the period 1974 to 1990" (Ministry of Agriculture, 1994).

However, after the fall of the past regime, the Ethiopian economy has been showing a relatively better performance mainly due to the relative peace and stability that existed in the country. In the years 1992/93 to 2000/01 Ethiopian GDP grew at an annual average rate of around 5 percent. Ethiopia's Sustainable Development and Poverty Reduction Program (SDPRP) document shows that the sectoral growth rates are registered as follows: 2.5 percent for agriculture, 5.3 percent for industry, 6.3 percent for distributive services and 8.2 percent for other services (MOFED, 2002).

Despite this relatively better performance in recent years, economic growth is still constrained by the country's deteriorating environment and natural resource base. This is mainly reflected in the decline of agricultural productivity due to the loss of soil fertility, a decrease in forest-related output due to increased deforestation, and water resource degradation due to various reasons. In fact, all of these resource deterioration problems are interrelated and the problem of one sector will possibly have an effect on the other sector.

Coupled with the increase in population, mismanagement of natural resources is really becoming an impediment for growth and development process of Ethiopia. According to EFAP (Ministry of Agriculture, 1994) if present trends in population growth continue, this deterioration will be much faster in the future and its effect in the economy will be much more severe.

The history of national income accounting in Ethiopia dates back to the early 1950s when the National Bank estimated the GDP of the country using the expenditure approach. After that, different agencies have taken this responsibility and now MoFED is in charge of it.

The system of national accounts (SNA) for Ethiopia shows that in the last few decades the agricultural sector accounts for about 45 percent of the GDP. Out of this, the forestry sector constitutes about 5.5 percent. But still, information on the contribution of forest to the national accounts is not well surveyed and the stock of the national forest was not known. Even until now there is no reliable information, although there are estimates of different projects like that of WBISPP.

It is worth mentioning the fact that the official report on the forest resource contribution to the GDP of Ethiopia does by no means reflect the true forest contribution because there are various omitted contributions. In addition to their timber and fuel wood contribution, forests provide other services such as amenity, waste disposal, watershed and others that can be considered as an economic type of contribution.

In this paper, we argue that amenity values and tangible Non-Timber Forest Products (NTFP) deserve inclusion in the national income accounts, although its applicability at the national level would require a lot of work, since it may necessitate employing environmental valuation techniques. The watershed benefit need not be included if the adjustment is going to be made from the overall GDP because change in such service could be reflected via the increase or decrease of output in other sectors. However, when sectoral GDP calculations are employed these watershed benefits have to be reallocated to the forest sector benefits. The case of waste management service has also a similar nature with the watershed case and the arguments provided for inclusion of watershed benefits shall also apply here.

Hence, amenity values and tangible NTFPs are consumption of the environmental benefits and their values need to be computed and included in national accounts. While computing these amenity and tangible NTFP values there is also a need to see what determines their value; it may be income, education or some other variable.

Besides, there is no any estimate of either man-made or natural resource capital depreciation in the system of national accounts of Ethiopia. This implies that the system does not reflect true sustainable income of the country that can be defined as the maximum amount of income, which can be obtained in a given economy without affecting the country's ability to produce in the future.

It is indicated in the literature that Net Domestic Product (NDP) is a better measurement of human well-being because it can at least take into account capital consumption allowance, for the wear and tear of man-made capital. This somehow takes into account sustainable production of outputs although it still ignores one important capital viz. natural capital. One of the objectives of environmental policy of Ethiopia is ensuring "renewable natural resources are used in such a way that their regenerative and productive capacity is maintained" (EPA, 1997). From this, we can understand that calculation of natural resource depreciation is necessary because the information to be obtained from such calculation helps to see how much our stock is depreciating and shows us how much reinvestment is required in this sector.

Most importantly calculating such depreciation helps us to see if our production is sustainable and whether we are living beyond our means or not. Although this calculation has to be made for all the resources possible, it would be better to start with few resources and widen the scope gradually especially if there are financial, skilled labor, information and other constraints; which is typically the case for Ethiopia.

Hence we have noticed two core problems here; the first one is the deficiency to include amenity and tangible NTFP values of forest resources in the national income accounts. The second one, on the other, hand is the problem of not considering natural resource depreciation of Ethiopia. If there are time and financial limitations, those computations can be made in specific area for a specific resource.

This study focuses on Shashemene forest of the Oromiya region. As we have tried to indicate earlier the majority of the remaining forest cover is located in the Oromiya region. One of the areas of this region that can qualify for the definition of forest is the above-mentioned Shashemene forest. Although it is considered as a protected forest, observers in that area think that it has faced some threat of over exploitation from the people residing around the area. This forest is also giving amenity and tangible NTFP values to these people of the area. Therefore, it is a very good research place for the purpose in the caption.

Unless there is proper understanding and treatment of forest resources' (or any other natural resource) contribution and depreciation, indicators in the system of national accounts may be misleading. Especially in resource dependent countries like Ethiopia ignoring the depletion and degradation of natural resource stock in the calculation of national income would be a mistake. This is mainly because the sustainability of economic activities in the country lies in the proper utilization of these resources. Understanding this fact, the environmental policy of Ethiopia put special focus for the proper treatment of natural resources in the planning and accounting processes and placed it as one of its major objectives. Since it is very much relevant for our case let us put the full statement of this specific objective; it is to

Incorporate the full economic, social and environmental costs and benefits of natural resource development into the planning, implementation and accounting processes by a comprehensive valuation of the environment and the services it provides and by considering the social and environmental costs and benefits which cannot currently be measured in monetary terms. (EPA, 1997, Page 3).

This and other objectives of the country's environmental policy coincide with the general objective of this paper, as our objective here is to initiate the proper inclusion of costs and benefits of natural resources, with particular reference to the forest resources of Ethiopia.

2. Research Methodology

To conduct this study mainly primary, and in some cases secondary, information has been used. In the case of measuring amenity and tangible NTFP values, a primary survey research method is employed by directly presenting questions to the respondents for which a questionnaire was prepared. The sample size of this survey is 240 households and the selection of the sample was using random sampling method. The other survey for calculating depreciation mainly depends on the physical accounting survey of EPA group of experts and some registered documents of Shashemane Forest enterprise that give highlights on background information and price.

For valuing forest amenity benefits: which can be defined as "those natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes" (PCE, 1997). The study employed contingent valuation method. This involves measuring willingness to pay for the amenity value of that forest. Here the study applied a probit model due to the discrete choice nature of the data. The willingness to pay of the respondents takes the following form: -

$$WTP = f(Y, E, A, O) + \varepsilon$$

Here, we should note that willingness to pay (WTP), depends on income Y, education level E, age A, and other possible variables O.

In order to make a rigorous measure of tangible NTFPs and other non-market forest benefits this study tries to utilize two types of information. The first one is the respondent's own estimate of the good/benefit under consideration and the second is the market price of the good (or its close substitute). Efforts were made to compromise the difference that may exist from the information of the two sources.

For calculating the value of timber resource and depreciation, different options have been introduced in the literature. However this paper will try to use the net price method for the indicated purposes. This method has the following mathematical form in the case of depreciation.

$$D(t) = -\left(p - c\right)\left[q(t) - g(s(t))\right]$$

Where g(s(t)) refers to growth in the forest resource and q(t) refers to reductions in that resource. The value of timber is calculated using the same method that takes the following form

$$V(t) = Q(t) * (P - AC)$$

3. Results and Discussion

3.1 Physical and Monetary Accounting for Shashemene Forest

3.1.1 Physical accounting

Based on the standard physical forest account structure we have indicated in the pervious sections, the team of experts from EPA have prepared physical accounting table of Shashemane forest for three consecutive years of 2001/2002, 2002/2003 and 2003/2004. We have taken here the relevant year of 2003/04 for our case.

While preparing the account, those experts estimate growth of timber stock using the average growth rate of timber calculated by Silvinova ab (2000). Since it is a plantation forest where records are kept, those experts have also been able to get reliable information of annual harvest and reforestation from the records of the enterprise. An annual account is prepared for five species categories and it has three main activity components. The 2003/2004 physical account takes the picture presented in Table 2.

Table 2: Physical Account by Volume (M^3)

Activity	Cupressus L.	Pinus P.	Eucalyptus pp	Juniprius	Others
I. Opening Stock	1078821	42520	44759	13941.5	22243
1.1. Addition					
Growth	85375	5656	44330	1044	1997
Reforestation	178	80	1416	-	-
1.2. Depletion					
Harvesting	22743	1009	9420	-	-
Deforestation	854	57	443	10.5	20
Logging Damage	-	-	-		
II. Net Change	61956	4670	35883	1033.56	1997
III. Closing Stock	1140777	47190	483432	14975	24220

Source: EPA 2004/2005

As we can see from Table 2 the net change that can be computed from Shashemene physical timber account is positive. This is mainly due to the fact that this plantation forest is well protected and harvesting is made in a manner that would not reduce the standing stock. In such kind of protected plantations, as opposed to open access forests, illegal cutting, encroachment towards the boundary of the forest and other distractions are very much minimal. In 2004/2005 the total volume of forest stock increased by about 8 percent. This is a significant figure, which shows that additions in volume well outweigh subtractions from the existing stock.

The total volume of timber at the beginning of the year is estimated to be 1202284 m3 and this figure shows an increment and reached a total volume of 1710594 m3 at the end of that given year. Simple subtraction can lead us to the total 2003/2004 volume of net timber stock change for Shashemane forest. The total change in timber stock equals 148049 m3.

It is necessary to see the composition and increment in volume of each species in the forest. Starting from the opening stock of timber, the percentage share of the above displayed species categories is presented as follows: Cupressus is 66 percent, Pines 3 percent, Eucalyptus 28 percent, Juniperus 0.8 percent, and Others 1.2 percent.

Most of the opening stock volume goes to Cupressus and Eucalyptus. Even in the case of closing stock the share does not change much and we observe almost the same kind of composition with that of the opening stock. The figures clearly show that Cupressus is the most dominant species in Shashemane forest.

In the case of increment on the volume of different species the dominant species Cupressus has revealed the lowest annual increment of 5 percent. When it comes to absolute net change this species still has got the largest figure. However, this net change as a percentage of the already large opening stock is pushed down and makes the annual increment lower than other species. The highest percentage increment is registered for Pines, which is about 10 percent per annum. The increments of other species fall between the two ranges of 5 and 10 percent.

3.1.2 Monetary Accounting of Shashemene Forest

Monetary account of timber resources for the Shashemene forest can be directly obtained from the physical account of the area that we have presented earlier by just assigning appropriate value to the resource. The method applied here is the net price method. However, for calculating economic rent this paper uses average cost rather than marginal cost by assuming linearity in the cost function. The components in this monetary account table are more or less the same as the physical accounts except the revaluation item of the former.

It has been indicated in the literature that resource values applied to harvest and mature timber cannot be used for other elements of forest account mainly because, as Baytas et al. (1993) put it, growth, reforestation and deforestation components of the account refer to secondary forests.

Hence, this study shall not use a uniform net price for all components of the account; rather we measure secondary forests by attaching 50 percent of the net value given to primary forests (harvest). This is based on the principle reflected by Repetto et al. (1989), which assumes that the economic rent of secondary forest is equal to 50 percent of the rent obtained from timber harvest. Actually Baytas et al. (1993) have also used an arbitrary percentage of 25 percent value for growth and deforestation, while calculating the monetary forest account of Ghana.

Table 3: Monetary Account of Shashemane Forest

Activity	Cupressus L.	Pinus P.	Eucalyptus pp	Juniperius	Others
I. Opening Stock	84350780	2858773	20089781	2175450	1746298.5
1.1. Addition					
Growth	3337647	190136.7	1834167.266	81453.9	78369.5
Reforestation	6958.726	2751.745	31781.0232	-	-
1.2. Depletion					
Harvesting	1778229	69820.5	422849.26	-	-
Deforestation	33386.25	1916.158	9942.792	814.539188	785.1
Logging Damage	-	-	-		
II. Net Change	1532991.634	121152	1433156.29	80639.3	77584.5
III.Revaluation item	0	0	0	0	0
IV. Closing Stock	85883771	2979926	21522937	2256089	1823882

While calculating the net price value of opening and closing stock, the initial intention was to use the 2002/2003 price for the former and use the current (2003/2004) price for the latter one. However, the prices indicated in the financial report of Shashemane forest enterprise for the two consecutive years are almost the same and the change is negligible. Hence, we assume constant price and average cost for both elements.

Actually, timber (after harvest) in Shashemane forest has multiple purposes. Based on these different uses its price also varies. Therefore, this paper takes such price difference into account by considering the weight attached to each of these uses. The physical accounts table of Shashemane forest shows the total and disaggregated (by species) value of the timber stock. The result shows that the value of timber stock for species of Cupressus, Pines, Eucalyptus, Juniperius, and others, is 85880771, 2979926, 21522936, 2256089, and 1823882 ETB[1] respectively. We see a wide difference in the values of these different species.

Table 4: Price of timber for different uses of each species

Item	Units	Quantity	Unit price	% Share of value (%)
Cupressus				
Lumber log	M3	879635	104.5	
Construction log	M3			
Fuel wood	M3	261142	11.4	75
Sub total	M3	1140777		
Euclyptus				
Lumber log	M3	302940	57.7	
Transmission pple	M3	32600	45.6	18
Construction log	M3	29644	57.7	
Fuel wood	M3	118248	29.1	
Sub total	M3	483432		
Pine				
Lumber log	M3	30835	104.5	
Construction log	M3			
Fuel wood	M3	16355	11.4	3
Sub total	M3	47190		
Juniperius				
Lumber log	M3	8393	245.5	
Construction log	M3	4286	75.7	2
Fuel wood	M3	2296	17.1	
Sub total	M3	14975		
Others				
Lumber log	M3	5508	169.6	
Contruction log	M3	11242	75.8	2
Fuel wood	M3	7288	32.3	
Sub total	M3	24220		

Source: Financial report of Shashemene forest, 2004/2005

Since all of the values are expressed in the same physical and currency unit aggregation is possible. Simple addition of the above species-specific values gives us the total monetary value of timber resource in Shashemane plantation forest. Our estimation shows that the total timber value at the end of year 2003/2004 is around 114,466,608 ETB.

Once we calculate the total vale the next step is calculating the percentage share of each species from the total timber value. Out of the total value of timber resource the value of Cupressus (the dominant species) takes the largest share. The result shows that, this species constitutes about 75 percent of the total timber value. The dominance of Cupressus in the value of timber resource is followed by another important species--Eucalyptus; its share of the total value is 18 percent. The remaining three species categories constitute only around 7 percent of the total value.

We now consider each element of the accounting table row wise. The first one to be discussed is the revaluation item part. This part is the term in monetary accounts, which takes into account the price difference between the beginning and the end of the accounting period. This residual difference displays a zero figure in the case of Shashemane forest due to a negligible change in prices between the opening and closing time of that given period (so that we have already assumed constant price for the case at hand).

The second part to be considered is the value of additions in the above five species categories. The total value of additions comprises natural growth and reforestation. When we add for all species together it is equal to 5563266 ETB. When compared to the total value of closing stock for that given year, this addition is equivalent to 4.9 percent of the former. It should be remembered that the unit value given for the subcomponents of additions is half of the price given to harvest and matured trees.

The third element is subtractions. This is a part which can give us an important indication about the usage and destruction of the timber resource. A higher value in this section could give us a red light, especially if additions display lower figures. Coming to the total subtractions value of Shashemane forest, our estimation shows that harvest and deforestation values together reached around 2317742 ETB.

However, still it is the total subtraction value of Cupressus that takes the largest portion of this value. Out of the total subtraction value Cupressus has a share of 78 percent, Eucalyptus constitutes 18 percent and the remaining 4 percent goes to the other three species categories. When we compare the total value of subtractions with the total closing stock timber value it constitutes only about 2 percent.

The opening and closing stock sections of the monetary account show the value of standing timber at the beginning and end of that given period. The total value of standing timber at the beginning of 2003/2004 (or at the end of 2002/2003) is estimated to be 111221083 ETB. As we can guess from the previous results, if we disaggregate those values of this opening stock the value of Cupressus still stands to be the highest.

3.1.3 Depreciation/Appreciation of Timber Resource in Shashemene Forest

As we have expected from the observed results of the physical accounts, the calculated values obtained from monetary account of Shashemane forest displayed a positive change on the physical stock value of timber, for the year 2003/04. Since there is no change in the price of timber, we take the observed change in the stock value as depreciation/ appreciation. Here also, we have employed the net price method used for valuation of timber stock because the methods employed in the two have to be consistent. Our result shows that timber in that given year has shown an appreciation of 3245524 ETB.

The appreciation value indicated above leads us to the calculation of annual increment in the timber stock value of Shashemene forest. In the year 2003/04 the total timber stock value has increased by 3 percent. As it may have been noticed, the increment in the physical stock registered is more than double of this increment in stock value. This variation between the two kinds of increments partly comes from the 50 percent value given to growth and deforestation elements.

The monetary value of total timber stock displayed in forest account table of Shashemane forest does not show the total value of the forest. The forest has other benefits and when the values of these missing benefits are captured its total worth will be higher.

3.2 Amenity Value of Shashemene Forest

3.2.1 Descriptive Statistics of the CVM Survey

In this survey respondents are asked how much they are willing to pay a specified amount of money just for protecting the amenity benefit of the forest, if protection responsibility is going to be transferred to the surrounding community. Accordingly yes or no responses have been given. Before calculating WTP and check its determinants let us first present the descriptive statistics results of the survey

Table 5: Descriptive statistics results

Variable	Mean	Minimum	Maximum
Family size	7.4	1	22
Education	5.1	0	18
Age	38.4	12	86
Sex 1= female 0= male	0.1	0	1
Total asset	10415.6	0	59780
Number of trees	68.76786	0	1000
Income	6656.2	0	38558
Distance	2.0	0	14
Acquaintance	27.8	1	80

The average education level of the respondents is grade 5 and this can be considered as low education level since it can only be categorized in the primary education level. Out of the total respondents covered in this survey, 6 percent do not have any formal or religious type of education at all. Out of those who do not attend any education 59 percent of them are females.

However, when it comes to income, the average income per month is around 550 Birr; this means average annual income of the respondents is about 6556 birr. Such amount of income is relatively high when compared to incomes earned in most other rural parts of Ethiopia

The average distance of the respondent's residence is 2 km away from the forest. Zero distance comes from the fact that few farmers live within the forest. The survey result shows that only 1 percent of the respondents live inside the boundary of the plantation. Although it might seem a lower figure such kind of encroachment should not be tolerated and solutions have to be considered before things get out of hand. The average distance of the respondent's residence is 2 km away from the forest. The other variable that can interest us here is acquaintance. Since most of the respondents permanently settle in this area they know Shashemane forest very well. The average number of acquaintance is 27 years. Out of those respondents who know that area for more than 27 years 32 percent of them live within the boundary of 2 km around the forest.

When we see the family size of our respondents around Shashemane forest it is higher than the average household size of the country as a whole. According to CSA (2001 – 2002) the average household size of Ethiopia is around 4.8. However, in our case, the average household size is about 7.3. The results also show that on average a household around Shashemaene forest has around 68 trees on its land holding. Among those trees that households of that area have Cupruses, Eucalyptus and Pines are the dominant ones. These results show that a household in Shashemane area has a relatively large number of trees which is perhaps due to the fact that people in that area have an advantage of getting seedlings by being near to the plantation forest.

3.2.2 Estimated WTP function for closed-ended responses

In this CVM survey a dichotomous choice approach has been employed mainly because it has an advantage of putting the respondent in a more market like decision making and it gives less opportunity both for the interviewer and the respondent to purposefully influence survey results. However this approach is not without problems (see the disadvantages in Willis et al, 1999)

Table 6: Estimation results for the closed-ended response

Variable	Coefficient	P>z	Marginal Effect
Constant	.5426375	0.245	
Age	-.0256468	0.006	-.0091572
Education	.0288725	0.271	.0103089
Total asset	.0000145	0.161	5.18e-06
Income	.0001219	0.000	.0000435
Fuel wood benefit	.7509539	0.002	.2681282
Distance	-.0070293	0.886	-.0025098
Knowledge of other forest	.3007201	0.143	.1081885
Initial bid	-.072717	0.000	-.0259636
Acquaintance	.0133482	0.087	.004766
Number of trees in the land	-.0002181	0.691	-.0000779
Family size	-.0317726	0.361	-.0113444
Sex	.0398737	0.901	.0141288
WTP	Mean= 13		

Log likelihood = -115.99589 Pseudo R2 = 0.2037 LR chi2(12) = 59.35
Prob > chi2 = 0.0000

The amenity value of the forest is calculated using mean willingness to pay. As we can see from the above table we have a mean willingness to pay of 13 Birr per month just for the amenity value of the forest. Since national income accounts are prepared annually one can derive from this procedure the fact that a household around Shashemane forest is willing to pay 156 Birr per annum on average. Results show that household's willingness to pay for amenity benefits constitutes about 1.3 percent of their income. The ultimate goal here is calculation of total amenity value for Shashemane forest based on the mean WTP results. Multiplying mean WTP by the number of population that live adjacent to the forest, total amenity value of Shashemene forest is estimated to be 10, 920, 000 ETB just for the year 2003/04 (GC).

We now briefly discuss those factors that determine the willingness to pay of the household. Age has a significant effect on the WTP of the respondent. Although there cannot be any definite sign to be expected from the relationship, we found a negative sign in our case. Despite its significance, the marginal effect of age on WTP is minimal, i.e. it is around -.009. The negative sign of age could be an indication that those who have lower time to enjoy this amenity benefit would have a lower probability to pay for it than those who are expected to live longer.

An important variable that is found to be a significant determinant of WTP with the expected positive sign is income of the household. What we can infer from this estimation result is that as income increases the probability of respondent's willingness to pay for amenity benefits of Shashemane forest also increases. However, as it has been the case for age, the marginal effect of income is low, i.e. .0000435. Fuel wood benefit, which is labeled as 1 for those who get fuel wood benefit from the forest and 0 otherwise, is also significantly affecting the respondents' willingness to pay and as it can be seen from the above table its marginal effect is also relatively higher (when compared with other variables). We also see that the probability of paying for amenity values will be higher if the respondent gets fuel wood benefit than otherwise. This can be explained by the fact that those who get fuel wood benefit may have a frequent visit of the forest and can enjoy the amenity benefit of the forest than those who do not get fuel wood benefit. The initial bid variable is significant and has the expected negative sign implying that respondents' probability of saying yes to the offered bid decreases as the initial bid presented to the respondent increases.

The other variable considered in the above regression estimate is acquaintance; by acquaintance we mean the number of years that the respondent knows Sheshmene forest. According to the above estimation acquaintance significantly affects WTP at

10% level of significance and this variable affects WTP positively, i.e., the more the number of years the respondent knows the forest the more it will be willing to pay for the amenity value of the forest. This may be due to the fact that the respondent will have more attachment to the forest. The remaining variables viz. education, distance, number of trees on the respondents' land, family size and sex, have no significant effect on the WTP of the respondent. Family size and sex were also found to be insignificant.

3.3 Interaction between Shashemane Forest and the Surrounding Community (Special focus to tangible NTFPS/Non-Market Values)

Shashemene forest plantation is an independent state enterprise, which primarily manages forest plantations in the three districts of Munissa (Dagaga), Gambo and Sole and processes logs into lumber, which is mainly sold in the domestic market. This plantation forest is located in the Oromiya region and gets its name from the nearby Shashemane town.

Table 7: Size and Location of Shashemene Forest

District	Plantation coverage per ha	Main nearby town	Distance from the nearby town
Gambo	1,354	Arsinegele	18 km
Dagaga	2, 567	Goljota	3 km
Sole	2, 183	Shashemane	7 km

Source: Silvinova ab 2000

The total area coverage of the plantation is around 6000 hectare. It is an area under intensive forest management system from the enterprise. There is also a natural forest portion, which is under the protection of the enterprise, but there is no annual recorded information of this portion; it is mainly a preservation forest that contains a wide variety of forest species. In the above-indicated districts of the forest there are significant number of residents that have attached their livelihood to the benefits obtained from the forest. The main theme of this section is to analyze this interaction between the forest and the people in the surrounding area and give an indication about the importance of non-market values of the forest.

3.3.1 Tangible NTFPs, of Shashemene forest

According to Vincent (2000), forests provide tangible non-timber products that are collected and consumed by households but not bought and sold in the market. This may comprise products directly harvested mainly for their own consumption like, fuel wood and wild fruits, or it may be wood products used for construction, tools, furnitures and other similar purposes. In our context, when we say timber products we mean timber logs used for commercial purposes by the Shashemane forest enterprise. Those wood products that may be collected by households from the falling and pruning of part of the trees are considered as tangible NTFP.

Table 8: Economic utilization of environmental goods

NTFP utilization	% of households who get the benefit from the forest	Economic use of environmental goods				
		Consumption	Durable	Production input	Asset formation	sale
Fuel wood	68.4	X		X		X
Construction wood	58.4		X	X		X
Wood for Furniture	54.0		X		X	
Wood for Farming implements	52.2		X	X	X	
Wild fruit	55.8	X				
Wild medicine	45.5	X				
Grazing	65			X	X	

The aforementioned figures clearly show the fact that a significant percentage of the surrounding community gets at least one of the tangible NTFPs from the Shashemane forest. The minimum percentage of households who benefit from at least one of the categories of benefits is 45 percent. We may also note that different social groups are utilizing different resources. For example children mainly eat wild fruits during the time of livestock herding while the female mainly collect fuel wood.

The second feature to be mentioned is that tangible NTFPs provide the surrounding community with goods that have different economic characteristics. This issue can be supported by the results displayed in the above table. Products like fuel wood, wild fruit and wild medicine are consumption goods. Others such as construction wood, wood for farming implements and even fuel wood are serving as production inputs. Whereas Furniture woods and others are categorized as consumer durables. Coming to tangible NTFP values, we found out that the monetary values of these products which are obtained by the surrounding community are relatively substantial. The average value of NTFP that a given household gets per annum is around 1722 ETB. This makes the annual value obtained from Shashemane forest 120, 540, 000 ETB in the year 2003/04.

Table 9: Tangible NTFPs

Variable	Mean	Minimum	Maximum
Tangible non-timber forest values	1722.165	0	6965

When we analyze the composition of tangible NTFPs, 90 percent of tangible NTFPs are obtained from fuel wood. A comparison of tangible NTFPs with household income shows that the value of these products obtained by the households is estimated to be about 26 percent of their income. We also found that 95 percent of the households use fuel wood for cooking and around 25 percent of them use only fuel wood for lighting purposes. This shows the heavy dependence of the surrounding community on wood products. Grazing, employment and other benefits are also obtained by the community due to the existence of Shashemane plantation forest. Out of the respondents who have livestock, 65 % reported that at least one of their livestock's grazing lands is inside the forest. On the other hand a significant number of people from the surrounding community are getting employment opportunity from the plantation.

The question would be who is getting these NTFP benefits of Shashemane forest? Our result shows that, in terms of percentage share of the total benefit, while the lowest 10 percent income category of households get around 14 percent of the benefit the upper 10 percent income category gets only 9.8 percent of the total tangible NTFP benefit. This means poor people in the surrounding community are benefiting more from the forest NTFP than the richer ones.

4. Conclusion and Recommendation

The system of national accounts that mainly focus on measuring the production of goods and services cannot properly record the welfare impacts reflected from the use of forest resources in a society. The benefits obtained from multiple uses of forest resources and the future welfare reduction/increment that may arise due to current utilization do not get appropriate treatment in the system.

This paper tries to discuss a number of issues related to forest accounting and illustrates it by making an expanded application in the Shashemane forest. Such kinds of expanded forest accounts may either be a base for further analysis of the interaction between forests and the economy or it could play a major role in showing the welfare gains/losses related to forestry and other sectoral policies.

The results of this study show that the total value added of Shashemane forest in the year 2003/04 is estimated to be around 163,705,524 ETB. This estimation comprises the benefits obtained from timber products, amenity services and tangible non-timber forest products. Tangible NTFPs are found to have a significant proportion of the value added although most of this is not captured by the system of national accounts. Findings of this paper show that the poorer section of the community benefits more from such products compared with the richer ones. This may give an important indication that keeping forests alive can be one of the options for fighting poverty.
Amenity values have also a share, which can by no means be negligible. Our results show that the rural community around the Shashemane forest is benefiting from the amenity services provided by the forest. The findings of this paper also show that appreciation of Shashemane forest constitutes about 1.9 percent of the total value added in the year 1997.

Results show that current SNA measures can underestimate the contribution of Shashemane plantation forest to national income and wealth. This would not necessarily be the case for open access type of forests of the country. In fact, the system would even overestimate the contribution, because depreciation in such cases would be high. The over/ under estimation of values mainly come from the omission of net accumulation values.
Suggestions for future research work

- There are different types of natural resources; this paper only touched one of these resources. However, further research work on natural resource accounting can be done for other resources like soil, minerals and water.
- This study tries to incorporate important values of forest resource; however, it is not exhaustive. Research works may include other benefits like carbon sequestration, watershed and other benefits to make it as comprehensive as possible.
- Large part of the forest resource in Ethiopia is not protected like that of Shashemane forest. Forest accounting research can be done in those forest areas that have different features than Shashemane forest.
- This paper focused on one specific area due to different constraints. Natural resource accounting would be more meaningful if it had been conducted for a

wider geographical area and different resources. Although it may require a lot of effort a national or state level natural resource accounting would be a more comprehensive indicator of welfare to a wider portion of the society

References

Asheim Geiber B. (2000), Green National Accounting; Why and how, Environment and Development Economics, p.25- 48

Atlaw Alemu (2004) Human capital inclusive green accounting and social well-being, M.Sc. thesis, Addis Ababa University, Addis Ababa.

Baytas, Ahmet and Farahmand Rezvani (1993), Forest Resource Accounting in Ghana 1970-1987, Ghana

Bengt, Kristrom (1996), On the Incorporation of Non-Market Outputs of Forests into The National Accounting System, Edinburgh

Cavendish, William (2000), Empirical Regularities in the Poverty- Environment Relationship of Rural Households, World Development, Elsevier Science, Great Britain.

El Serafy, Salah and Ernst Lutz (1999), Environmental and Natural Resource accounting, in a book of Environmental Economics and Development, London, 334- 350

Environmental Protection Authority (EPA) (1997), Ethiopian Environmental Policy, Addis Ababa

Eth-UNCED, (1992), National Report on Environment and Development, Addis Ababa.

FAO (2002), Applications of the contingent valuation method in developing countries, Retrieved from, www.fao.org/DOCREP/003/X8955E. HTM

Garrod Guy and Kenneth G. Willis, (1999), Economic Valuation of the Environment: Methods and Case Studies, Cheltenham

Haab, Timothy C. and Kenneth E. McConnel (1997), Valuing Environmental and Natural Resources, Elgar Collection, UK

Hanley, Nick, Jason F. Shogren and Ben White, (1997), Environmental Economics: in Theory and Practice, Macmillan press Ltd. London

Harpriya G.S (2000), Integrating Forest Resources into The System of National Accounts in Maharastra India, India

Hartwick, John M and Jeffrey R Vincent. (1997), Accounting for the Benefits of forest resources: concepts and experience, retrieved from www.fao.org/DOCREP/005/AC272E.HTM

Hassan, Rashid M. (2000), Improved Measure of Contribution of Cultivated Forests to National Income and Wealth in South Africa, Pretoria

Hassan, Rashid M. (2002), Accounting for Stock and Flow Values of Woody Land Resources, University of Pretoria, Pretoria

K. G. Loewn and S.N. Kulshreshtha (1996), Recreation and Wilderness: Participation and Economic Significance in Saskatchawan, Canada

Lange Glenn-Marie, Rashid Hassan and Kirk Hamilton (2003), Environmental Accounting in Action, Case studies from South Africa, Elgar reference collection, UK

Martina, Bjorkman (1999), Forestry Accounts For Namibia: The Value of Timber and Firewood in Namibian Economy, Umea University

Ministry of Agriculture (1994), Ethiopian Forestry Action Program, Vol.2., Addis Ababa

MoFED, (2007), Ethiopia Population Images 2006, Addis Ababa

MoFED (2002), Sustainable Development and Poverty Reduction Program, Addis Ababa

Mogas, John, (2002), Comparison of Contingent Valuation and Choice Modeling: Estimating the Environmental Values of Catalonian Forest, Department d'Economia, Rovira I virgili, Spain.

MoPED, (1994), National Accounts of Ethiopia: Coverage, Source and Methods, Addis Ababa

Munessa – Shashemene State forestry project, Arsi-Negelle

OECD (1999), Frameworks to Measure Sustainable Development, an OECD workshop, Paris

Parliamentary Commissioner for the Environment (1997), The Management of Sub- urban Amenity values, retrieved from www.pce.govt.nz

Repetto, R, William Margrath, Michael Wells, Christine Beer and Fabrizio Rossini, (1992), Wasting Assets: Natural Resources in the National Income Accounts, book of Environmental Economics and Development(Opschoor , Kenneth, and Petter, ed.), London, pp. 310- 334

Repetto. R, William M, Michael W, Christine B. and Fabrizzio R (1989), Wasting Assets: Natural Resources in National Income Accounts, Washington D.C .

Reusing, Matthias (1998), Monitoring of Forest Resources in Ethiopia, MoA & GTZ, Addis Ababa

Ronaldo Seroa da Motta and Claudio Ferraz (1998), Estimating Timber Depreciation In The Brazilian Amazon, Rio de Janeiro.

Shahsmene Forest Enterprise (2001), Survey of Lumber Market, Arsi-Negelle

Shahsemane Forest Enterprise (2004/2005), Enterprise production cost estimation report, Arsi-Negelle

Shahsemane Forest Enterprise (2004/2005), Financial Report of the Enterprise, Arsi-Negelle

Silvinova ab (2003/2004), Study on Enterprise Formation, Management and Operatiom

Statistical Cooperation Board, (1998), Integrated Environmental Management For Sustainable Development, Philippines

United Nations (2000), Integrated Environmental and Economic Accounting: An Operational Manual, New York

United Nations (2003), Integrated Environmental and Economic Accounting: A Draft operational manual, New York.

Vincent, J.R (2000), Green accounting: from theory to practice, Environment and Development Economics. pp. 13-23

Vincent, J.R, (1998), Theoretical Aspects of Forest Accounting, Development discussion paper, Harvard University

Weitzman, Martin L. (2000), The Linearised Hamiltonian as Comprehensive NDP, Environment and Development Economics, pp. 55-68

Willis Kenneth G, Kenneth B and Peter Nijkamp (1999), Environmental valuation, volume I, Elgar Reference Collection, UK

Woody Biomass Inventory and Strategic Planning Project, (2002), Forest Resources of Ethiopia, MoA, Addis Ababa

1. 1USD is exchanged at approximately 8.9 ETB

FUEL EFFICIENT TECHNOLOGY ADOPTION IN ETHIOPIA: EVIDENCE FROM IMPROVED"MIRT" STOVE TECHNOLOGY: A CASE IN SELECTED KEBELES FROM "ADEA" WEREDA EAST SHOA ZONE

Dawit Woubishet[1 2]

Abstract

The increasing scarcity of biomass and the increment of the number of people who use biomass, particularly firewood, threaten the capability of the country even to maintain the already existing low income and living standard of the people. Therefore, the need for adopting improved "Mirt" stove technology not only enables the households to use fuel efficiently, but it will enable them to curb the problems caused by using traditional and open fire stoves as well as biomass energy related problems. It can also mitigate the impacts on the users' health, the over all environment and natural resources brought by using those traditional and open fire stoves.

With two estimated equations, that is information and adoption equation. This study result reveals that improvement in socio economic conditions of the people have positive impact on information acquisition and access in urban and rural households. Moreover, the result supports the "energy Ladder" hypothesis as theoretical and functional useful framework to explain the fuel use and improved technology adoption in the study area. The findings also reveal that socio-economic improvement have direct and significant impact on adoption decision. This finding also reinforces the role of government and non-government organizations to play a major role in information diffusion and to enhance the adoption decision of the people to protect the country's natural resources and to resolve environmental problems that arise due to excessive utilization of biomass resources.

Key words: improved stove, information, adoption and "energy ladder"

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[1] Addis Ababa University

[2] Derived from author Masters Thesis, March 2007, Addis Ababa University, Addis Ababa.e-mail hello3dayz@yahoo.com

1. Introduction

Poor people are both the agents and the victims of environmental damage. Fuel-wood gathering can lead to land degradation, biomass combustion to indoor air pollution, dirty fuels to outdoor air pollution and through green house gas emission, global warming. In all those cases, poor people both contribute to the environmental damage through their actions and suffer from its consequences. Moreover, the energy sector has a significant part to play in reducing the environmental damage and its harmful effects by introducing renewable energy source, supplying modern cooking fuels, and substituting cleaner fuels for dirty ones and increasing energy efficiency.

Energy is vital to economic development. Without fuel that power cars, trains and planes, and without electricity, light and heating, life in industrialized countries would be considerably less comfortable. In developing countries, however, it is not just a question of comfort. Poverty could not be reduced without the greater use of modern forms of energy. Even now, around two billion people have no access to electricity, relying instead on traditional fuels such as dung and fuel-wood. Those who are fortunate in developing countries enough to have electricity, on average spend 12% of their income on energy; more than five times the average for people living in OECD countries. At the same time, the provision of energy services, especially the combustion of fossil fuels and biomass can have adverse effects on the environment. (WB, 2000)

Ethiopia has significant energy resource. This resource endowment is said to be enough to meet the present need and long-term energy requirement of the country. Overall, only some of this endowment is being presently exploited (EEA, 1994). The main endogenous sources of energy are biomass, hydropower, fossil fuel (natural gas, coal), geothermal, solar and wind. The country's energy use and/or consumption are 95.6% from traditional source and only 4.4% from modern source. In terms of the level of sectoral use; household accounts for about 91.3% of the total final energy consumption. And the biomass fuel account 98.5 % while the modern energy only takes 1.5%. With in the household sector the rural and urban household energy consumption accounts for 92 and 8%, respectively. (Asres, 2002)

In Ethiopia, few studies have attempted to investigate the problems, constraints and factors affecting the household decision to adopt fuel efficient technology with the context of environment and natural resource protection. Tadelech (2001), considered the problem of population pressure and rural-urban migration and their impact on energy need in urban areas and analyzed the determinants of fuel-efficient technology adoption. She only looked at demographic and socio economic variables and her study were limited to two kebeles with in Addis Ababa. Hence, this study focuses on both rural and urban households. It is obvious that the rural household takes a significant share in energy consumption and the adoption of this technology is extremely low. Along with the socio-economic and demographic factors; dwelling characteristics, information diffusion and attitudinal or perceptions of the household to the technology are considered. The paper also provides knowledge and information with regard to promoting fuel-efficient technology and conserving energy, forest resource and environment.

The major objective of this study is to analyze the nature, problems and main determinant factors in household decision to adopt improved fuel-efficient technology, the factors that determine to acquire information about the technology and their impact on environment, fuel scarcity, household time and income. And also to drive policy implications and interventions on environment, natural resource and energy/

The findings may also help to rehabilitate policy regarding energy, environment, natural resource and information. In addition, the results have anticipated in assisting development practitioners, both governmental and non-governmental organizations that are interested in alleviating poverty, satisfying the energy need of poor households and protecting natural resources.

In Ethiopia, projects involvement in this particular activity has not well developed. One of the projects involved in production and dissemination of improved stove is an improved ("*Mirt*") "injera"[3] stove, which is undertaken by GTZ- Household Energy and Protection of Natural Resources Project with the participation of private sectors in production and commercialization of the stove.

The Ministry of Agriculture and GTZ, The German Development Cooperation, in 1998 have launched an improved stove dissemination program to promote biomass energy efficiency in households. The main objective of the project is to enhance the efficient use of biomass resources by integrating household energy measures into development plan. Moreover, the overall goal of the project is to contribute to environmental protection and sustainable environmental development. The project focuses on the dissemination of improved ("Mirt") stove fuel saving for "ingera"

[3] "Injera" is the traditional food of Ethiopian households, and mostly prepared from "teff".

baking. The technology choice has been taken on the ground that baking “injera” alone takes a significant share of the primary energy consumption.
The improved (“*Mirt*”) stove has been under extensive research and testing by the Ethiopian Rural Energy Development and Promotion Center (EREDPC) in the beginning of 1990s, when the stove was introduced in Addis Ababa market. The improved (“*Mirt*”) stove has certain features that make it particularly suitable for commercial dissemination approach. Among the desirable features include it can save fuel expense for the households, accommodate different types of fuel, and it has a modern design and create clean kitchen environment.

2. Theoretical Background

From the mid 1970’s onwards, the rapidly increasing cost of all forms of energy, led by the world oil price, stimulated the development of new analytical tools and policies (Munasinghe,1980). First, the need became apparent for greater coordination between energy supply and demand options. Second, energy-macroeconomic link began to be explored more systematically. Third, the more disaggregate analysis of both supply and demands within energy sector offered greater opportunities for inter fuel substitution (especially away from oil). Fourth, the analytical and modeling tools for energy sub-sector planning became more sophisticated. Fifth, in the developing countries, greater reliance was placed on economic principles, including the techniques of shadow pricing. Finally, heightened environmental concerns have led to a better understanding of energy – environment interactions.

The environmental and health consequences associated with various cycles of energy production and consumption is, for a large part, very similar among energy sources. Differences may exist mainly in terms of the magnitude of those effects. Major disruptions in the environment and health impacts are linked to biomass energy from gathering and combustion.

Gathering of fuel-wood and removal of crop residues or animal manures in the course of using biomass as fuel have; for instance, been argued to contribute to serious deforestation in the long run, increased incidence of floods, stream sedimentation, and decreased water yields from watersheds. Excessive removal of agricultural residues or animal dung affects soil fertility, and exposes soil to increase wind and water erosion. Biomass combustion has the potential to create indoor air pollution, if wood stoves are improperly installed. Among the emission control method, improved stove technology is one of the alternatives for most developing countries because biomass is the most important source of energy and its use is wide spread, especially by the poor.

2.1 The Energy Ladder Hypothesis

The most comprehensive hypothesis regarding energy use pattern of households focuses on the concept of “energy ladder”. The energy ladder depicts various combinations of fuels used by a household at its different stage of development. With movements up the ladder, fuel mixes are generally considered as clean and efficient. This is also directly correlated with income growth, bringing about an increased use of modern fuels and less use of biomass (Israel, 2002). The basic assumption of energy ladder is that a household is faced with a range of different energy supply choices, which can be classified in order of increasing technological sophistication.

Households use fuel for a variety of activities, including cooking, water heating, lighting, and space heating. The order of different fuel types on the energy ladder can vary according to this end use. For cooking Munasinghe and Meier (1993), for example arranged the range of different energy leader as follows: first, dung and crop residues (which are inferior quality biomass fuels, and grouped at the bottom of the ladder); second, fuel-wood and charcoal (relatively higher quality biomass fuels and placed in the next step); third, kerosene; forth, Liquefied Petroleum Gas (LPG); and finally, natural gas and electricity.

As the economic status of a household rises, reduced use of lower quality fuel type and switch to consumption of relatively higher quality ones occurs. As a result, the household is said to move up in the energy ladder. If, on the other hand, the economic status of a household declines, then it is expected to consume a relative inferior quality fuel. In this regard, Hosier and Dowd (1988) point out that energy ladder acts as a stylized extension of the economic theory of a consumer. That is, as household’s income increases, it makes a decision not only to consume more of the same good, but switches towards consuming other goods of higher quality.

2.2 Theoretical background on energy conservation determinants

Economic theory suggests that, in order to gain comfort and time, households are becoming excessive energy users, neglecting the environmental impact of their choices. According to household production theory, households are treating as productive units organized to provide services for the occupants; energy is treat as input in the provision of a range of household services. Consumers' choices define the utility they can derive (Becker, 1965; Muth, 1966). The extent of service that we can derive from a given amount of energy depends not only on the efficiency of the technology but also the consumers' lifestyle. Several theoretical and empirical studies focused on households' energy conserving behavior and its links with socio-economic parameters, which hint at lifestyle changes.

In the context of residential energy use, lifestyle should reflect the understanding that environmental responsibility and concern for energy sources go part and parcel with our daily energy based actions (Held, 1983). This demand-conscious lifestyle does not necessarily imply curtailment or sacrifices as far as the level of comfort or the quality of living are concerned. On the contrary, this approach is centered on an altered awareness of energy consumption in our daily lives.

As coomer (1977) claimed a significant decrease in energy consumption may mean a perceived lifestyle change and should not be identified by means of reduced quality of life or social status, and as Leonard-Barton (1981) defined in a discretionary change of lifestyle, a low energy lifestyle is characterized by ecological awareness and attempts to become more self-sufficient users, known as voluntary simplicity lifestyle.

Van Raaij and Verhallen (1983) and Weber and Perrels (2000) specified that lifestyle approach should take into consideration a broader socio-cultural concept. In this concept, lifestyle patterns are shaped as a consequence or enduring activities with regards to time, housing, family and income conditions that households face and partly as a way or self-expression and self-realization.

3. Methodology

3.1 Data source and methodology

3.1.1 Data source

Adea is selected for this study as it is one of the major urban and rural centers of the country with severe forest degradation and fuel-wood and other energy source problems. The data type used in the study mainly includes primary and cross-sectional for the period of 2006. Data sources were mainly on survey conducted for this purpose and relevant documents from *Adea* Municipality and Rural Administration Office. The primary data were collected by making a household survey with questionnaire having five parts: household information; household energy pattern; fuel use; cooking pattern, kitchen environment and improved stove and household perception, and attitude towards the improved stove technology.

After designing the draft questionnaire, pre-testing of the questionnaire was conducted through a focused group discussion with municipality officials, producers of the improved stove, and fifteen randomly selected households. The purposes of the pre-test were to make some possible modifications in the design of the questionnaire for the main survey, so that objectives of the survey can be met. Based on the pre-test the order of the questionnaire was restructured, making questions on household characteristics (particularly questions with economic characteristics, income, for which households were reluctant to give true responses).

First, the *Adea* wereda divide into rural and urban households. To identify the well informed households'; for urban households GTZ-SUN energy Project organized a demonstration activity about the improved ("*Mirt*") stove technology in different places and time. It is estimated that about 30000 household attend the demonstration activity in *Adea* wereda. For rural households the rural development agent's in collaboration with GTZ-SUN Energy Project provided training and demonstration about the stove in church, local people associations meeting and in extension training programs. According to GTZ-SUN energy in *Adea* wereda approximately 6,856 stoves are distributed of which 1,596 and 5,260 in rural and urban households, respectively.

For consistency of data analysis, for urban households those who attend the demonstration activity effectively had been considered as well informed and know very well about the improved ("*Mirt*") stove technology and those who did not attend the demonstration activity effectively are considered as not well informed about the technology. And for rural households, who are not actively participate in demonstration activity by development agents and weak in extension participation and training programs are considered as not well informed about the technology.

A Stratified and random sampling technique was used for the study. Due to lack of well documented information on number of households and their location for the newly established 9 urban and 27 rural kebeles from each settlement; three kebeles were randomly selected. The rural kebeles' were selected from the surrounding eleven kebeles which is near to the town of "Debrezeit". Then from each selected urban and rural kebeles 30 and 40 households are randomly selected, respectively. Time and financial limitations were taken into account and random sampling technique employed to select a sample population of 210 households for this study.

Seven enumerators, four of them diploma holders in rural development and three college students and two supervisors including the researcher, participated in the main survey. For this purpose, a two-day long training was given to the enumerators on nature of the survey and how to administer it. The survey was conducted from September10 up to November 3, 2006. Finally, the data collected was coded and prepared for analysis using Excel and STATA 9 for econometric analysis.

3.2 Model specification

The model begins with the information held by the household, the potential adopters. It would be misleading to categorize the population of households into adopters and non-adopters; if not all members of the potential adoption community are informed. The adopting households are therefore those that are informed about the existence of the technology and find it efficient. Thus, the adoption decision is conditional on the availability of information.

3.2.1 Information Equation

A common practice in adoption studies is to divide the adoption population in to adopters and non-adopters without worrying about whether all members of household of the potential adoption population are informed about the existence and utilization the technology under the study. This usually results in inefficient and biased estimator. Then, if in any community, some potential adopters are not informed about the existence and how to use the technology, the information equation should be the first equation of adoption model (Seha. et al 1994)

Let us take a household with a level of information equal i* and let i^0 be the threshold of level of information that a household should have in order to be classified as informed. Then the household is informed if $i^*>i^0$

By defining the latent variable Y^{H^*} as $Y^{H^*} = i^*-i^o$ the condition to classify a household as informed becomes,

$$Y^{H^*}= i(X^H)-i^O>O \qquad \textbf{(1)}$$

Where superscript H stands for household who have heard that the technology exists and knows how to use it.

X^H= vector of household characteristics and attributes that could influence i*, say the supply and demand of information

Then the theoretical equation to be estimated is then.

$$Y^{H^*} = X^{H}.\ \beta^{H^*} + \epsilon^{H^*} \dots \qquad \textbf{(2)}$$

Where, β^{H^*}= *Vector of parameter to be estimated*
ϵ^{H^*}= *error term*

i*,i^{o} and consequently Y^{H^*}, are not observable. To estimate the information equation, we need to construct a variable that accounts for whether the household is aware of the technology and how to use it. Let us denote that variable by Y^{H}. Which takes the value **1** for a positive answer ($Y^{H^*}>0$) and **0** for a negative or null answer ($Y^{H^*} \leq 0$).

The theoretical Probit equation to be estimated is therefore

$$Y^{H} = \Phi\,(X^{H}.\ \beta^{H}) \qquad \textbf{(3)}$$

Where β^{H} = *vector of parameter to be estimated*

3.2.2 Adoption equation

After the information equation formulate, the adoption equation conditional on information. If the household is not informed, it is not possible to consider adoption. Households may well be informed about the existence and use of the technology but there are different factors that affect the decision of the household whether to adopt or not. Therefore, adoption equation formulates to analyze only for informed households.

Dominich and Mc Fadden (1975) used a random utility approach, permit a more systematic look at the primary determinants of adoption behaviour and make possible a systematic sensitivity analysis of the predicted probabilities of adoption decision to changes in key explanatory variables. The model uses the random utility approach; the household chooses the technology because it provides a maximum expected utility among the available choices.

Haab and McConnell (2002) quoted Hanemann (1984) also developed the basic model to analyse dichotomous responses based on the random utility theory. The central theme of this theory is that although an individual knows his/her utility certainly, it has some components, which are unobservable from the viewpoint of the researcher. As a result, the researcher can only make probability statement about respondent's 'YES' or 'NO' responses or decisions.

The Probit Model is used to identify factors that affect the probability of adopting the improved ("Mirt") stove technology. In this study, households are informed about the existence and how to use the technology, which they may adopt or not. Hence, it is a single bounded dichotomous choice model to be framed under the random utility method (approach). The random utility model also provide convenient approach and the point of departure is a utility model that is composed of two parts, one observed by the analyst, the other treated as random.

Let us consider the decision of a household regarding whether he/she adopt the improved ("Mirt") stove or he/she adopt the traditional or open-earthed stove for the household baking appliance

Let's define that indirect utility function for the j^{th} household can be specified as follows:

$$U_{ij} = U_i(Z_j, H_j, C_{j,} D_j, \varepsilon_{ij}) \qquad \textbf{1}$$

Where D_j= j^{th} respondent's dwelling status.

H_j= vector of household socio economic and demographic characteristics and attributes.

$Z_{j=}$ j^{th} household response about the compatibility and complexity of the technology.

$C_{j=}$ j^{th} household cost (expense) for fuel, and members of household participate for collection of fuel-wood and other energy sources for the household energy need

ε_{ij}= random component of the given indirect utility

Equation (2) represents the household utility function with the baking appliance (stove) for the household is the improved ("*Mirt*") stove technology.

$$U_{1j}(Z_j, H_j, C_j, D_{j,} \varepsilon_{1j}) \qquad \textbf{2}$$

Equation (3) represents the household utility level with the baking appliance (stove) for the household is the traditional or open hearth stove technology.

$$U_{0j}(Z_j, H_j, C_{j,} D_j, \varepsilon_{0j}) \qquad \textbf{3}$$

The household is introduced about the improved ("*Mirt*") stove technology and knows improvement in household energy efficiency and environment; the household adopts the improved ("*Mirt*") stove technology if and only if:

$$U_{1j}\left(Z_{j,}H_{j,}C_{j},D_{j},\varepsilon_{1j}\right) > U_{0j}\left(Z_{j},H_{j},C_{j},D_{j},\varepsilon_{0j}\right) \qquad \mathbf{4}$$

Then, for individual j, the probability statement is:

$$P(Yes) = \left[U_{1j}\left(Z_{j,}H_{j},C_{j,}D_{j},\varepsilon_{1j}\right) > U_{0j}\left(Z_{j},H_{j},C_{j},D_{j},\varepsilon_{oj}\right)\right] \qquad \mathbf{5}$$

This probability statement provides an intuitive basis to analyse binary responses. Assuming that the utility function is additively separable in deterministic and stochastic preferences:

$$U_{ij}\left(Z_{j},H_{j},C_{j},D_{j}\right) + \varepsilon_{ij} \qquad 6$$

Given the additive specification of the utility function the probability statement for respondent j becomes:

$$P(Yes) = \left[U_{1j}\left(Z_{j},H_{j},C_{j},D_{j}\right) + \varepsilon_{1j} > U_{0j}\left(Z_{j},H_{j},C_{j},D_{j}\right) + \varepsilon_{0j}\right] \qquad 7$$

This probability statement is the point of departure for the linear utility function in a set of covariates, which is assumed by our empirical model. However, the adoption decision of individual household, is conditional on the acquisition of information. This procedure needs to be sequential and let denote the vector of explanatory variables that explain adoption decision by $\boldsymbol{X^A}$. Then, we obtain the following theoretical model:

$$Y^{A*} = X^{A}.\ \beta^{A*} + \epsilon^{A*} \qquad \mathbf{8}$$

Where: B^{A*}, vector of parameters to be estimated,
ϵ^{A*}, error term

The latent variable Y^{A*} is not observable and we defined by its proxy Y^A taking a value **One (1)** for adopters and **Zero (0)** for non-adopters for the sub-sample of informed households (Y^H=1). Thus, the conditional Probit model to be estimate is:

$$Y^{A} = \Phi\ (X^{A}.\ \beta^{A}) \qquad 9$$

Equation (3) and (9) are model of sequential, adoption of one technology based on information acquisition. This model of sequential adoption of one technology based on information acquisition is in essence different from that of Khanna (2001) as sequential adoption of components of technological package. Nevertheless, the statistical implications for econometric analysis of adoption are quite similar. As in Khanna (2001), under the study of sequential adoption components of technological packages and just making the substitution of technological component for decision. It is possible that, since decisions (information and adoption) are interrelated, single equation is inefficient because they ignore the correlation of error terms of equations that explain each decision. This correlation arises because the same unobserved characteristics may influence all inter-related decisions.

For the empirical estimation, let us assume that $(\varepsilon^H, \varepsilon^A,)$ has a bi-normal distribution. That is:

$$(\varepsilon^H, \varepsilon^A)\, BVN\,(0,0;1,1,\rho) \qquad \mathbf{10}$$

Where: ρ is the correlation coefficient between ε^A *and* ε^H.

Under the above assumption, the conditional probability of the adoption decision given by equation (10) (see Seha et al., 1994; Maddala, 1983)

$$\begin{aligned} &\mathrm{Pr}ob\left(Y^A = 1/Y^H = 1\right) \\ &= E\left[Y^A / \left(i^* - i^0\right) > 0\right] = \Phi\left(X^A.\beta^A\right) + \rho.\frac{\phi\left(-X^H.\beta^H\right)}{1-\Phi\left(-X^H.\beta^H\right)} \end{aligned} \qquad 11$$

$$Note\ \alpha = -X^H.\beta^H\ and\ \lambda(\alpha) = \frac{\phi(\alpha)}{1-\Phi(\alpha)}; \lambda(\alpha)\ is\ the\ inverse\ of\ Mills's\ ratio.\ Then, we\ have$$

$$\mathrm{Pr}ob\left(Y_A = 1/Y_H = 1\right) = \Phi\left(X_A.\beta_A\right) + \rho.\lambda(\alpha) \qquad 12$$

Φ and ϕ are the functions of cumulative distribution and normal probability density, respectively.

For traditional Probit and Logit estimations, only element $\Phi\left(X^A.\beta^A\right)$ is considered in equation (12), resulting in inconsistent estimators β^A. More importantly, application

of traditional Probit and Logit estimations that ignore self-section would result in biased estimates of marginal effect on probability of adoption of a variable **X** $_j$ that is common to vectors X^H and X^A.
From (12), we have:

$$\partial \Pr ob \frac{(Y^A = 1/Y^H = 1)}{\partial \chi_i} = \Phi\left(X^A.\beta^A\right)\beta_j{}^A + \rho.\beta_j^H.\left(\lambda\alpha - \lambda^2\right) \qquad 13$$

If the possibility of self-section is ignored, the second element of the right side of equation (13) will be omitted. For all parameters to be identified, $\mathbf{X^H}$ and $\mathbf{X^A}$ should differ at least in one independent variable.

Therefore, the maximum likelihood estimates of parameters β^A, β^H, ρ can be obtained from maximizing the following log-likelihood function, which rests on the definition of conditional probability:

$$\ln L = \sum_{Y^A=1, Y^H=1} \ln \Phi_2\left[X^H \beta, X^A \beta^A, \rho\right] + \sum_{Y^H=1, Y^A=0} \ln \Phi_2\left[X^H \beta^H, -X^A \beta^A, -\rho\right] + \sum_{Y^H=0} \ln \Phi\left[-x^H \beta^H\right] \qquad \mathbf{14}$$

4. Empirical Findings: Results and Descussion

4.1 Descriptive results

4.1.1 Socio-economic characteristics of the households

On average 11% of the rural households were female-headed and 89 % were male-headed while the proportions in urban areas were 64 and 34%, respectively. Household age ranges from 20 to 83 years and the sample average equals 47 and 50 years for rural and urban households, respectively. About 78 and 64% of the rural and urban households, respectively, were married. However, the average household consisted of seven individuals for rural areas, ranging from one to eighteen members and five individual for urban areas.

The education of the household head was categorized into four levels. Those who cannot read and write are categorized under illiterate group and constituted 37% of the rural households' heads. Nonetheless, those with a formal education of 1-6 grades are grouped under primary level education since they can read and write and constituted about 40%. Those with a formal education of between 7 and 12 grades accounted for 21% of the rural respondents and were grouped under secondary level. About 2% of the rural respondents have completed high school, and thus they are grouped under tertiary level. In rural areas female literacy level is very low; only 38% of the household wives are literate.

From among urban households heads, about 34% attended primary level education while 30 and 7% attended secondary and tertiary level, respectively. The remaining 29% are disappointedly illiterate. However, female literacy in urban areas takes 56%. The average monthly rural households' income is found to be 656.12 birr and 53% of the respondent rural households earn monthly income of less than five hundred Birr whereas in urban households, the average is only 506.72 birr and the majorities (74%) earn monthly income of less than five hundred Birr. Thus, the study indicates that the average income of the rural households is surprisingly greater than urban households.

The respondents stated that their income is not enough to cover their basic needs. Since the urban households were not interested to disclose their monthly income, expenditure on major items has been taken as a proxy of monthly income. For rural households their monthly income is estimated by considering the major crop they produce per annum, off-farm income source and livestock capital of the household. Currently, there are a number of microfinance institutions and other credit organizations that facilitate credits for dwellers, but only 52% and 58% of the urban and rural households have access to credit facilities, respectively.

Dwelling status is used to indicate the standard of living of the people. As per the survey result, 78% of the rural households live in their own house while the rest 22% live either with their relatives or in rental house. But, in urban households, only half of the sample households live in their own house while the rest reside in kebeles' house, temporary shelter or private rental house. The study found that housing problem is more severe in urban households than in rural households.

The average dwelling size and the kitchen environment are almost similar in both settlements, urban and rural. The great numbers of houses are built with mud, wood and corrugated iron, and they consist of three rooms on average. About 60% of the rural households bake and cook in separate kitchen. However, the remaining 40% bake and cook in open air and in their living rooms. Nonetheless, about 42% of urban households bake and cook in shared kitchen, open air and with in their living rooms.

Those households, who do not have separate kitchen, are faced problems related to cooking and baking activities such as accident to burning, heat and smoke problem.

About 44 and 51% of the rural and urban households who are interviewed are actively participating in local associations, such as “Idir”, “Iqub” and “Mahiber”, respectively. Participation in those associations is believed to enable households to get informal source of information.

4.1.2 Fuel Consumption and related issues

Most of the interviewed households (92%) mentioned that they are using fuel-wood and cow dung as a major source of energy. About 37 and 44% of the households always use fuel-wood and cow dung as a substitute while facing shortage of any kinds of fuel sources, respectively. This result thus indicates that there is excessive utilization of biomass resources in rural and urban areas, which might cause a negative impact on the natural resources and environment.

Households collect fuel-wood and other energy sources from different areas. In rural areas, 31% collect energy sources from their back yards while 36 and 22 % collect from their own farm (field) and open field, respectively. The remaining 11%, however, purchase from their nearest fuel market. In urban areas 21% of the households collect from their back yard where as 20 and 15% collect from their own field and open field areas, respectively. The remaining 44% are using commercial means to meet their energy need.

The study has identified that households adopt different coping strategy to overcome fuel shortages: Storing of fuel and substituting one fuel source by other are some of the coping strategies to alleviate the problems. About 40 and 32 % of the urban households and 54 and 31 % of rural households use Storing of fuel and substituting strategies, respectively.

Concerning getting information about the new and improved stove technology, around 49% of the urban households obtain their information from demonstration activities undertaken by GTZ- SUN energy whereas 62 % of the rural households obtain from development agents demonstration. Thus, provision of information is important through informal channels to address all the population.

4.1.3 Time and effort involved in gathering fuel wood/dung and expense for fuel.

The responsibility of gathering fuel-wood and other energy sources lay on women and children in most developing countries. It is also known that collection and transportation of fuel involve tedious and tough work such as walking long distance with carrying loads and others that might cause health disorders on individuals. Similarly, the study indicates that those who collect fuel-wood and other energy sources have to cover long and tiresome distances at least two times per week and about sixteen hours per month to fulfill their energy consumption.

About 78% of the rural households meet their energy need from collection. On average, from two to three members of the family, participate in fuel gathering activities and 73% of the households, at least they travel two times per week and two of family members participate in fuel collection. Among the rural respondents who adopt improved stove and their main source of energy is through collection, about 77% of households collect fuel from their own farm to meet their needs and took less than half an hour. However, 45 and 62 % of non-adopters and non-informed households spent more than one hour for fuel collection, respectively. This indicates that the rural households spent a lot of their time for fuel wood collection.

However, 42% of urban respondents have to travel two times per week to collect fuel sources and 48% of the households, at least two member of the family, participate in fuel collection. Accordingly, the study has identified that the effort exerted and the time spent to collect fuel sources in urban areas are relatively less from that of rural areas. It might be because of the prevalent use of commercial energy sources in urban areas.

Since traditional and open fire stoves consume too much fuel, households are not able to meet their fuel need from their surrounding areas non-informed and non-adopters of the improved stove are forced to move longer distance to find open field and backyard places in order to collect fuel sources. In those areas, fuel-wood and other energy sources are not easily accessible. About 57 and 45% of rural and urban households who use traditional and open fire stoves spent on average more than two hours for gathering energy sources on which at least two household members involve and they travel twice per week, respectively. Therefore, if a household collects fuel for nine months assuming that they may use the stock or any other means of energy need for the rest three months of a year, an individual member of the household will spend 135 working hours per year only for fuel gathering activities in those households. This indicates that children have to miss their school day and women are left less time to carry on other house chores.

The average monthly expenditure for fuel need is 41 and 17 birr in urban and rural households, respectively. Adopters of improved *Mirt* stove on average spent 29 Birr in urban households and 11 Birr in rural households. However, non-adopters of the stove spent 49 Birr in urban areas and 18 Birr in rural areas. In both settlements, the non-informed households mostly use collection of fuel as a source and they spent about 35 and 21 Birr for fuel in urban and rural households, respectively. Thus, if effort is made to distribute one million improved stoves in Ethiopia, it is possible to save on average 11.5 million Birr per month. This result indicates that the contribution of improved fuel saving technology towards households expenditure saving and directly to reduce impacts on fuel-wood and other biomass resources demand.

If this extra effort and time were to be put for some other productive use, it would surely help to reduce the burden of rural women and children in household activities and environment. It might also enhance the economic status of those women who participate in fuel collection. However, it is understood that not all of this time and effort can be put into productive and income earning activities due to many reasons such as child labour, low efficiency, low skill and lack of employment opportunity. Nevertheless, it will be possible for the households to generate income and reduce the burden of women should they utilize sixty percent of the extra time, which they spend to collect fuel, for productive purposes. The children will also able to use the time for their education. Put

4.1.4 Reasons for not using improved stove

This study focuses on those who are well informed, but not yet adopt the technology. The result reveals that low purchasing power only evidenced by rural households, about 76% of the households responded that the meager income they get prevents them to adopt the improved stove. About 53% of urban households reported that their main reason that hinders them from adoption is financial constraint. About 42% of urban households responded that their housing or dwelling status was the other key reason not to adopt the improved stove, especially the absence of separate kitchen in their living compound for those resides either in kebele house, temporary shelter or in private rental house. Particularly, urban households who use shared kitchen complained that their stove is easily accessible to all who live in the compound and other outsiders. Therefore, improving the kitchen environment and dwelling status of the people may contribute a lot for the household’s energy efficiency and usage of better energy appliance. By doing so, households will be able to move into the upper energy ladder.

4.2 The Econometric Results

The conditional probability functions are very similar for both Probit and Logit models, except in the extreme tails. The Probit model estimation is applied for this study. In order to check whether there is any serious multicollinearity among the explanatory variables, a correlation matrix was generated to drop some variables having higher multicollinearity.

It is worth nothing that the values of certain variable contrast greatly in size with other variables which may induce hetroscedasticity. A test for the presence of heteroscedasticity[4] problem in the model was also done. The test result shows that the null hypothesis of homoscedasticity is rejected implying that there is heteroscedasticity problem in the model as it is expected and common problem in cross-sectional data. To minimize this problem, the natural log of the monthly income of the household is considered in the model and heteroscedasticity-consistent Probit models from STATA 9 program were applied. the empirical results of information and adoption equations of rural and urban households summarized in Annex Table A-1-A and A-1-B , respectively.

4.2.1 The information results

Many empirical evidences show that acquisition of information and adoption decision determined by the socio-economic status, demographic characteristics, modern source of energy, educational attainment and income Hence, the study tries to analyze the factors that determine information acquiring and adoption decision on improved *Mirt* stove technology in both rural and urban households in the study area.

In rural areas, the probability of information acquisition is higher in female-headed households than in male-headed and significant (at 5%). This supports the common tradition practiced in Ethiopian rural households, i.e. women are responsible to

[4] The LR test is 88.17 and 84.27 for rural and urban estimates, respectively. The critical value of the chi-square at each estimation degree of freedom is at 95% level. Comparison of the results (test statistics) with critical table value shows that all of the test statistics (computed values) are found to be larger than the critical table value. This implies that the null hypothesis of homoscedasticity is rejected, i.e. hetroscedasticity is the problem for the model.

prepare food and collect fuel. As a result, rural women are concerned about the improved stove technology information.

Surprisingly, family size has a positive and significant impact on information acquiring in rural households. At the margin, the increase of rural household member by one may raise the probability of information acquiring by 7.9%. This indicates that particular rural family household members may disseminate and pass information to their family.

As expected, household age has negative impact on information acquiring in both urban and rural households, yet it is not significant. An increase in household age causes a reduction on the probability of information acquiring. The result suggests that information acquiring about improved *Mirt* stove is higher in young-headed households than older-headed ones.

On the supply side of the information, the source of information is either formal or informal sources. Access to electricity means that households can attend television and radio programs; as a result the households may get access to formal sources of information. This variable is highly significant and has positive impact in rural households than in urban areas. The probability of information acquisition is higher in rural households that have access to electricity than those of with out electricity access. Therefore, provision of electric service to rural areas plays a pivotal role to disseminate information through formal means.

Producers of the improved *Mirt* stove have been exercising different commercialization strategies and promotional activities to introduce *Mirt* stove. The activities of producers may indirectly enable the society to access information about the technology. Thus, the study has revealed that the presence of *Mirt* stove producers in the urban households' living area or market has a positive and highly significant impact on information acquisition. Being the urban households near to market the probability of information acquisition will increase by 45.1%. It has also positive impact on rural household's information acquiring despite its insignificant. The insignificance of this variable in rural households may be due to the inaccessibility of market for *Mirt* stove in the vicinity of the people. This study has also identified that the rural households mainly obtain information about *Mirt* stove from development agents.

Finally, Active participation in local associations such as “Idir”, “Iqub” and “Mahiber” bring positive influence and highly significant for information acquiring in both settlements (at 1%). Both in rural and urban households who are actively participating in local associations have higher probability to acquire information than households who are not active in participation. Being active in local associations' participation will increase the probability of information acquiring by 71.4 and 71.8% in rural and urban households, respectively. Indeed, informal channels of information dissemination are more effective for those households who are active in local association participation.

We can conclude, then, among other variables the probability of rural households' information acquiring relating to the improved *Mirt* stove technology are statistically explained by family size, sex of household heads, active participation of households in local associations, and availability of modern source of energy (electricity). Regarding to urban households, the study result has indicated that active participation in local associations, and market or presence of producer of *Mirt* stove technology are the main significant factors to acquire information. Therefore, the study results reveal that improvement in the socio economic status and facilitation of information provision in rural and urban households would bring positive impact on information acquisition.

4.2.2 The adoption results

The "energy ladder" hypothesis relates improvement in socio-economic status of the household with transition to more energy efficient stoves and higher quality and less polluting fuel appliance is often invoked as theoretical model for analyzing household energy demand practice. The finding of this study is consistent with *Barbara D and others (2000)* and *Hosier and Dowd (1987),* and *Reddy* (1995) who have studied in Mexico, Zimbabwe and India, respectively. The energy ladder hypothesis was also discussed in Ethiopia, by *Tadelech* (2001) in Addis Ababa households and *Berhanu* (1998) in Nazareth town. Those studies tested the hypothesis and found that as socio economic status of the household increases, the households move up to the upper energy ladder.

Income is found to be one of the major variable which has a positive and highly significant (at 1%) impact in rural households. A 10% increase in income will increase the probability of adoption decision for improved *Mirt* stove technology by 0.05% in rural households. However, this variable has positive impact but it is not significant in urban households.

Contrary to the expectation of the study, the probability of adoption decision is higher in female-headed urban households than male-headed and it is highly significant. The finding is contrast to the result by *Tadelech* (2001). The plausible reasons in urban households' female are becoming decision makers, where as in rural households the probability of adoption decision is higher in male-headed household than female-headed and it is insignificant. The result indicates in rural households men are still decision makers on resources than female but for urban households female may have an influence on resource decisions for households' activities.

The coefficient of the household head age is negative, and it is significant in rural households. An increase in household head age causes a reduction in the probability of adopting improved stove. At the margin, an additional year of age reduces the probability of adoption decision by 1.8% and it has negative relation with urban households even if it is insignificant. Thus, the result reveals that the probability of adoption decision for improved *Mirt* stove is higher in younger rural households than older ones.

Similarly, marital status is positively related to household's adoption decision for improved ("Mirt") stove in urban household but due to collinearity problem this variable dropped from the rural households regression. The probability of adoption decision is higher in married urban households than unmarried ones and it is significant (at 10%). This may be due to married people are likely to have a responsibility for family members and mostly in urban areas; unmarried households may outsource their food consumption. Accordingly, family size also has a significant and positive influence on adoption decision of urban households. As the member increase by one, the probability of adoption of the technology will increase by 4.3 %.

Household's schooling has a large positive and highly significant effect (at 1%) on adoption decision of the urban households. The marginal contribution of completion of an additional schooling of the households head on the probability of adoption decision is 43.9%. Education also has significant effect in rural households too, with marginal effect, additional schooling on rural household result increase in the probability of adoption decision by 48.6%. Therefore, household's schooling or the educational level is one of the most important variable explaining the adoption decision of improved *Mirt* stove technology.

Another vital result from this study in relation to education is the literacy level of the rural household wives. This variable has a significant and positive influence on the adoption decision. This finding suggests that provision of education to female would result higher benefit for the rural areas and possible to get economic and environmental benefits that could derive from stove adoption.

The main source of fuel for rural households is through collection. If the rural households have a capacity to participate more of its members for fuel-wood and other energy source collection, the probability of adoption decision will decreased. This variable has a negative sign as expected and it is highly significant. In fact, as members of the family participate for fuel collection increased by one member, the probability of adoption decreased by more than ten percent. The result indicates the availability of labour force in rural areas is one factor that affects the adoption decision.

Households are the users of the technology product and it is important to note that their subjective preferences for the characteristics of new technologies affect adoption decision. Some of the desirable characteristics considered in this case: convenience of the stove, compatibility and a relative advantage. The households' perceptions about those characteristics may have impact on adoption decision. The result is expected because adopters and non-adopters of the technology differ based on their perception about the technology. The probability of adoption decision is higher in rural household that have considered the stove has relative advantage and compatible than those who do not have this perception, and it is insignificant (at 5%).

Existence of separate kitchen in households is the indicators of the household dwelling standing and their living standard. At the margins, the variable indicates that the passage from households whose habitat is without a kitchen room to those whose habitat is provided with separate external kitchen involves a rise of 14.1% in urban households' adoption probability and it is highly significant. The result indicates that the presence of separate kitchen enables the urban households' independent utilization of their stoves and increase in socioeconomic status resulted in better kitchen and housing environment.

Since the majority of rural households may get advantage mainly for fuel storage, to decide on free space and others in their living compound, as a result the existence of separate kitchen may provide weak support for adoption decision in rural households. In addition, surprisingly, the probability of adoption decision is lower in households having external kitchen than households who do not have separate kitchen and it is insignificant variable for rural areas.

5. Conclusion and Recommendations

5.1 Conclusion

A number of studies identified many of the population in developing countries are still primarily dependent on biomass energy for domestic use. Fuel efficient and convenient stoves therefore have important implications for a number of interrelated aspects of development including health, protection of natural resource and environment, and household economy. Indeed, various empirical studies reported that “energy ladder” relating improvements in socioeconomic status with transition to more efficient appliance and to higher quality fuels is often invoked as a theoretical model for analyzing household’s energy management practice. Thus, the findings of this study also support the energy ladder hypothesis.

This study result reveals that household sector use significant share of energy consumption. The sector was highly dependent on biomass resources. Especially, in rural areas, the major source of fuel is through collection and it has adverse impact on natural resource and environment such as deforestation and soil erosion due to fuel-wood collection, loss of soil fertility due to animal dung used as a source of energy. Although in urban households due to an ever increasing price of electricity and Liquid Petroleum Gas (LPG), household back to use biomass sources. This indicates the need for efficient biomass stoves through promotion of technically simple and economically feasible that could be adopted by the majority of the people.

The result shows that acquiring of information relating to the improved *Mirt* stove technology are significantly explained by the socioeconomic variables that are family size, sex of household heads, active participation of households in local associations, and availability of modern source of energy (electricity). Regarding to the urban households, the study result has indicated that active participation in local associations, and market or presence of producer of *Mirt* stove technology are the main significant factors to acquire information. Therefore, improvement in the socioeconomic status of households and facilitate the provision of information in urban and rural households would bring positive impact on information acquisition.

The study also shows the most important factors that determine the adoption decision of improved *Mirt* stove in rural and urban households. Educational level of the household head is the common significant variables. In addition to this variable, particularly for urban households’ existence of separate kitchen, sex of the household head, family size and marital status are the main ones. In rural households members of the family participate in fuel collection, age, compatibility and educational level of the household spouse (wives) are found to be significant. Similarly, improving the dwelling status and cooking and baking environment for urban and rural households has positive impact for energy efficiency.

5.2 Recommendations

With those major findings of the study, the following are the implications of the results for policy:

- The household energy demand has significant adverse impact on natural resource and environment. Therefore, energy policy, programs and measures should give due attention and consideration to the households' rationale, especially, in fuel-wood and other biomass resources gathering and combustion.
- Decision makers should enhance the provision and disseminating information about the environmental and economic benefit of energy efficiency derived from improved stove technology. This would be an effective instrument for economic development. In particular, intervention through provision of information in local associations and demonstration programs are more important.
- Finally, adoption of efficient and improved stove technology has an important implication for natural resource conservation and environmental protection. To this end, policy makers and other stakeholders in energy sector should seriously consider the fact that provision of information and enhancement of the adoption decision for improved stove technology is as a means and ways to create viable economic benefit for the country. Particularly, improve the provision of education and income of the rural people and the dwelling status of the urban households.

References

Albert N-HonLonwow (2004), "Modeling of Adoption of Natural Resource Management technologies: The Case of Fallow System", *Environment and Development Economics Journal (9),* Cambridge University Press, pp 289-314.

Asres W/Giorgis (2002), "Overview of Ethiopian Energy Status and Trends in Ethiopia",Paper Presented on Energy Conference 2002, Professional Association Joint Secreteriat , UNICC, Addis Ababa , 21-22 March 2002.

Barbara D. Saatkamp, Omar R. Masera, Daniel M. Kammen (2000), "Energy and Health Transitions in Development: Fuel Use, Stove Technology and Morbidity in Jaracuaro, Mexico", *Energy for Sustainable Development,* Volume IV No 2, Aug 2000. pp 7-31.

Becker L. (1965), "A Theory of Allocation of Time", *Economic Journal*, Vol. No 75, pp 493-517.

Berhanu Dirissa (1998), "Pattern and Determinants of Urban Household Energy Consumption in Nazareth and the Prospect of the Nazareth fuel wood Project", Addis Ababa University, School of Graduate studies, Department of Geography, June 1998.

Black. J, P. Stern and J. Elworth(1985), "Personal and Contextual Influences on household energy Adaptations", *Journal of Environmental Psychology*, Vol. 70(1),pp. 3-21.

Brandon G. and A.Lewis(1999), "Reducing Household energy consumption: A qualitative and quantitative field study", *Journal of Environmental Psychology*, Vol. No 19(1),pp 75-85.

Cecelski, E (1985), "The Rural Energy Crisis, Women's work and Basic Need: Perspectives and Approaches to Action", Technical cooperation report, Rural Employment policy Research Program, ILO, Geneva, 1985.

Coomer J (1977), "Sowing Energy Dilemma". *The Futurist*, Vol. 11. pp 228-230.

Damodar N.Gujarati (2001), "Basic Econometrics", 3rd edition, United States-Military Academy; West Point, Mc Graw Hill Inc, New York.

Dominich T.A and D. McFadden (1975). "Urban Travel Demand: A Behavioral Analysis". Amsterdam, North Holland.

Duncan G. Labay and Thomas C. Kinnear (1981), "Exploring the Consumer Decision Process in the Adoption of Solar Energy System", *The Journal of Consumer Research,* Vol 8, No. 3, Dec 1981, pp 271-278.

Eleni Sardinonu (2005),"Household Energy Conservation Patterns: Evidence From Greece", Graduate Program of Sustainable Development, Harokopio University.

Erick Boy, Nigel Bruse, kirk R. Smith and Ruben Hernandez(2000), "Fuel Efficiency of an Improved Wood Burning Stove in Rural Guatimala: Implication for Health, Environment and Development". Energy for Sustainable Development, Vol IV No. 2 Aug. 2000.

G.S. Madalla (1983), "Limited Dependant and Qualitative Variables in Econometrics", Econometric Society Monographs Cambridge University Press.

GTZ-HENRP (2000), *Project Brief, First Phase*, Jan 1998-Dec2000.

Habb and McConnel,(2002),Valuing Environmental and Natural Resources, The Econometrics of Non-market Valuation, Edward Elgar, Cheltenham, UK

Held M (1983), "Social Impacts of Energy Conservation". *Journal of Economics Psychology,* Vol. No 3(3-4) pp 379-394.

Hosier R. and Dowd J (1988), "Household Energy use in Zimbabwe: An Analysis of Consumption Patterns and Fuel Choice, Energy for Rural Development in Zimbabwe". Energy, Environment and Development in Africa (11), The Beijer Institute and the Scandinavians Institute of African Studies.

Houser R (1995), "Energy use in Rural Kenya Household demand and rural transformation", Beijer Institute and the Scandinavian; Institute of African study.

Howes, M (1985), "Rural Energy Survey in Third world, Manuscript report IDRC-MR 1907e", International Development Research Center, Ottawa, May -1985.

Israel D. (2002) "Fuel Choice in Developing countries: Evidence Economic Development and Culture Change", University of Chicago, Vol No 1, pp 865-890.

Khanna,M (2001) , "Sequential adoption of site-specific technologies and its implication for nitrogen productivity: A double selectivity Model", *American Journal of Agricultural Economics* ,Vol 83 ,No 1, pp 35-51.

Leonard-Barton D (1981) "Voluntary Simplicity Life Style and Energy Conservation", *Journal of Consumer Research*, Vol. No 8 pp 243-252.

Moges Mesfin(2005), "Fuel-wood Consumption and Forest Degradation in Rural Highlands of Ethiopia: The Case of Amhara Region", School of Graduate Study, Addis Ababa University, Oct 31, 2005.

Munasinghe M. (1980), "An Integrated Framework for Energy Pricing in Developing Countries", *Energy Journal*, London, Oelgeschlager, Gunn and Haine, Vol 1, No 3.

Munasighe M. and Peter Meier (1993), "Energy Policy Analysis and Modeling", Cambridge University press.

Reddy, B.S (1995), "A multi-logit Model of Fuel Shifts in the Domestic Sector Energy", Vol 20 (9), pp 929-936.

Saha H, A. Love and R. Schwart (1994). "Adoption of Emerging Technologies under Output Uncertainty". *American Journal of Agricultural Economics*, Vol No 76, November pp 836-846

Schipper L et.al (1991)," More efficient household electricity use", Energy Policy, Vol 19(3), pp. 244-265.

Scott S. (1997), "Household energy efficiency in Ireland: A Replication Study of Owner of Energy Saving Items", Energy Economics, Vol No 19 (2) pp 187-108.

Tadelech Debele (2001), "Factors Affecting the Use of Fuel-Saving Technologies in Urban Areas. The case of Addis Ababa", Addis Ababa University, School of Graduate Studies, Regional and Local Development Studies, June 2001.

Takeshi Amemiye (1981), "Qualitative Response model A Survey", Stanford University.

Trudy Koemund, Hiwot Teshome and Samson Tollossa, "What Alternative do we have to Bridge the Gap Between Fuel-wood Demand and Supply in Ethiopia", GTZ- HEPNR, Addis A Forum for Environment Rio + 10 Preparation Process.

Van Raaij and T. Verhallen (1983) "A Behavioral Model of Residential Energy Use", *Journal of Economic Psychology*, Vol. No 3, pp 39-63

Vijay Laxmi, Jyoti Parikh, Shyam Karmakar and Pramod Dabrase (2003), "Household Energy, Women's Hard ship and Health Impact in Rural Rajasthan, India; Need for

Sustainable Energy Solution”. Energy for Sustainable Development Vol V11 No. 1. March 2003.

Weber C and A Perrels (2000), “Modeling Lifestyle Effects on Energy Demand and Related Emissions”, Energy Policy, Vol. 28 (8), pp 549-566.

William W. Greene (2003), Econometric Analysis, New York University, Upper ladder River, New Jersey, 07458, Fifth Edition.

World Bank (2000), **“**Fuel for Thought”**,** An Environmental Strategy for the Energy Sector**.**

Appendix I

Table A-1-A Probit estimation of sample selection for rural households

Number of obs	**= 120**	**LR chi2(11)**	**= 88.17**
Censored obs	**= 62**	**Pseudo R2**	**= 0.5304**
Uncensored obs	**= 58**	**Wald chi2(11)**	**= 33.38**
Log pseudolikelihood	**= -53.3968**	**Prob > chi2**	**= 0.0005**

Adoption	**Coefficient**	**Marginal Effect**	**Standard Error**	**P>|z|**	**Mean**
Members participate for collection**	-0.6808	-0.1689	0.2536	0.007	1.93333
Family size	0.1073	0.0266	0.0872	0.219	7.03333
D[5] Dwelling status	0.5499	0.1161	0.8081	0.496	.783333
D separate kitchen	-0.7334	-0.1909	0.6057	0.226	0.575
D compatibility**	1.3820	0.3788	0.6815	0.043	0.4
D spouse education***	1.3884	0.3991	0.8413	0.099	0.35
Age**	-0.0734	-0.0182	0.0230	0.001	47.325
D head of the household	1.1136	0.1928	0.9436	0.238	0.80833
D access to credit	0.7870	0.1913	0.5150	0.126	0.525
D education**	1.7467	0.4864	0.8403	0.038	0.60833
L income*	2.2085	0.5479	0.6098	0.000	6.2065
_constant*	-12.3860	-	3.1867	0.000	-
D active participation	(offset)				
Information					
D marital status	0.2955	0.0342	0.7271	0.684	0.89166
Family size**	0.1920	0.0796	0.0753	0.011	7.03333
D spouse education	0.5304	0.2077	0.3647	0.146	0.35
Age	-0.0092	-0.0039	0.0135	0.494	47.325
D head of the household**	-1.0584	-0.3803	0.4276	0.013	0.80833
D active participation*	2.1819	0.7144	0.4050	0.000	0.441667
D access to credit	0.4047	0.1730	0.3509	0.249	0.525
D electricity access **	1.2242	0.4469	0.4451	0.006	0.60833
D market	0.0815	0.0730	0.5496	0.882	0.21666
D education	0.2426	0.0948	0.4593	0.597	0.597
L income	0.4331	0.1626	0.3012	0.150	6.2065
_constant **	-4.9715	-	2.1584	0.021	-
athrho |	0.6198		1.2219	0.612	0.612
rho |	0.5510	0.8509			

*** Significant at 10%   ** Significant at 5%   *Significant at 1%

[5] D indicates for variables that are Dummy.

Table A-1-B Probit estimation of sample selection for urban households

Probit model with sample selection **Number of obs = 90**
LR chi (12) = 84.27 **Pseudo R2 = 0.7183**
Censored obs = 33
Uncensored obs = 57
Wald chi2(12) = 28.04
Log pseudolikelihood = -33.63697 **Prob > chi2 = 0.0055**

Adoption	**Coefficient.**	**Marginal effect**	**Standard. Error.**	**P>|z|**	**Mean**
Age	-0.0593	-0.00759	0.0379	0.118	50.4333
D marital status ***	2.2639	0.29652	1.2361	0.067	.566667
Family size **	0.3366	0.04308	0.1729	0.052	5.31111
D dwelling status	0.2791	0.03603	0.8090	0.730	.488889
D separate kitchen **	1.1748	0.14142	0.8018	0.043	.577778
D compatibility	0.6088	0.07864	1.1171	0.586	.511111
D spouse education	0.5289	0.06928	0.8129	0.515	.488889
D head of the household **	-4.3273	-0.92108	1.4616	0.003	.677778
Fuel expense	0.0131	0.00168	0.0166	0.429	41.0444
D access to credit	1.1795	0.20348	0.7585	0.120	.344444
D education**	3.4843	0.43912	1.2413	0.005	.611111
L income	0.2721	0.03482	0.6331	0.667	5.88359
_constant***	-5.2242	-0.00759	3.1936	0.102	
D active participation	(offset)				
Information					
D marital status	-.4286643	0.07418	.8178782	0.600	0.5666
Family size	.1765413	0.03083	.136889	0.197	5.3111
D spouse education	1.048235	0.18711	.9874462	0.288	0.4888
Age	-.0221105	-0.00386	.0235583	0.348	50.433
D head of the household	-.9716964	-0.14128	1.147533	0.397	0.6777
D active participation *	3.65241	0.71873	.7598789	0.000	0.5111
D access to credit	-.8260403	-0.16356	1.114081	0.458	0.3444
D market ***	2.617077	0.45128	1.41075	0.064	0.4444
D electricity access	.8047146	0.18816	1.190112	0.499	0.7666
D education	.0949537	0.01405	.8640634	0.912	0.6111
L income	.8235751	0.14724	1.122381	0.463	5.8835
_constant|	-6.424711	-	6.698139	0.337	-
/athrho	.0848789	-	3.270068	0.979	-
rho |	.0846757	-	3.246622	-	

****** Significant at 10%*** ***** Significant at 5%*** ****Significant at 1%***

Table A-2-A. Descriptive summary for rural households

Variable	Mean	Standard deviation	Minimum	Maximum
Income	656.12	603.2842	95	5000
Marital status	0.89166	0.3121	0	1
Family size	7.03333	2.8252	0	1
Separate kitchen	0.5750	0.4137	0	1
Compatibility	0.40	0.4964	0	1
Spouse education	0.35	0.4789	0	1
Age	47.32	13.570	20	80
Sex of household head	0.8083	0.3952	0	1
Fuel expense	17.69	15.22	0	110
Active participation	0.525	0.5014	0	1
Credit	902.075	1102.36	0	4000
Access to credit	0.525	0.5014	0	1
Electricity	0.3666	0.4137	0	1
Market	0.2166	0.4137	0	1
Members for collection	1.93	1.11	0	6
Education	0.6083	0.4901	0	1
Log income	6.2064	0.7390	4.5538	8.5171
Dwelling status	0.78333	0.413709	0	1
Number of Observation 120				

Table A-2-B Descriptive summary for urban households

Variable	Mean	Standard deviation	Minimum	Maximum
Income	506.72	586.89	85	3500
Marital status	0.5666	0.4983	0	1
Family size	5.31	2.56	1	12
Separate kitchen	0.5777	0.4966	0	1
Compatibility	0.5111	0.50267	0	1
Spouse education	0.48888	0.502677	0	1
Age	50.43	13.25	20	83
Sex of household head	0.6777	0.4699	0	1
Fuel expense	41.04	27.80	0	130
Active participation	0.5111	0.50267	0	1
Credit	489.76	1014.99	0	7000
Access to credit	0.3444	0.4778	0	1
Electricity	0.7666	0.4253	0	1
Market	0.4444	0.49968	0	1
Education	0.6111	0.4902	0	1
Log income	5.883	0.7701	4.4426	8.1603
Dwelling status	0.4888	0.5026	0	1
Number of Observations 90				

TABLE A-2-C Factors Affecting household to acquire information and adoption decision for improved ("Mirt") stove

	RURAL HOUSEHOLDS		URBAN HOUSEHOLDS	
1. Head of the household	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Male	106	88%	59	65%
Female	14	12%	31	35%
2.Dwelling status of the household				
Owners	84	70%	45	50%
Non-owners	36	30%	45	50%
3.Presence of separate kitchen in the house				
YES	72	60%	53	58%
NO	48	40%	37	42%
4. Source of fuel-wood and other energy sources				
Purchase	12	10%	40	44%
Collection and purchase	14	12%	28	31%
Collection	96	78%	22	25%
5. Presence of modern source of energy (electricity)				
YES	52	57%	69	77%
NO	68	43%	21	23%
6. Active participant in local associations and activities				
YES	50	42%	46	51%
NO	70	58%	44	49%
7. Spouse educated or not				
YES	45	38%	50	56%
NO	75	62%	40	44%
8. The stove is compatible				
YES	41	34%	48	54%
NO	79	66%	42	46%
9. Having access to credit				
YES	70	58%	47	52%
NO	50	42%	43	48%
10. Marital status				
Yes	93	78%	58	64%
NO	27	22%	32	36%

TABLE A-2-D Description of variables

Age	Number of years the household heads live
Dummy foe sex of the household head	1 If the head is male , 0 otherwise
Income	Log of monthly income of the household head
Dummy for Availability of modern energy source (electricity) for household lightning	1 if the household have access to modern electric source (electricity), 0 otherwise.
Dummy for access to credit	1 if the household get credit during the current six month period, 0 otherwise.
Family size	The number of individuals who are the members in the family
Dummy for households participation in local associations	1 if the household actively participate in local associations, 0 otherwise.
Dummy for location of household access to the market for improved ("Mirt") stove	1 if the households near to producers of improved stove or market, 0 otherwise
Dummy for dwelling status of the Household	1 if the household is owner of the house, 0 otherwise
Dummy for existence of external and separate kitchen	1 if the household have separate external kitchen, 0 otherwise
Dummy for household response on technology which has a relative advantage, compatible and lower complexity	1 if the household believe that the stove has an advantage and compatible, 0 otherwise.
Members of the family who participate in fuel collection	Members of a family participate to collect fuel for the household fuel need or requirement.
Dummy for spouse education	1 if the household spouse(wife) is literate, 0 otherwise
Fuel expense	Monthly expense for fuel need
Dummy for the household head education	1 if the household head is literate, 0 otherwise

DETERMINANTS OF CROP MIXES GROWN ON HOUSEHOLD FARMS IN NORTHERN ETHIOPIA[1]

N. Haile[2,3], A. Oskam[3], T. Woldehanna[3], and J. Peerlings[3]

Abstract

Rural households in semi-arid areas often experience rainfall-related shocks that result in low and uncertain income. Household's survival depends on the ability to anticipate and to cope with this uncertain income. Through time, households have developed ex-ante risk management and ex-post risk coping strategies. These include crop portfolio adjustments and off-farm activity diversification. This paper investigates the role of rainfall variability and farmer risk aversion behavior on household's crop portfolio choice. To answer the research questions Heckman's selection model is used. The method was applied to a four-year panel data of two districts in Northern Ethiopia, Tigray.

The study showed that farmer's ex-ante strategic response to rainfall variability is through diversification of crops to be grown. Choosing the crops most suited to specific rainfall conditions was proven a strategy of farmers to cope with unpredictable rainfall. In times of low rainfall, the dominant crops to be chosen are teff and grass pea. Ex-ante crop choice and reliable water availability for farming can be viewed as complements.

Keywords: rainfall variability, ex-ante risk management, ex-post risk coping strategies, crop choice, Northern Ethiopia, Tigray.

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[2] Tigray Food Security Coordination Office, KfW-SUN Program, Mekelle
Corresponding author e-mail address, nhaileabreha@yahoo.com, P.O.Box 1055, Tigray Food Security Coordination Office, KfW-SUN Program, Tel: 0911 760574

[3] Wageningen Univeristy and Research, Agricultural Economics and Rural Policy Group, Hollandsweg 1, 6706 KN Wageningen, The Netherlands

1. Introduction

It is well known that households in semi-arid areas often experience rainfall-related shocks that result in low and uncertain incomes (Dercon and Hoddinott, 2003). A large body of literature explores the ex-ante and ex-post responses to these shocks. One line of literature examines how households respond to these shocks ex-post. Udry (1995) assesses the extent to which saving allows households to smooth consumption, Fafchamps, *et al*. (1998) and Dercon (1998) focuses on the role of livestock holdings as a means of smoothing consumption, and Kochar (1999) on the role of off-farm labor supply as a response to income shocks. A second line of research looks at the effectiveness of ex-ante income smoothing strategies in reducing fluctuations in income. Dercon (1996), Larson and Plessmann (2002), and Morduch (2002) find evidence that farmers choose to diversify into less profitable crops or choose less productive technology.

In the absence of credit and insurance markets for insuring risk ex-post against adverse shocks, many farm families depend directly on diversity of their crops for the food and fodder they use (Benin *et al*., 2004). For example, diversification of crops grown in Tigray is often considered as a precaution against rainfall variability. Moreover, risk attitudes of farmers have also shown to influence crop choice and input allocations (Ramaswami, 1992; Isik, 2002).

In recent years using Pakistan, Punjab data Kurosaki and Fafchamps (2002) examined farmers' crop choices in the presence of price and yield risk. They conclude that even in well-developed markets, crop choices are dependent on risk. Woldehanna (2000) addresses the relationship between off-farm income and crop choice in northern Ethiopia. He pointed out that off-farm income and agronomic conditions heavily influence crop choices. Rainfall is highly variable in northern Ethiopia and it is of importance to analyze the effect of rainfall variability and farmers' risk attitudes on crop choice. Here rainfall variability is considered as an ex-ante perception of risk. Prior to the realization of rainfall household's know the distribution of rainfall overtime. A key question is how crop choice is influenced by risk perception and risk attitude of farmers. Understanding farmers' crop choices and land allocation decisions in drought prone areas are important in identifying the factors that determine farmers' crop choices decisions. Therefore, this paper examines the impact of risk on the probability of growing crops and on the allocation of land to crops. Specifically the following questions will be addressed: (1) Does rainfall variability, which represents farmers' risk perceptions, has a significant effect on the crops grown and land allocation decisions to each crop? (2) Do farmers' risk attitudes affect farmers' crop choices and land allocation decisions? (3) Do socio-economic variables of households determine crop choice?

To answer the research questions Heckman's selection model is used. Rainfall variability and risk attitude of farmers are incorporated in the model. The method is applied to a four-year panel data of two districts in Northern Ethiopia Tigray.

The rest of the paper is organized as follows: section 2 presents the theoretical model. Section 3 presents the empirical model and estimation methods. Section 4 describes the data used. Estimation results are presents in section 5. Section 6 concludes the paper.

2. Theoretical Model

A household model was developed to investigate the relationship between crop choice and rainfall variability and socio-economic characteristics. The model draws upon the economic theory of farm households (Singh *et al*., 1986). The model explicitly accounts for the fact that farm households in Tigray are both producers and consumers of their own agricultural products. As a result, production decisions are influenced by consumption needs, so that production and consumption decisions in the model are assumed to be made jointly in response to rainfall uncertainty.

It is assumed that agricultural households maximize the expected utility of profit $(EU(\pi))$, where π is profit and E is the expectation operator. Assume that farmer's utility function is a von-Neumann Morgenstern utility function, which is concave, continuous and differentiable function of profits, thus $U'(\pi) > 0$ and $U''(\pi) < 0$. Outputs are assumed to be stochastic. This assumption seems plausible, as rainfall risk is the major source of uncertainty in crop production in northern Ethiopia. Further, let Y_i (the output produced on the farm of crop $i, (i = 1,..., N)$ be a random variable with subjective probability density function $f(Y_i)$ reflecting farmer's output expectations. A farm household allocates his total size of land (A) to i crops mainly: wheat (A_W), teff (A_T), barley (A_B), grass pea (A_V), and lentil (A_L).

Farmer's utility maximization problem can be represented as follows:

$$MaxEU(\pi) = EU\left(\sum_{i=1}^{N} P_i Y_i (H_i^F, X_i, K_i, A_i; G_i, Z, \theta, \gamma) - \sum_{k=1}^{K} W_k X_k\right)$$
$$s.t \qquad A_i \geq 0, \sum_{i=1}^{N} A_i = A \qquad \textbf{(1)}$$

where P_i is the output price of crop i; H^F, on-farm labor supply[4]; X is a vector of variable inputs (seed, fertilizer, and pesticide); K is capita (value of livestock and value of farm equipment) l; A is amount of land cultivated; G is household characteristics, Z is district level characteristics (such as off-farm labor market opportunities). Moreover, output Y_i is assumed to be a function of rainfall variability (θ), and farmers risk attitude (γ). W_k is the variable input price of k, $(k = 1,...,K)$. $\sum_{i=1}^{N} P_i Y_i$ represents the expected total revenue from N crops produced on the farm and $\sum_{k=1}^{K} W_k X_k$ represents the total variable cost of production and A_i is the share of land allocated to crop i.

The optimal risk responsive land allocation decision is derived by differentiating the expected utility of profit with respect to the quantity of fixed input (i.e., land):

$$\frac{\partial EU(\pi_i)}{\partial A_i} = P_i \frac{\partial Y_i}{\partial A_i} - \lambda = 0 \qquad \textbf{(2)}$$

Where λ is the shadow price of land.

Condition (2) states that the optimal share of land allocated to crop i is equal to the shadow price of land. We assume the shadow price of land is determined by household risk perception (rainfall variability), household risk attitude, household characteristics, and market characteristics.

Using the first order condition one can derive the optimal land allocation demand function for crop i. Crop i's land demand function can be expressed as:

[4] On-farm labor supply is proxied by the number of adults (aged 15-65) in the household.

$$\begin{cases} A_i = f(P_i,...P_N, W_k, H^F, A, K, G, Z, \theta, \gamma) & if \quad \lambda > 0 \\ A_i = 0 \quad if \quad \lambda \leq 0 \end{cases} \tag{3}$$

The reduced form optimal share of land allocated to crop i is a function of all variable input prices, expected output prices, on-farm labor supply, total cultivated land size, capital, and farmers risk perception (rainfall variability) and farmer's risk attitude. The share of land allocated to each crop is also a function of household and village level characteristics.

The optimal demand function for the land allocated to crop i can be expressed as follows:

$$A_i = A_i(P_1,..., P_N, W_k, H^F, K, G, Z, \theta, \gamma); \quad i = 1,..., N; k = 1,..., K \tag{4}$$

The allocation is done subject to the constraint that the total land area is fixed in the short run. Equation (4) is the risk responsive input demand function and is the theoretical framework for specification of the share of land allocated to each crop under rainfall risk.

Economic theory states that a risk neutral farmer will allocate its land such that expected marginal returns are equalized across crops. When expected return of the land allocated to one crop is greater more land is allocated to that crop and less will be allocated to the rest of the crops. However, if farmers are risk-averse and the expected utility of choosing one crop to be grown is greater then more land is allocated to this crop. Here it might be the case that farmers may be willing to accept lower returns by choosing less risky crops.

3. Empirical Model and Estimation

In this section the empirical model of crop choice and the land share model are presented. Here it is tested whether sample selection bias exists. It is hypothesized that if the expected marginal utility of one crop is greater than of another crop more land is allocated to this crop. As both the farmer's crop choice and land allocation decision are influenced by the expected utility of the farmer, there is a possibility that the error terms of the crop choice model and the land share model are correlated. Therefore the land share model should account for the factors that determine the farmer's crop choice and sample selection bias should be tested for.

3.1 Crop Choice Model

The crop choice model is binary and models the probability of choosing a crop to be planted. Equation (3) is used to derive the crop choice model.

$$P(I = 1/y) = F(y'\delta + v > 0) \quad \textbf{(5)}$$

$$\begin{aligned} I &= 1 \quad if\ I^* > 0 \\ &= 0 \quad \text{otherwise} \end{aligned}$$

Where I^* is an unobserved latent variable. What is observed is a dichotomous variable I, which takes the value of 1 if crop i is chosen to be planted on the specified plot and zero otherwise. y is a vector of independent variables that are hypothesized to influence choice of crops to be planted, δ is a vector of parameters F is the distribution function, v is a normally distributed error with zero mean and variance σ_v^2.

In this section the probability of choosing a crop to be planted is estimated by a probit model. From the estimated model the Inverse Mills Ratio (IMR) was derived that was included in the land allocation model to test whether there is a selection bias or not (Maddala, 1983: 158; Green, 2003: 757-761).

The explanatory variables included in the crop choice model are prices of outputs, prices of variable inputs (seed, fertilizer, and insecticides), capital (value of livestock and value of agricultural equipments), family labor input, household characteristics (head age, dummy for head education), off-farm income, rainfall variables (Gurgand index,), index of farmers risk preference, and district characteristics (proxy for distance to the capital city). A district dummy variable equal to 1 if the district is Enderta, zero otherwise.

3.2 Land Allocation Model

The dependent variable in the land share allocation model is the share of land allocated to each crop. Then the observed allocation can be denoted as:

$$A_i^* = x'\beta + u \quad \textbf{(6)}$$

Where A_i^* is a latent variable that is observed for values greater than 0 $I = 1(I^* > 0)$) and is censored for values less than or equal to 0. x is a vector of exogenous variables that are hypothesized to influence the land allocation decision, β is a vector of unknown parameters and u is a normally distributed error with zero mean and variance σ_u^2.

It is assumed that u and v follow a bivariate normal distribution with correlation ρ. The model that applies to the observation of equation (6) is:

$$
\begin{aligned}
E\left[A_i \middle| A_i^* > 0\right] = E\left[A_i \middle| I^* > 0\right] & \\
= E\left[A_i \middle| v > -y'\delta\right] & \\
= x'\beta + E\left[u \middle| v > -y'\delta\right] & \\
= x'\beta + \rho\sigma_u \lambda(\alpha_v) &
\end{aligned}
\qquad \textbf{(7)}
$$

Where $\alpha_v = -y'\delta / \sigma_v$ and

$$
\lambda(\alpha_v) = \frac{\phi(y'\delta / \sigma_v)}{\Phi(y'\delta / \sigma_v)} \qquad \textbf{(8)}
$$

Equation (8) is the IMR (for details see Green 2003: 782-783). The term ϕ and Φ are the normal and the cumulative distribution function respectively, σ_u and σ_v are the standard deviation of u and v respectively. Rewriting the land allocation model (equation 6) yields:

$$
\begin{aligned}
A_i \middle| A_i^* > 0 = E\left[A_i \middle| I^* > 0\right] + \varepsilon & \\
= x'\beta + \rho\sigma_u \lambda(\alpha_v) + \varepsilon &
\end{aligned}
\qquad \textbf{(9)}
$$

Where ε is a normally distributed error term $(\varepsilon \approx N(0, \sigma_\varepsilon^2))$.

If u and v are uncorrelated, then equation (9) can be estimated using ordinary least squares. However, if u and v are significantly correlated, then there is a problem of sample selection bias and the estimates of the land allocation model (equation 9) must be corrected. Hence, the least squares method of regressing $A|A^* > 0$ on x is an inconsistent estimator of β if the second term on the right-hand side of equation (9) is non-zero. Under the joint normality assumption of (u, v) a selection model is used to estimate the land allocation model to each crop (equation 9) (Heckman, 1979; Amemiya, 1985; and Wooldridge, 2002).[5] Heckman's (1979) idea is to first estimate equation (5) by probit maximum likelihood and then obtain an estimate of δ and $\lambda(\alpha_v)$. In the second step, the IMR ($\lambda(\alpha_v)$) is included as a separate explanatory variable in the land allocation model (equation 9).

The choice of explanatory variables to be included in each of the two models is problematic. It is possible that $y = x$, that is the same set of explanatory variables can be included in the land allocation model (equation 9) and crop choice model (equation 5). In this case the identification of β comes from the nonlinearity of the IMR. Because the IMR is a nonlinear function of the variables included in the first-stage probit model, then the second equation (equation 9) is identified even if $y = x$ (Wooldridge, 2002: 564). In this study we used a district dummy as an identification restriction. It is hypothesized that access to markets (proxy by a district dummy) may affect the decision of crops to be grown but not the proportion of land allocated to the crop.

4. Some Notes on the Data

A Tigray farm household survey is used to estimate the model developed above. The dataset was collected in 1996, 1997, 2001, and 2002 covering four years. Among others the data consists of information on household use of farm inputs (such as variable and quasi fixed inputs), household characteristics, rainfall and index of farmers risk attitude.

In the crop choice model (equation 5) the dependent variable is the probability of choosing crops to be grown. It is a binary indicator of whether the crop is chosen to be grown (for details on the proportion of farmers choice on each crop type, see

[5] The selection model consists of two equations, one outcome equation, the demand of land by each crop type, and the second the selection equation , describing the relation between a binary choice model (the probability of growing a particular type of crop). This model is known as the Heckman selection model (Heckman, 1979), or the type II Tobit model (Amemiya, 1985), or the probit selection model (Wooldridge, 2002).

Appendix 5.II). The dependent variable for the land allocation model (equation 8) is the proportion of land allocated to the specific crops. It measures the proportion of land allocated to each crop.

The independent variables included in the two models are variable expected output prices, input prices (seed, fertilizer, and insecticides), family size, total cultivated land size, capital (value of livestock and value of farm equipments), farmers risk perception (rainfall variability), farmer's risk attitude, and household (head age, head education, and off-farm income) and village district characteristics. The variable input prices are computed by dividing the value of the inputs by the amounts used for each crop. Family size is the number of adult (aged 15-65) members in the household. Total cultivated land is measured by the sum of rented and owned cultivated land. Value of livestock includes value of cattle, horses, mules, camels, and donkeys. Value of farm equipment includes value of traditional oxen plough equipment, sickles, hoe etc.). Household characteristics (includes age and education of the household head, off-farm income). Age is measured as completed years. For education an education dummy is used indicating whether the household head is literate or not. Off-farm income is measured as the sum of incomes from wage and self-employment income. The major aim of this paper is to estimate crop choice under risk. Crop choice and land allocation model then includes rainfall variability, which is measured by the Gurgand index (2003) (for details on the computation of this index see Appendix 5.IV), and farmers risk attitude index. Farmers risk attitude index—a subjective measure of risk—was measured by asking hypothetical questions which resemble farming conditions.[6] The mean and standard deviations of the variables used in the analysis are reported in Appendix 5.I.

5. Discussion of Results

5.1 Crop-Choice Model

Estimation results for the probability of choosing a crop to be planted are presented in Table 1 showing the marginal effect (the effect of a unit change in each independent variable on the probability of growing that particular crop, holding the other factors constant).[7]

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[6] The conventional methodology for measuring farmers risk attitude is to choose a specific preference function, and then estimate the value of the unknown parameters of the degree of risk aversion. This requires parameterization of a utility function. In this study an experimental approach, which does not require the specification of a utility function, is used.

[7] The marginal effect for district change of dummy variable (such as for farmers risk attitude dummy variable and the district dummy) is from 0 to 1.

As expected rainfall variability has a significant negative effect on the probability of growing wheat and lentil. The marginal effect indicates that if the rainfall variability increases by one millimeter (mm), probability of growing wheat and lentil crop decreases by 0.001 and 0.01 respectively. It is known that wheat and lentil crops are very sensitive to rainfall variability. For teff and grass pea the effect of rainfall variability is positive and significant. If the rainfall condition is not promising then, teff and grass pea are planted in August.[8] The marginal effect indicates that the probability of growing teff and grass pea crop increases by 0.02 and 0.01 respectively if rainfall variability increases by one mm. The probability of growing barley is negatively associated to rainfall variability but not significantly. This is a surprising result given that barley is known to be a drought resistant crop.

Farmers risk aversion plays a role in the probability of choosing crops to be grown. Farmers risk aversion is negatively related to the probability of growing wheat and lentil. Being a risk-averse farmer reduces the probability of growing wheat and lentil by 0.01. This is not surprising as wheat is very sensitive to drought and plant pests and diseases.[9] Being a risk-averse farmer increases the probability of choosing teff, barley, and grass pea by 0.35 and 0.19, and 0.02 respectively. These could be interpreted that teff and barley are the preferred crop for subsistence in the study area and grass pea is a drought resistance and early maturing crop. Choosing for teff, barley, and grass pea to be grown reduces consumption variability.

The effect of value of livestock on the probability of growing crops is positive for all crops. Cultivated land size positively and significantly influences crop choice for the five crops. This indicates that farmers who have access to large farmland tend to diversify crops. The effect of family size on the probability of choosing crops to be grown is as hypothesized, positive for the probability of growing wheat and teff, but only significant for the probability of growing wheat. Teff and wheat are the most labor demanding crops. Off-farm income negatively and significantly influences the probability of growing wheat and teff. For crop production, farm households rely almost entirely on their own manpower. Hence, off-farm employment reduces the availability of labor for wheat and teff production. The effect of off-farm income is positive for the probability of growing barley, lentil, and grass pea, but only significantly for barley. Here off-farm income and probability of growing barley, lentil, and grass pea are complements. The household head age coefficient is negative and significant for the probability of growing teff, lentil and grass pea and positive for the probability of growing wheat and barley.

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[8] It is evident that barley, *Sa'sa* variety and teff variety which only require 45 days to mature are likely to yield more stable returns than wheat crop under extreme rainfall variability.
[9] This is confirmed by informal interviews with the farmers.

Table 1: Marginal effects of the probability of growing a crop (z-value in parenthesis)[10] [11]

Variable	Wheat	Teff	Barley	Lentil	Grass pea
Price of seed	-0.00***	-0.00***	0.02***	0.01	-0.00
	(-4.85)	(-3.99)	(4.75)	(1.94)	(-1.20)
Price of insecticide	-0.01	-0.03**	-0.01		
	(-1.15)	(-3.26)	(-0.47)		
Price of fertilizer	-0.00	0.01***	0.00*		
	(-0.69)	(3.30)	(2.16)		
Family size	0.14*	0.07	-0.06*	0.113	-0.01
	(2.65)	(1.96)	(-2.28)	(1.93)	(-0.02)
Head age	0.00	-0.01*	0.01	-0.02*	-0.01**
	(0.91)	(-2.32)	(1.22)	(-2.46)	(-2.77)
Total land cultivated	0.8**	0.23***	0.07*	0.06*	0.13***
	(2.92)	(8.41)	(2.35)	(2.55)	(5.98)
Value of livestock	0.11	0.07	0.08	0.00	0.07
	(1.51)	(0.99)	(1.72)	(0.01)	(1.19)
0ff-farm income	-0.00**	-0.00*	0.00**	0.00	0.00
	(-2.74)	(-2.25)	(2.74)	(0.64)	(1.55)
Farmers risk aversion	-0.01	0.35**	0.19*	-0.01	0.02**
	(-2.49)	(3.20)	(2.10)	(-0.05)	(3.13)
Rainfall variability	-0.00*	0.02**	-0.01	-0.01***	0.01*
	(-2.49)	(2.88)	(-1.57)	(-4.79.)	(2.13)
District dummy	0.02	0.10	-0.36	0.87***	-0.28
	(0.54)	(0.97)	(-1.71)	(3.99)	(-1.60)
Number of observations	796	796	796	796	796
LR chi2	281.46	282.86	223.14	130.46	163.39
Log likelihood	-328.19	-378.37	-298.41	-217.72	403.87
Pseudo R^2	0.30	0.26	0.27	0.23	0.17

*Significant at 0.05 significance level; ** significant at 0.01 significance level; *** significance at 0.001 significance level.

The probability of growing wheat and teff crop reduces if the price of seed input increases. If farmers do not have the required amount of wheat and teff seed at their disposal for planting, then purchasing of these seed inputs at planting period would

[10] Since the left hand side variable is binary the crop specific output price variable is perfectly collinear and is therefore excluded from estimation.

[11] The variable value of farm equipment was initially included in the model. Initial estimate was not significantly different from zero for the five crops, suggesting that almost all farmers own the same quantity of oxen plough equipments, sickle and hoe, which causes insufficient variability in the data and was omitted from estimation.

be very expensive. However, the price of seed positively influences the probability of growing barley and lentil. In the study area, it is a common practice that farmers keep barley for planting in the following year's, as barley is the most staple food grain.

5.2 Land Allocation Model

To test for sample selection bias in the land allocation model, equation (8) is estimated using the Heckman selection model. The model is fitted with maximum likelihood estimation, with null hypothesis of no selection bias $H_0 : \lambda = 0)$. Table 2 indicates that the null hypothesis of no selection bias is rejected at the 1% significance level for the proportion of land allocated to wheat, teff, barley, and grass pea.[12] With the exception of the inverse Mills ratio the same set of variables was used as in the selection model. Here, district dummy was taken as a selection restriction. The land share allocation estimation is presented in Table 2.

As expected, the Gurgand index, which measures rainfall variability, negatively influences the allocation of land to wheat and lentil. The amount of land allocated to wheat and lentil production are more responsive to a unit change in the rainfall variability index. The marginal effect suggests that a 1 unit increase in the Gurgand index reduces the amount of land allocated to wheat and lentil by 0.18, and 0.01 respectively. This is due to the fact that wheat and lentil are very sensitive to the variability of rain. If rainfall conditions are poor then the amount of land allocated to wheat and lentil will decline, these crops only grow well when rainfall is relatively high and reliable.[13] An increase in the Gurgand index leads to a reduction of the proportion of land allocated to barley, but not significantly. This result may be explained by the variety of barley grown in the survey period.[14]

The effect of the Gurgand index is as expected, positively and significantly related to the amount of land allocated to teff and grass pea. The result shows that a 1 unit

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[12] For these crops (wheat, teff, barley, and grass pea) the IMR appeared to be significant, indicating sample selection bias is a problem.

[13] Wheat and lentil are long-day plants, after planting they are ready to be harvested after 80-120 days. Hence they are more sensitive to rainfall variability.

[14] It is true that barley is known to be a drought resistant crop. However, it depends on the choice of barley variety grown. For example '*atena*' is a long period growing variety that needs sufficient rain and is susceptible to rainfall variability. The '*Sasa*' variety is a short period growing variety of barley and known to be drought resistant. If farmers expect that rainfall is higher and more reliable they go for '*atena*' if they expect that rainfall is light and more variable they opt to plant 'sasa' (source: own interviews with the farmers). Since the data do not account for varieties within crops, it is not possible to make inferences within crop varieties.

increase in the variability of rainfall (Gurgand index) increases the proportion of land allocated to teff and grass pea by 0.01 and 0.02 respectively. When the June and July rains fail, or the gap between rainy seasons is too long for the crops to survive, short-growing season teff and grass pea are planted in August. This implies that the proportion of land allocated to crops is adjusted according to the rainfall conditions. That is plots can be replanted with teff and grass pea if the rainfall amount is not reliable. The fastest-growing varieties of teff, which farmers have at their disposal are planted can mature in 45 days using limited soil moisture.[15] Moreover, grass pea is a well-known legume crop that can survive under extreme rainfall variability. Whenever rainfall is insufficient or highly variable farmers show flexibility in their land allocation decisions. This kind of flexibility plays a critical role in reducing the cost of rainfall variability to farmers. For this reason, when farmers expect high variability in rainfall and experienced an insufficient rainfall amount later in the cropping season (August) they allocate more land to grass pea and teff.

Table 2 shows that farmers' risk aversion behavior negatively influences land allocated to wheat, teff and lentil. Being a risk-averse farmer reduces the proportion of land allocated to wheat by 0.01. Wheat is more susceptible to drought and is not able to survive under conditions of pest and disease infestation. As hypothesized farmers' risk aversion positively and significantly affects the proportion of land allocated to barley and grass pea. When farmers are risk-averse, they select crops to be grown that give them the lowest probability of falling below some subsistence threshold regardless of the expected yield generated by alternative crops. Risk aversion behavior of farmers leads to an increase of land allocated to barley and grass pea. The marginal effect suggests that, being a risk-averse farmer increases the proportion of land allocated to barley and grass pea by 0.03 and 0.01 respectively.

Off-farm income significantly and negatively influences the land allocated to wheat and teff. Off-farm income and the proportion of land allocated to wheat and teff are substitutes, an increase in off-farm income decreases the proportion of land allocated to wheat and teff. As hypothesized teff and wheat demand more on-farm labor for land preparation, weeding, threshing and harvesting. This is negatively correlated

[15] The performance of teff under less moisture is improved by an appropriate choice of teff varieties. The '*wafe taff*' variety (sown period is August) is a short-season variety and performs well under poor soil moisture conditions. Short growing period teff and grass pea are capable of giving higher yields under large rainfall variability than any other crops.

with off-farm employment (see Appendix 5.II).[16] The marginal effect suggests that a one unit increase in the off-farm income reduces the proportion of land allocated to wheat and teff by 0.09 and 0.13 respectively. However, off-farm income is positively correlated with the proportion of land allocated to barley and grass pea. These crops require relatively low labor input for production. Although the decision of land allocated to each crop is thought to be dependent on the value of livestock, for all of the five crops the number of oxen is not statistically different from zero.

Table 2: Marginal effects of the proportion of land allocated to crops (t-values in parenthesis)

Variable	Wheat	Teff	Barley	Lentil	Grass pea
Price of seed	0.14**	-0.42***	0.20***	-0.00	-0.01
	(2.64)	(-5.83)	(4.60)	(-0.53)	(-0.63)
Price of insecticide	-0.001	-0.002	-0.00		
	(-1.00)	(-1.35)	(-0.90)		
Price of fertilizer	-0.00	-0.03*	-0.06		
	(-0.02)	(-2.49)	(-0.52)		
Family size	0.02**	0.01*	-0.02**	0.01	-0.01
	(3.09	(2.04)	(-2.81)	(0.54)	(-0.42)
Head age	0.10	-0.01	0.02**	-0.02	-0.02*
	(1.54)	(-1.06)	(3.10)	(-1.03)	(-2.16)
Total land cultivated	-0.10	0.01	-0.02***	-0.01**	0015
	(-1.42)	(1.79)	(-5.42)	(-2.60)	(1.41)
Value of livestock	0.01	0.02	0.01	0.01	0.03
	(1.24)	(1.50)	(1.49)	(0.60)	(0.36)
Off-farm income	-0.09**	-0.13*	0.00	-0.01	0.00
	(-2.72)	(-2.16)	(1.44)	(-0.53)	(0.80)
Farmers risk aversion	-0.01**	-0.03	0.03*	-0.00	0.01*
	(-2.84)	(-1.78)	(2.03)	(-0.02)	(2.07)
Rainfall variability (Gurgand index)	-0.18***	0.01***	-0.002	-0.01*	0.02*
	(-4.04)	(5.63)	(-1.69)	(-2.27)	(2.25)
Rho	0.89***	0.93***	0.89***	0.04	0.99***
Mills Ratio (λ)	0.15***	0.17**	0.18***	0.00	0.19***
Number of observations	796	796	796	796	796
Left censored observations	221	272	169	705	558
Uncensored observations	575	524	627	91	238

*Significant at 0.05 significance level; ** significant at 0.01 significance level; *** significance at 0.001 significance level.

[16] This result is consistent with Woldehanna (2000), who concludes that off-farm income decreases the proportion of land allocated to wheat and teff (Woldehanna, 2000: 168).

Family size positively and significantly influences the proportion of land allocated to wheat and teff.[17] The marginal effect suggests that a one unit increase in the family size increases the proportion of land allocated to wheat and teff by 0.02 and 0.01 respectively. Family size negatively and significantly influences the proportion of land allocated to barley. Here family size and barley production are substitutes. If more adult labor is available in the household less labor is devoted to barley production and more to off-farm employment.

6. Concluding Remarks

This chapter analyzes the relationship between rainfall variability and crop choice. Heckman's selection model was used and the land allocation model was estimated using maximum likelihood. In the model the farmer first decides what crop to produce, and then decides the land allocation among crops. It has discussed the first step, which is the crop choice, and the second step, the land allocation decision.

It was found that rainfall variability was the most important factor in affecting the probability of crops to be grown. The evidence suggests that choosing the most suited crop mix given the specific rainfall conditions is the most important strategy of farmers in coping with unpredictable rainfall. In conditions of low rainfall, the dominant crop to be chosen for food security is teff and grass pea. The empirical results further suggest that households choose to increase the land allocated to teff and grass pea by 0.01 and 0.02 respectively and reduce the land allocated to wheat by 0.18 as variability of rain increases by 1 unit, which may help in explaining some of the ex-ante risk management strategies of farmers in the study areas. It was shown that risk reduction is a primary objective of farm households in the study areas.

Off-farm income has a negative effect on the proportion of land allocated to wheat and teff crops. These crops require more labor per unit of land which is not available if farmers work off-farm. On the contrary off-farm income has a positive effect on the proportion of land allocated to barley and grass pea crops. The result suggests that less on-farm labor availability increases the proportion of land allocated to barley and grass pea. This result is in line with Woldehanna (2000). He concludes that off-farm employment competes with the production of wheat and teff, while off-farm employment increases the proportion of land allocated to grass pea (Woldehanna, 2000: 168).

[17] This finding is consistent with Woldehanna (2000). He founds that family size positively influences the share of land allocated to wheat, teff, and barley crops.

It has shown that rainfall variability has a substantial impact on the proportion of land allocated to crops. This suggests that more coordinated effort in the intensification and expansion of irrigation and rainwater harvesting techniques as an ex-ante risk management strategy would have a substantial effect in minimizing the effect of rainfall variability. In so doing farmers would then be able to take the risk of adopting packages of inputs involving new technologies.

References

Amemiya T. (1985). *Advanced Econometric,* Cambridge, MA: Harvard University Press.

Benin, S, Smaleb, M., Penderc, J., Gebremedhin, B., Ehui, S., 2004. The economic determinants of cereal crop diversity on farms in the Ethiopian highlands. *Agricultural Economics* 31, 197-208.

Dercon, S., 1996. Risk, crop choice and savings: evidence from Tanzania. *Economic Development and Cultural Change* 44 (3), 385-514.

Dercon, S., 1998. Wealth, risk and activity choice: cattle in Western Tanzania. *Journal of Development Economics* 55, 1-42.

Dercon, S., Hoddinott, J., 2003. Health, shocks and poverty persistence. World Institute of Development Economic Research, Helsinki.

Fafchamps, M., Udry, C., Czukas, K., 1998. Drought and saving in West Africa: are livestock a buffer stock? *Journal of Development Economics* 55 (2), 273-305.

Greene, W.H., 2003. *Econometric Analysis.* Upper Saddle River, NJ: Prentice Hall.

Gurgand, M., 2003. Farmers education and the weather: evidence from Taiwan (1976-1992). *Journal of Development Economics* 71, 51-70.

Isik, M., 2002. Variable rate nitrogen application under uncertainty: implications for profitability and Nitrigen Use. *Journal of Agricultural and Resource Economics* 27, 61-76.

Heckman, J., 1979. Sample selection bias as a specification error. *Econometrica* 47 (1), 153-162.

Kochar, A., 1999. Smoothing consumption by smoothing income: hours-of-work responses to idiosyncratic agricultural shocks in rural India. *Review of Economics and Statistics* 81 (1), 50-61.

Kurosaki, T., Fafchamps, M., 2002. Insurance market efficiency and crop choices in Pakistan. *Journal of Development Economics* 67, 419-453

Larson, D., Plessmann, F., 2002. Do farmers choose to be inefficient? Evidence from Bicol, Phillipines. *Policy Research Working Paper* 2787. World Bank, Washington, D.C.

Maddala, G., 1983. *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge: Cambridge University Press.

Morduch, J., 2002. Consumption smoothing across space: testing theories of risk-sharing in the ICRISAT study region of South India. WIDER discussion paper 2002/55. United Nations University, World Institute for Development Economics Research, Helsinki.

Ramaswami, B., 1992. Production risk and optimal input decisions. *American Journal of agricultural Economics* 74, 860-869.

Singh, I., Squire, L., and Strauss, J., 1986. The theory and comparative static of agricultural household models: a general approach. In: Singh, I., Squire, L., Strauss, J. Eds., *Agricultural Household Models: Extensions, Applications and Policy*. Baltimore and London, Johns Hopkins University Press.

Udry, C., 1995. Risk and saving in northern Nigeria. *American Economic Review* 85 (5), 1287-1300.

Woldehanna, T., 2000. *Economic analysis and policy implications of farm and off-farm employment: a case study in the Tigray region of northern Ethiopia*. PhD. Thesis Wageningen University, Wageningen.

Wooldridge, J., 2002. *Econometric analysis of cross section and panel data*. The MIT Press, London.

Appendix I Descriptive statistics of price of variable input per kilogram by crop types

Table 5.I: Crop specific descriptive statistics (standard deviation in parenthesis)

Variable	Wheat	Teff	Barley	Lentil	Grass pea
Price of seed (Birr/kg)18)	2.07 (1.20)	2.01 (0.40)	1.66 (0.39)	2.05 (0.97)	0.87 (2.44)
Price of insecticide (Birr/kg))	32.40 (10.64)	35.60 (13.58)	23.25 (0.01)		
Price of fertilizer (Birr/kg)	2.38 (0.40)	2.40 (0.42)	2.45 (0.42)		
Labor (hours/hectare)	88.94 (50.64)	181.54 (117.22)	81.52 (411.64)	76.35 (62.27)	70.89 (37.37)
Share of land allocated (cropland size/total cultivated land) in hectare	0.34 (0.16)	0.30 (0.17)	0.40 (0.19)	0.18 (0.08)	0.22 (0.13)

Note: the mean and standard deviation of all prices are computed for strictly positive values only.

Table 5.II: Descriptive statistics for overall sample[19]

Variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
Number of adult in the household	796	2.69	1.21	0	8
Head age	796	49.79	12.03	22	83
Education household head (=1 if head is literate, 0 if illiterate)	796	0.37	0.48	0	1
Cultivated land size (hectare)	796	1.79	1.23	0	10.63
Value of livestock (Birr)	659	4162.8	3520.69	150	25200
Off-farm income (Birr)	412	1139.48	1265.77	18	8948
Rainfall variability (Gurgand index)	796	48.16	16.95	14.20	70.78
Farmers risk aversion (=1 if farmers are risk-averse)[20]	398	0.52	0.50	0	1

Note: the mean and standard deviation of value of livestock, and off-farm income are computed for strictly positive values only.

[18] Birr is the local currency, 1$=8.65 Birr

[19] The descriptive statistics are computed for those households who farm their land. About 11% of the farm households do not cultivate their land.

[20] Farmers are said to be risk-averse, if he opts for the safe choice and a value 1 corresponds to the choice of the safe option, while 0 indicates that the risky option is chosen. Since farmers risk assessment data was collected for the year 2001 and 2000. In each year 199 family heads were participated.

Table 5.III: Crop input use per hectare (standard deviation in parenthesis)

	Wheat	Teff	Barley	Grass pea	Lentil
Enderta					
Yield (kg)	154 (83)	141 (98)	217 (112)	122 (70)	78 (92)
Share of land (Tsimedi)	0.32 (0.19)	0.16 (0.16)	0.39 (0.22)	0.06 (0.11)	0.04 (0.08)
Labor hour	96 (55)	232 (142)	92 (41)	74 (40)	77 (66)
Local seed (kg)	30 (15)	15 (7)	44 (14)	33 (12)	27 (10)
Improved seed (kg)	6 (14)	0.30 (3)	0.42 (5.75)	0	0
Fertilizer (kg)	12 (14)	47 (59)	10 (15)	0	0
Hintalo-Wajerat					
Yield kg	134 (79)	115 (72)	154 (87)	131 (84)	100 (34)
Share of land in Tsimedi	0.24 (0.19)	0.27 (0.21)	0.31 (0.21)	0.09 (0.15)	0.01 (0.04)
Labor hour	81 (44)	139 (67)	71 (39)	68 (37)	68 (45)
Local seed in kg	31 (15)	10 (6)	37 (15)	16 (5)	13 (7)
Improved seed in kg	3 (9)	0.20 (2.28)	0.12 (2.13)	0	0
Fertilizer in kg	3 (8)	11 (17)	4 (10)	0	0

*Note: neither grass pea nor lentil improved seed is available on the market.

Appendix IV: computation of household's ex-ante perception of rainfall risk variables

Prior to the realization of rainfall the household knows the distribution of rainfall over time. Households ex-ante expectation of rainfall can be represented by its 10-year rainfall average and variability of rainfall by its variance. The 10-year rainfall average is computed by dividing the sum of annual rainfall over the 10-year period by the number of observations. Variability of rainfall is computed using Gurgand index (2003). That is, $\sigma^2 = \sqrt{1/7\sum_{m=1}^{7}(m_{dmt} - \overline{m}_{dm})^2}$

where d, t, and m denote district, a given year and a given month respectively and σ^2 is variance of rainfall. m_{dmt} measures monthly rainfall amount in district, d during the year, t and in a specific month m. And $\overline{m}_{dm}$ measures the average monthly rainfall amount in district d and m over the period 1993 to 2002.

DECISION-MAKING UNDER RISK: EVIDENCE FROM NORTHERN ETHIOPIA[1]

N. Haile[2] A. Oskam[3], J. Peerlings[3], and T. Woldehanna[3]

Abstract

There is a long standing discussion in the literature, whether expected utility theory (EU) or prospect theory (PT) explains best the behavior with respect to risky choices. Often these two approaches are compared by putting questions to students in laboratory situations. Here we try to investigate stated preferences of farmers which are functioning under high levels of risk in real life. As part of a larger survey, four binary choices were offered during two successive years. The experimental test was done for 199 farmers in two different districts in Tigray, Northern Ethiopia. Two items were central in comparing the risk attitude according EU and PT: the asymmetry of risk perceptions, the independence axiom and the shape of the utility function. The farmers in the two different districts (Enderta and Hintalo-Wajerat) differed significantly in their risk attitude. Enderta farmers were significantly risk-averse for gains and risk-seeking for losses, and their preferences conformed to the hypothesis of prospect theory. However, expected utility maximization were found to be an appropriate descriptor for Hintalo-Wajerat farmers.

In order to identify the factors that affect farmer's preferences a binary choice model was used. Household income were found to be positive and significant, while value of livestock had the expected negative sign and directly related to a decrease in risk aversion. This result has important implications for the characterization of risk attitudes in policy applications.

Keywords: risky choice, risk attitude, expected utility, prospect theory, Tigray.

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[2] Tigray Food Security Coordination Office, KfW-SUN Program, Mekelle
Corresponding author e-mail address, nhaileabreha@yahoo.com, P.O.Box 1055, Tigray Food Security Coordination Office, KfW-SUN Program, Tel: 0911 760574

[3] Wageningen Univeristy and Research, Agricultural Economics and Rural Policy Group,
Hollandsweg 1, 6706 KN Wageningen, The Netherlands

1 Introduction

In semi-subsistence agriculture, farm households face numerous natural, market and institutional risks in generating means of survival. Yield risk, crop price risk, risk of illness and injuries are important that prevail in developing economies. Households have developed various mechanisms for coping with risk. Some of these mechanisms offer short-term protection at long-term cost (e.g. diversification versus specialization). Their attitude towards risk, therefore, tends to display an explanation for the many observed economic decisions.

In measuring attitude towards risk, two approaches are identified: econometric and experimental. The econometric approach is based on farmers' actual behavioral data, which typically assumes that farmers maximize the expected utility of income. Given a production technology, the risk associated with production and market conditions, the observed level of input use can reveal the underlying degree of farmers risk aversion. Examples of this line of research include (Bar-Shira *et al*., 1997; Kumbhakar, 2002). The experimental approach is based on questionnaires regarding hypothetical risky alternatives with or without real payments. Here, respondents are asked to choose between lotteries that differ in payoffs and probabilities or both. The experimental approach is further classified into expected utility and non-expected utility approaches. For example Binswanger (1981) measured attitude towards risk in rural India. His approach is embedded in expected utility theory. Humphrey and Verschoor (2004) report an experimental test of individual decision making behavior under risk in rural east Uganda. They found that east Ugandan farmers' risk attitude exhibit systematic deviations from expected utility theory. Binswanger (1981) measured risk attitude to a set of real payments while Humphrey and Verschoor (2004), used in eight of the twelve decision problems real money payments, however all choice problems were considered as if they were being played for real money (Humphrey and Verschoor, 2004: 67). Real money payments may result in incentive effects and may not reveal the true risk preferences of farmers.

Using the experimental approach without real payments, this paper will identify which choice model best describes risk attitude of Northern Ethiopian subsistence farmers.[4] The objective of this paper is to measure farmer's attitude toward risk and to see how an individual's attitude toward risk relates to observed characteristics. Specifically this

[4] As the econometric approach is criticized for confounding risk behavior with other factors that are unrelated to risk preferences such as physical constraints and market imperfections (Just and Pope, 2003: 1255). This is particularly important in Ethiopia where market imperfections are prominent.

study seeks to answer: (1) does the expected utility theory explains risk attitude of north Ethiopian farmers better than the non-expected utility approach (such as prospect theory)? (2) Are farmers risk-averse to gains and risk seeking to losses? And are there concave utility shapes for gains and convex utility shapes for losses? (3) Are there systematic differences in attitudes amongst farmers? (4)Is there any evidence to suggest that farmer's socio-economic variables determine aversion to risk? From the research question it is attempted to test whether the farmers made decisions according to the expected utility theory or the non-expected utility theory (prospect theory). Empirical studies on how risk varies across individuals can be useful in predicting households' technology adoption, participation on off-farm work and in crop portfolio selection, since risk and risk aversion behavior plays an important role in these decisions.

In the next section a data set containing farmers' choices of hypothetical binary lotteries are presented. Experimental results on the shape of the utility function and a test of the independence axiom are discussed in section 3. In section 4 factors affecting risk behavior are econometrically determined. Section 5 concludes.

2 Expected Utility versus Non-Expected Utility: Literature Review

2.1 Expected utility: background

In general the expected utility (EU) model has been the dominant model for the last decades in modeling behavior under risk. Von Neumann and Morgenstern (vNM) are the major contributors to a large body of work that provides the justification for the use of the expected utility model by a rational decision maker. This model views decision making under risk as a choice between alternatives. Decision makers are assumed to have a preference ordering defined over the probability distributions for which the axioms of the EU model hold (Mas-Colell *et al*., 1995). Risky alternatives can be evaluated under these assumptions using the expected utility function $U(x)$.

In maximizing the decision maker's utility, consider a risk prospect in which the decision maker does not know ex-ante which state of the world will occur. However, he can list the various alternatives and can attach probabilities to them. For simplicity, assume two possible states of the world, state 1 and state 2, with respective probabilities p1 and p2 and denote x_1 the individual's monetary gain if state 1 occurs and x_2 if state 2 occurs. The individual must choose ex-ante between the risky bundles (x_1, x_2). Ex-post, the individual gets x_1 or x_2 depending upon which state of the world has occurred. If the decision maker's preference ordering over risky alternatives satisfies all the axioms of expected utility, including the independence and continuity axioms (see next section), then there exists a vNM expected utility function. This vNM expected utility function reflects the decision maker's choice as if he maximizes utility of the different states weighted by the probabilities for each state to occur.

vNM began by stating that utility maximization is a rational goal when a decision maker is faced with risky choices. In this framework, an individual will evaluate the expected value and objectively given probability of occurrence of each alternative. This evaluation is carried out by first entering the probabilities and expected outcomes into an individual's utility function. It is then a matter of selecting the combination of available alternatives that maximizes the function. The manner in which individuals choose among available alternatives is then dependent upon their utility function. For this setting the vNM expected utility function can be specified as:

$$U(p_1,..,p_i,..,p_N) = \sum_{i=1}^{N} p_i u(x_i) \tag{1}$$

Where, U is the vNM expected utility function, $u(x_i)$ is the utility of the $i\text{th}$ element of a vector of possible outcomes, and p_i is the probability of outcome x_i, $\sum p_i = 1$. The vNM expected utility function $U(p_1,..., p_i,..., p_n)$, defined up to a positive linear transformation, characterizes both the utility of the outcome and the individual's attitude toward risk. The curvature of this utility function contains information about the degree of individual's risk aversion (Mas-Colell *et al.*, 1995: 173).

Axioms of the expected utility theory

There are three main axioms in the expected utility framework. They are defined over a binary relation where:

$\succeq$ denotes weak preference,

$\succ$ denotes strict preference, and

~ denotes indifference.

For preferences over probability distributions $p, q, r \in P$ that are defined over a common (discrete or continuous) outcome vector X. The three axioms that are necessary and sufficient for the expected utility representation $U(\cdot)$ over preferences are:

Axiom O (Order):

The binary relation $\succ$ on P is asymmetric and transitive. The asymmetric part of axiom O says that the decision maker will not both prefer p to q and prefer q to p. According to expected utility theory, it is irrational to hold a definite preference for p over q and a definite preference for q over p at a time. However, there is a possibility that neither p nor q is preferred (i.e. $p \sim q$, the decision maker is indifferent between p and q).

The transitivity part of axiom O holds if and only if both $\succ$ and ~are transitive, i.e., for all $p, q, r \in P$, ($p \succeq q$, and $q \succeq r$) $\Rightarrow p \succeq r$; ($p \sim q$ and $q \sim r$)$\Rightarrow p \sim r$. Transitivity implies that it is impossible to face the decision maker with a sequence of pair wise choices in which preferences appear to cycle. For example, a decision maker feels that an apple is at least as good as a banana and that a banana is at least as good as an orange but then also preferring an orange over an apple.

Axiom C (Continuity):

For all $p, q, r \in P$ with $p \succeq q$ and $q \succeq r$ there exists $\alpha, \beta \in (0,1)$ such that: $\alpha p + (1-\alpha) r \succeq q$ and $q \succeq \beta p + (1-\beta) r$. This axiom gives continuity to the preferences. Continuity means that small changes in probabilities do not change the nature of the ordering between two lotteries (see Mas-Colell *et al.*, 1995: 171). Continuity rules out lexicographic preferences.

Axiom I (Independence):

For all $p, q, r \in P$ and for all $\alpha \in (0,1)$, if $p \succeq q$, then $\alpha p + (1-\alpha) r \succeq \alpha q + (1-\alpha) r$. This axiom states that preferences over probability distributions should only depend on the portions of the distributions that differ (p and q), not on their common elements (r) and of the level of α that defines the linear combination. In other words, if we mix each of two lotteries with a third one, then the preference ordering of the two resulting mixtures does not depend on the particular third lottery used.

Axioms O, C, and I can be shown to be necessary and sufficient for the existence of a function $U(\cdot)$ on the outcomes $x \in X$ that represents preferences through $\succeq$. The role of the order, completeness and continuity axioms are essential to establish the existence of a continuous preference function over probability distributions. It is the independence axiom which gives the theory its empirical content and power in determining rational behavior. That is, the preference function is constrained to be a linear function over the set of probability distribution functions, i.e. linear in probabilities (Machina, 1982: 278).

If an individual obeys the expected utility axioms, then a utility function can be formulated that reflects the individual preferences (Mas-Colell *et al.*, 1995: 175; Robison and *et al.*, 1984: 13). Further individual's risk attitude can be inferred from the shape of his/her utility function. Since vNM (1947), the expected utility model has been the dominant model in predicting choice behavior under risk. Starting with the well-known paradox of Allais (1953), however, a large body of experimental evidence has been documented which indicates that individuals tend to violate the axioms underlying the expected utility model systematically. This empirical evidence has motivated researchers to develop alternative theories of choice under risk able to accommodate the observed patterns of behavior. A wave of theories designed to explain the violation of expected utility theory began to emerge at the end of the 1970. Examples are prospect theory (Kahneman and Tversky, 1979), regret theory (Loomes and Sugden, 1982), dual theory (Yaari, 1987), cumulative prospect theory (Tversky and Kahneman, 1992), and rank-dependent utility (Quiggin, 1993). For a thorough review see Starmer (2000). In the empirical literature, prospect theory is the dominant theory. Therefore, it will be discussed in section 2.2.

2.1.1 Violation of the independence axiom

The common consequence effect. The well-known risky choice provided by Allais is given in a paper by Kahneman and Tversky (1979). They synthesize the work by Allais and by others who have shown experimental violations of expected utility. The Allais paradox depicted in Table1 is the leading example of this class of anomalies. There are two different choice sets, for each choice set there are two lotteries from which you can choose. For example, in lottery A1 there is a guaranteed payoff of $1M and there is zero probability of winning nothing. In lottery A2 there is a 0.10 probability of winning $5M, a 0.89 probability of winning $1M, and a 0.01 probability of winning nothing. Then one has to choose between A1 and A2, and between A3 and A4. Where A_1, A_2, A_3, A_4 are lotteries.

Table 1: The Allais paradox: the common consequence effect

Choice 1	A1	{1 M, 1; 0 M, 0}	A2	{5 M, 0.1; 1 M, 0.89; 0 M, 0.01}
Choice 2	A3	{5 M, 0.1; 0 M, 0.9}	A4	{1 M, 0.11; 0 M, 0.89}

Note outcomes are in Dollars and 1M = $1,000,000.

Many agents prefer lottery A1 to A2 and prefer lottery A3 to A4. This empirical tendency directly contradicts expected utility theory. According to expected utility theory $A1 \succ A2$ if and only if $1u(\$1M) > 0.10u(\$5M) + 0.89u(\$1M) + u0.01u(\$0)$. Subtracting $0.89u(\$1M)$ from each side, it follows that $0.11u(\$1M) > 0.10u(\$5M) + 0.01u(\$0)$. Adding $0.89u(\$0)$ to both sides, we have $0.11u(\$1M) + 0.89u(\$0) > 0.10u((\$5M) + 0.90u(\$0)$ which holds if and only if $A4 \succ A3$. Thus, from expected utility theory, one can deduce that $A1 \succ A2 \Leftrightarrow A4 \succ A3$. However, many people choose $A1$ over $A2$ and prefer $A3$ over $A4$. This pattern of choice violates the independence axiom and hence the expected utility theory. The Allais Paradox is now commonly known as a special case of a general empirical pattern called the common consequence effect. The name comes from the “common consequence” 1M in gamble 1 and 0 in gamble 2. The independence axiom requires that preferences be unaffected by changes in a common consequence, the Allais Paradox demonstrates that individuals are sensitive to shifts in probability mass. That is according to the independence axiom, an individual’s preferences in one event should not depend on the outcome in another event. Thus, it can be shown that violation of the independence axiom explains the observed inconsistencies in the measurement of the vNM utility model. If an agent is an expected utility maximizer then he must prefer A1 to A2 and A4 to A3. Agents may prefer A1 to A2 because they like to be a millionaire with certainty, implying risk aversion. But in choice set 2 the gambles are quite different with a high probability in each lottery of not winning any money. So, the agent may simply choose A3 because the chance of winning $5M is very similar to the chance of winning $1M and $5M is much more. The typical agent responds in a more risk-averse manner in choice set 1 and more risk neutral in choice set 2.

2.2.2 Violation of the order axiom

In addition to the violation of the independence axiom, there is experimental evidence suggesting that descriptive failures of expected utility may run deeper than violations of the independence axiom (Starmer 2000: 338). The two hidden assumptions in any conventional theory of choice are procedure invariance and descriptive invariance, which constitute another source of weak descriptive power for expected utility. Procedure invariance suggests that preferences over prospects and acts are independent of the method used to elicit them, whereas description invariance stipulates that preferences over prospects are purely a function of the probability distributions and do not depend on how these objects are described.

The most serious blow for the procedure invariance assumption may have been the discovery of preference reversal. Preference reversal, first reported by Lichtenstein and Slovic (1971), describes experimental results that appear to indicate systematic violations of transitivity of preferences. In their experiment subjects were asked to choose between two bets and then to give their true certainty equivalents for the bets in the form of a selling and a buying price. In many cases the subjects set the lowest price for the preferred lottery. In other words, individuals were presented with two gambles, one featuring a high probability of winning a modest sum of money (the P bet), the other featuring a low probability of winning a large amount of money (the $ bet). The typical finding is that people often choose the P-bet, but assign a larger monetary value to the $-bet. In their 1971 article Lichtenstein and Slovic presented the following pair of gambles (see Table 2).

Table 2: Preference reversal bets

P-bet	{$4, 0.99; -$1, 0.01}	Expected outcome of the P-bet = $3.95
$-bet	{$16, 0.33; -$2, 0.67}	Expected outcome of the $-bet = $3.94

The P-bet says that 99 percent chance of winning $4 and 1 percent chance of losing $1, the $-bet says that 33 percent chance of winning $16 and 67 percent chance of losing $2. Expected outcomes of the two lotteries are almost the same. The subjects were asked to choose which game they would like to play. Later they were told that they had the ticket to play the bet and were asked to name a minimum selling price for the ticket. Lichtenstein and Slovic found that 73% of the participants consistently have a higher price to the $-bet even though they had chosen the P-bet. The EU theory implies that the bet which is actually chosen also will be the one which will be assigned the largest selling or buying price. In an earlier study Slovic and Lichtenstein (1963) had observed that choices among pairs of gambles appeared to be influenced primarily by probabilities of winning and loosing, whereas buying and selling prices were more highly correlated with payoffs than with probability of winning. Following this observation they argue that, if the method used to elicit preferences affected the weighting of the gamble's components, it should be possible to construct pairs of gambles such that the same individual would choose one member of the pair but set a higher price for the other. This gamble when viewed from the standard theory perspective presents a puzzle. Both choices constitute ways of asking essentially the same question. In these experiments, however, the ordering revealed appears to depend upon the elicitation procedures. Moreover, choice and valuation tasks may invoke a different mental process, which in turn generates different ordering of a given pair of prospects. Consequently, the ranking observed in choice tasks cannot be explained with reference to a single preference ordering (Starmer, 2000: 338).

2.2 The non-expected utility model: Prospect Theory

As mentioned earlier the most commonly accepted model of decision making under risk is the expected utility theory. In the late 1970s the completeness of EU theory in explaining behavior has been challenged. These challenges give rise to the development of competing theories that attempt to explain individual behavior under risk. This section presents one of these alternative theories: prospect theory (PT).

PT was developed first by Kahneman and Tversky (1979). They develop their theory as an alternative to expected utility theory for explaining the outcomes of individual decision making under risk. They argue that choices that individuals make in risky situations exhibit several characteristics that are inconsistent with the basic axioms of expected utility theory. They argued that individuals underweight probable outcomes in comparison with outcomes that are certain. They called this phenomenon the certainty effect. They also pointed out that the certainty effect brings about risk-aversion in choices involving certain gains and risk-seeking in choices involving certain losses (Kahneman and Tversky, 1979).

Kahneman and Tversky (1979) distinguished two sequential phases in a decision process: the editing phase and the evaluation phase. In the editing phase, decision makers contemplate the choice situation and if possible simplify the problem. This includes the operation of coding that is outcomes are coded as gains or losses, prospects are simplified by combining probabilities associated with identical outcomes, and risky components of a prospect are separated from the risk less component of the prospect, and finally components of choices that are common to all prospects are discarded. The edited prospects are then evaluated and the most highly valued risky outcome is chosen. Prospect theory employs two functions: a probability weighting function $\pi(p)$, and a value function $v(x)$. These functions are combined to form the basic equation of the theory which determines the overall value of a prospect. Following is the equation that Kahneman and Tversky (1979) used for simple prospects with the form $(x, p; y, q)$, a gamble between two outcomes (x, y) with associated probabilities (p, q) which has at most two nonzero outcomes:

$$V(x, p; y, q) = \pi(p)v(x) + \pi(q)v(y) \quad \textbf{(2)}$$

When the prospects are strictly positive or negative, the evaluation follows a different rule. In the editing phase the prospects are separated into a risk less (the minimum gain or loss which is certain to be gained or paid) and a risky component (the additional gain or loss which is actually at stake). Thus, if $p + q = 1$ and either $x > y > 0$ or $x < y < 0$, so $\pi(q) = [1 - \pi(p)]$, then,

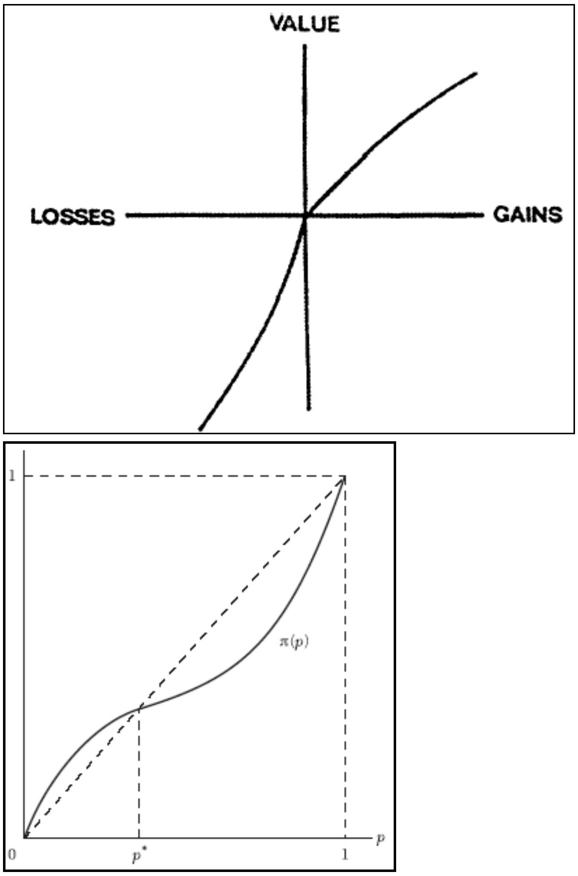
$$V(x, p; y, q) = v(y) + \pi(p)[v(x) - v(y)] \quad \textbf{(3)}$$

One of the essential features of prospect theory is that the overall value of a prospect is based on changes in a decision-maker's wealth reference point rather than on final wealth states, as in the case of the EU theory. Kahneman and Tversky propose the value function, one of the most widely used components of prospect theory, a function that is commonly S-shaped. It is generally concave for gains (implying risk aversion) and commonly convex for losses (implying risk-seeking), and steeper for losses than for gains (see Figure 1).

Another major departure of prospect theory from the EU theory is the treatment of the probabilities. In EU models the uncertain outcome is weighted by its probability, the uncertain outcome in prospect theory is multiplied by the decision weight $\pi(p)$. The weighting function, π, which relates decision weights to stated probabilities, is a monotonic function of p, with $\pi(0) = 0$ and $\pi(1) = 1$, but is not a probability and should not be interpreted as a measure of degree of belief.

According to prospect theory, very low probabilities are over-weighted, that is, the decision weight attached to the rare event is larger than the probability $\pi(p) > p$. Furthermore, prospect theory suggests that for all $0 < p < 1, \pi(p) + \pi(1 - p) < 1$, this is sub-certainty. It implies that as low probabilities are over-weighted, moderate and high probabilities are underweighted, that is the decision weight is smaller than the probability $\pi(p) < p$.

Figure 1: A hypothetical value function and a weighting function (Kahneman and Tversky, 1979: 279)



As in the EU model, values and weights are combined in prospect theory. Outcomes transferred into values by the value function, are weighted by the decision weights and then summed. This summed index is the index by which probability distributions are rank ordered and the subject is assumed to choose the distribution with the highest index (Smidts, 1990). Consider, the choice between the gamble $(x, p; y, q)$, a gamble between two outcomes (x, y) with associated probabilities (p, q): in expected utility maximization theory the value of the utility function is $U(X) = pu(x) + qu(y)$ and in prospect theory the value function is $V(X) = \pi(p)v(x) + \pi(q)v(y)$. In both cases the summed function is maximized and the highest value is chosen. Prospect theory and EU theory coincide when

$\pi(p) = p$ for all p and when $u(x) = v(x)$. In this case the expected utility of a lottery defined on $U(X)$ equals the value $V(X)$ of the gamble in prospect theory.

It can be concluded that prospect theory seems much more descriptive than expected utility theory. Prospect theory is capable of explaining decisions that expected utility theory is incapable of explaining. For example, expected utility theory cannot account for certainty gains, such as the certainty effect that may have a strong influence on individual's decision preferences.

3 Data Description

Two years (2001 and 2002) risk assessment data were collected from northern Ethiopia, Tigray. The respondents also participated in a survey on crop production, labor allocation, and consumption decisions. The questionnaire was framed as a farm decision problem. The respondents were head of the household. Two hypothetical questions, one question without loss and the other question with loss were asked in year 2001. The hypothetical questions asked in the year 2001 were also asked in the year 2002. The purpose of asking for the second year was to stimulate the actual process of decision making and to see whether there is a learning effect in the decision process. Seven other additional questions were asked in 2002, which did not involve loss (for details of the questions asked and description of the experimental designs see Appendix I and Appendix II). It is assumed that farmer's choice between the binary hypothetical outcomes was taken as an indication of his/her risk attitude behavior. The two hypothetical questions consisted of two possible outcomes with given objective probabilities, and the respondents were asked to state which of the two options (s)he prefers. It was mentioned that there was no right or wrong answers to these questions. In each year a total of 199 households were participated. It is assumed that by answering the hypothetical questions farmers exhibited their true preferences.

All outcomes of the hypothetical questions are in Ethiopian Birr.[5] In choice 1, for example, the choice is between the safest (certain) option labeled S1 and the riskier option R1 (the probabilistic gain option).[6] The mean is the expected monetary value of the lottery and its standard deviation is denoted by SD. In all of the choice

[5] Ethiopian Birr is a local currency with exchange rate as of 2005 is 1$=8.66 Ethiopian Birr.

[6] In this study safest option means a lottery with lower expected mean value but higher probability of winning the lottery. Riskier option means lottery with higher expected mean and low probability of winning the lottery.

problems the expected mean value of the riskier option is higher than the safest option. This can be considered as a control for the behavior of risk-aversion of experimental subjects. Accordingly, each decision problem is considered as a choice between a relatively safe and a relatively risky alternative. It can also be considered that the low variance choice is the safer option and the high variance choice is the riskier option.[7] Farmers opting for the safe option are called more risk-averse than farmers who choose the risky option. The percentage of farmers choosing the safest option for each choice is presented below. For choice 1 most of the respondents choose the certain gain rather than the gamble that is the certainty effect. Farmers choosing the gamble show risk-seeking behavior. And those who choose the certain outcome show risk-averse behavior.

Choice patterns of farmers in the year 2001 and 2002

Table 3 Choice 1

	Proportion safest choice chosen		Safest option: S1		Riskier option: R1	
	2001	2002	Mean	SD	Mean	SD
S1: (500,1) vs. R1: (1000,0.75) [8]	83.42	81.41	500	0	750	433

Choice 1 S1 offered a 100 percent chance of receiving 500 Birr and R1 offers a 75 percent chance of receiving 1000 Birr. The expected value for lottery S1 is 500 Birr with standard deviation zero. For lottery R1 the expected mean is 750 Birr with standard deviation 433. Thus the two lotteries have a relatively large difference in expected values. More than 80 percent of the farmers chose the safest choice in both years (year 2001 and 2002). When farmers are confronted with the sure gain and probability gain they tend to choose the sure gain rather than the probability gain. Roughly an equal number of farmers choose the sure gain in year 2001 and year 2002, as choice problem 1 involves no losses.

Table 4. Choice 2

	Proportion safest choice chosen		Safest option: S2		Riskier option: R2	
	2001	2002	Mean	SD	Mean	SD
S2: (-500, 1) vs. R2: (-1000,0.75)	49.75	56.78	-500	0	-750	433

[7] The measure of variability used is the variance of outcomes around the expected mean value.

[8] (x, p) denotes the hypothetical gain x with corresponding probability p .

Choice 2 is the opposite of choice 1, that the sign is reversed so that gains are replaced by losses. Table 4 shows that almost half of the farmers choose the sure loss in both years. The mean equality test for the two years choice indicates that there is no significant difference in means (t=0.52). This choice pattern indicates that farmer's preference between negative prospects is not the mirror image of the preference between positive prospects. This finding is in contrast with most of the findings of laboratory experimental studies with students as subjects (e.g. Kahnemans and Tversky, 1979).

Choice patterns in the year 2002

Table 5: Choice 3

	Proportion safest choice chosen	**Safest option: S3**		**Riskier option: R3**	
		Mean	SD	Mean	SD
R3: (5000,0.25) vs. S3: (2000,0.50)	51.3	1000	1000	1250	2165

In choice 3, about half of the farmers chose the safest choice. Here the safest choice has an expected value of 1000 Ethiopian Birr with a probability of winning equal to 50 percent, while the riskier option has 1250 as expected mean with a probability of 0.25 percent. It seems that half of the sample farmers exhibit risk-seeking behavior. They opt for the gamble rather than for the safest choice.

Table 6: Choice 4

	Proportion of safest choice	**Safest option: S4**		**Riskier option: R4**	
		Mean	SD	Mean	SD
R4:(9000,0.50) vs.S4: (4500,0.75)	48.7	3375	1949	4500	4500

Similar to choice 3 almost half of the farmers in choice 4 chose the riskier option. In choice 4 the safest choice has low variance (with standard deviation 1949) when compared to the riskier option (with standard deviation 4500). In this choice set about 48.7% of farmers choose the safest choice. However, more than half of the subjects opt for the riskier option, suggesting that subjects were more risk-lover in this choice set.

4. Test of the Expected Utility Axiom

4.1 Test on the shape of the utility function

Table 7 presents the proportion of choice in the gain and loss domain of the utility function. 82% of choices significantly reflect a concave shape for gains. That is Tigray farmers are very attracted to a sure gain compared to risky prospects, this is risk-averse behavior (the certainty effect).[9] Furthermore the result for gains confirmed that the utility function is concave which implies that the utility function has a diminishing marginal utility, which is also a well-known empirical finding in the agricultural economics literature. In Enderta and Hintalo-Wajerat, the vast majority, 89% and 76% of subjects respectively, were classified as showing a concave utility for gains. Thus, there were significantly large proportion of respondents classified as being concave than convex (the proportion is significant at 5% significance level). In these tests, the null hypothesis states that a concave classification is at least as likely as a convex classification. Tests are therefore two-tailed. As the experimental procedure in elicitation of utility did not use certainty equivalent procedures, linear classifications were not treated here.

Table 7: Percentage of concave and convex parts for gains and losses [choice1 vs. choice2]

	Gains			Losses		
	Full Sample	2001	2002	Full Sample	2001	2002
Enderta						
Concave	89	96	82	36	20	52
Convex	11	4	18	64	78	48
Hintalo-Wajerat						
Concave	76	71	81	71	79	62
Convex	24	29	19	29	21	38
Total Sample						
Concave	82	83	81	53	50	57
Convex	18	17	19	47	50	43

The utility shape for losses was also identified. The finding in this case is mixed. In Enderta most (about 64%) subjects exhibit a convex utility function for losses. This empirical finding is consistent with most of the findings in psychological studies. It

[9] The result is consistent with the findings of Humphrey and Verschoor, 2004.

says that losses loom larger than gains, so that people display loss aversion in the domain of losses, resulting in a utility function that is steeper for losses than for gains. Thus Enderta farmers can be classified as a risk-taking behavior over losses so that a risky loss is preferred to a certain one (i.e. they tend to choose the gamble rather than the sure loss). While in Hintalo-Wajerat a significant proportion (about 71%) of subjects exhibit concave utility for losses. Hintalo-Wajerat farmer's utility function for losses is concave rather than convex. This finding is not according to what prospect theory suggests, in that an individuals value function is convex in losses and much more sensitive to certain losses than to a risky loss. However, Hintalo-Wajerat farmers preferred a certain loss to a risky loss. Therefore Loss aversion would not help in explaining Hintalo-Wajerat farmers' decision behavior.

In Hintalo-Wajerat, the experimental evidence reveals that subjects increasingly inclined to select the safe choice in the domain of gains, the opposite happens in the loss domain (more subjects inclined to be more risk seeking in year 2002 than in year 2001). Subjects might realized that the riskier option has a higher expected value than the safer option and becomes more risk-seeking in the loss domain. This is contrary to what an expected utility maximization would prescribe. In Enderta, in the gain domain the choice is more stable and consistent. However, in the loss domain more subjects' choices converge to a utility maximization hypothesis in the year 2002.

4.2 Test on the Independence Axiom

The independence axiom of the expected utility theory requires that if a person chooses a safe option in the gain domain, he must also choose the safe option in the loss domain. If this does not hold the expected utility theory will be violated. To test the independence axiom we only used Choice set 1 and Choice set 2 (see Appendix I for details of the choices offered to farmers).

Table 8 reports the result of choice for the independence axiom. SS and RR choice responses are consistent with expected utility theory whereas RS and SR choice responses are not (SS response denote the safer S option being chosen in both the first and second choice and RR response denotes the riskier option being chosen in both the first and the second choice problems). In this test the null hypothesis states that the proportion of choice consistent with expected utility maximization (i.e., SS and RR choice) is equal to the proportion of choice to the prospect theory maximization (SR and RS).

Table 8: Proportion of choice responses in the lottery pair (choice 1 vs. choice 2)

	Enderta (n=99)					Hintalo-Wajerat (n=100)				
	SS	RR	SR	RS	p-value	SS	RR	SR	RS	p-value
2001	19	3	76	1	0.00(z=-7.82)	58	8	13	21	0.000(z=4.53)
2002	46	13	35	5	0.007(z=2.70)	51	8	31	10	0.011(z=2.55)

Table 9 clearly shows that in Enderta and Hintalo-Wajerat 40% and 63%, respectively, of choice responses is consistent with expected utility theory. In Enderta, subjects choose the sure gain rather than the risky gain in the first choice problem, in the second choice problem subjects prefer the risky loss rather than the sure one. About 79% and 41% of choices in Enderta are not consistent with expected utility maximization in 2001 and 2002 respectively. There is a significant difference of choice proportions between the year 2001 and the year 2002. Learning effects, market factors, and environmental factors might explain the difference. In Hintalo-Wajerat, although the choice in year 2002 reveals slightly more violations than 2001, the independence axiom does seem to hold.

Table 9: Summary proportion of choice consistent with expected utility theory

	Full Sample	2001	2002
Enderta	40	21	59
Hintalo-Wajerat	63	66	59
Total sample	51.5	44.22	58.79

Further Table 9 reports that 37% of subjects' responses are contradictory with the expected utility maximization theory in Hintalo-Wajerat. The majority of choice responses are consistent with expected utility theory. Therefore, the expected utility model would be the best descriptor of decision behavior under risk for Hintalo-Wajerat farmers. Moreover, the difference between the proportions of expected utility theory choices in Enderta and Hintalo-Wajerat is significant at the 5% level (t=2.48 with a two-tailed test of a difference in sample proportions based on the normal distribution). It appears that the difference is primarily driven by a higher proportion of risk-averse behavior (i.e., choosing the safest option in both choice problems) in Hintalo-Wajerat than in Enderta (where there is a higher proportion of relatively risk-seeking behavior SR in Enderta). Thus, expected utility theory does appear to be an appropriate descriptor of risky choices made by rural households in Hintalo-Wajerat. However, in Enderta, the result suggests that risk aversion may be an appropriate assumption in the domain of gains and risk-seeking in the domain of losses.

5. Factors Affecting the Risk Attitude of Farmers

It was shown that almost all the farmers surveyed were risk-averse, they choose the safest choice options (see choice 2 to choice 4 in Appendix II). Here, it is important to know the factors that influence farmers' risk attitude. Defining the set of factors that influence risk attitudes is difficult, since many are part of the psychological makeup of the individual. However, there are several observable physical and economic factors that might influence risk attitudes (Grisley and Kellog, 1987).

Empirical model

In order to identify the factors that affect farmer's preferences a binary choice model was used. When several continuous variables are used as explanatory variables in only one choice then estimating a logit model is necessary (Pindyck and Rubinfeld, 1998: 312). Therefore, the proportion of choices favoring the safest option is regressed on household specific characteristics. The model takes the form:

$$P(SC=1/x)=\frac{\exp(\beta x_i)}{1+\sum\exp(\beta x_i)}=x_i'\beta+\varepsilon \qquad \textbf{(4)}^{10}$$

where x is a $1\times k$ matrix of explanatory variables pertaining to observation i, $P(SC=1/x)$ is the probability that the safest choice is chosen given the full set of explanatory variables x, that influence the choice (such as age of the head, gender, family size, and total household income (off-farm and farm income), SC is the qualitative variable that indexed the safest choice with $SC=1$ indicating that the safest choice has been chosen and $SC=0$ indicating that the safest choice is not chosen. β is a $k\times 1$ vector of parameters, ε is an error term having a logistic distribution.

The probability model of equation (4) can take the form:

$$P(SC/x_i)=0(1-(x_i'\beta))+1((x_i'\beta))=x_i'\beta+\varepsilon \qquad \textbf{(5)}$$

Because the sign and magnitude of the estimated coefficients are relative to the response probability, direct estimation of the binary choice model is difficult. It is often

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[10] P(.) is non-linearly related to $x_i'\beta+\varepsilon$. This means that the ordinary least square (OLS) procedure cannot be used to estimate the parameters (Judge *et al*., 1982).

more insightful to estimate the marginal effects of changes in the independent variables on the probabilities of choosing the safest option (Greene, 2003: 668; Long and Freese, 2003: 139). The marginal effects of changes in each of the k independent variables can be calculated and used to map the impacts on the probability space.

$$\frac{\partial P(SC/x)}{\partial x_k} = (x_i'\beta)((1-(x_i'\beta))\beta \qquad \textbf{(6)}$$

The dependent variable is a dummy indicating whether the safest choice is chosen.[11] The dependent variables are household head characteristics (household age and head education), household size, household wealth (value of livestock which includes value of cattle, camel, horses, mules, donkey, sheep and goat), year dummy, district dummy, and district 10-year mean rainfall. Household size is measured by the number of persons living in the household for at least 9 out of 12 months. Household age is measured as completed years, and head education a dummy indicating whether the household head is literate. Year dummy captures the differences in rainfall between year 2001 and 2002. District dummy captures differences in access to markets and other district characteristics. The descriptive statistics of variables are presented in Appendix 4III

Estimation Results[12]

The results are presented in Table 10 which includes the values of the logit estimated coefficients, t-statistics, and marginal coefficients. None of the household head characteristics (age and education) are significant influences on risk attitude behavior. It is often assumed that older people are more risk-averse and numerous studies have confirmed this. In this study neither age of the household head, nor head education predicts risk preferences. Moreover, the insignificant results obtained for the household characteristics indicate that these variables may not be exogenous in determining household's risk preferences. The wealth variable (livestock value) is significantly and negatively associated with safest choice. This result is in line with many empirical findings which confirmed that wealthier households are more likely to undertake risky activities (Rosenzweig and Binswanger, 1993). The expectation that

[11] If the respondents choose the safest choice in one of the four choices, then *SC* takes the value of 1.

[12] The unrestricted log-likelihood for the logit model is -244.01. the Chi-squared statistic is, therefore, 53.07. the critical value from the chi-squared distribution with 8 degrees of freedom is 15.51, so the null hypothesis that all slope coefficients are zero is rejected at 5 percent significance level..

wealthier groups should be more risk taking is supported, but not significantly. The result is consistent with Yesuf (2004), who found negative correlations between wealth and risk aversion.

Table 10 – Estimation results and marginal effects of the probability of choosing the safest option

	Coefficient	z-value	Marginal effect
Intercept	-2.02*	-2.30	
Head age	-0.00	-0.01	-0.00
Head education dummy	-0.29	-1.16	-0.06
Family size	0.02	0.34	0.01
Value of livestock	-0.08*	-2.11	-0.02
District dummy (Enderta=1)	-0.74**	-2.98	-0.14
Year dummy (2001=1)	-2.13***	-4.19	-0.48
District mean rainfall	0.04***	3.64	0.01
Log likelihood	-244.01		
LR chi2(8)	53.07***		
Number of observation	398		

*Significant at 0.05 significance level; ** significant at 0.01 significance level; *** significance at 0.001 significance level.

The district dummy significantly affects risk-aversion behavior. This result confirms our expectations because Enderta is better-off than Hintalo-Wajerat with respect to the annual precipitation amount, access to markets etc. So, the results suggest that farmers in Enderta are more risk-loving than farmers in Hintalo-Wajerat. Finally, the most important variable that predicts risk preferences is the 10 year mean rainfall and year dummy. The year dummy is a good predictor of risky behavior. As 2001 was a good harvest year households were revealed to be more risk taking behavior in year 2001 than in 2002, a bad harvest year.

5. Discussion and Conclusions

In this paper we use experimental data from Enderta and Hintalo-Wajerat districts in Tigray. A set of hypothetical questions on lotteries were asked to farmers. Using the answers to these hypothetical lottery questions, we investigated: (1) whether farmer's preferences are consistent with expected utility theory or prospect theory, (2) whether farmers are risk-averse to gains and risk seeking to losses and have concave utility for gains and convex utility for losses, and (3) whether there is any relationship between farmer's socio-economic variables and farmer's risk preferences. In the experiment it is said that farmers opting for the safe option are called more risk-averse than farmer who choose the risky option.

The result indicates that more than 80 percent of the farmers chose the safest choice, when farmers are confronted with the sure gain and probability gain farmers tend to choose the sure gain rather than the probability gain. This is the certainty effect. However, when farmer's are confronted with sure loss and probabilistic loss, about 53 percent of farmers choose the safest choice (i.e., the sure loss) rather than the probabilistic loss. This finding is in contradiction with the findings of Kahneman and Tversky (1979). With respect to the shape of the utility function the finding is mixed. In Enderta about 64 percent of the subjects exhibit a convex utility for losses. This finding is consistent with most of the psychology literature findings. Prospect theory or loss-averse behavior is the appropriate model for explaining Enderta farmer's risk attitude. While in Hintalo-Wajerat a significant proportion of choice (about 71%) of the subjects exhibit concave utility for losses. This is in contrast to what prospect theory suggests. Here, expected utility maximization would be the appropriate model in explaining and modeling Hintalo-Wajerat farmer's risk preferences. None of the household head characteristics (age and education) are significant influences on risk attitude behavior of Tigray farm household heads. District dummy, ten years mean rainfall, and household income significantly influence risk preferences of farmers.

The caveats of risk analysis in this paper are: first, we used a simple hypothetical question, which was framed as a farm decision problem. More complex and advanced utility elicitation techniques, such as Trade Off method can also be used in surveys, and therefore, remains a future research option (for the Trade Off Method see Fennema and van Assen, 1999). Second, we examined the risk-attitude of the head of the household. We ignored risk-attitude of the spouse.

References

Allais, M., 1953. The foundations of a positive theory of choice involving risk and a criticism of the postulates and axioms of the American school, in: Allais, M., and Hagen, O. (eds.), Expected utility hypotheses and the Allais paradox, 27-145. Dordrecht: Reidel, 1979.

Bar-Shira, Z., Just, R., Zilberman, D., 1997. Estimation of farmers' risk attitude: an econometric approach. *Agricultural Economics* 17, 211-222.

Binswanger, H., 1980. Attitude toward risk: experimental measurement in rural India. *American Journal of Agricultural Economics* 62, 395-407.

Binswanger, H., 1981. Attitude toward risk: theoretical implications of an experiment in rural India. *Economic Journal* 91, 867–890.

Fennema, H., and Van Assen, M., 1999. Measuring the utility of losses by means of the Tradeoff Method. *Journal of Risk and Uncertainty* 17 (3), 277-295.

Greene, W.H., 2003. *Econometric Analysis.* Upper Saddle River, NJ: Prentice Hall.

Grisley, W., Kellog, E., 1987. Risk-Taking Preferences of Farmers in Northern Thailand: Measurements and Implications. *Agricultural Economics* 1, 127-142.

Humphrey, S., Verschoor, A., 2004. Decision-making under risk among small farmers in East Uganda. *Journal of African Economies* 13 (1), 44-101.

Judge, G.G., Carter Hill, R., Griffiths, W.E., Lütkepohl, H., and Lee, T., 1982. Introduction to the theory and practice of econometrics. New York: John Wiley and Sons.

Just, R., and Pope, R., 2003. agricultural risk analysis adequacy of models, data, and issues. *American Journal of Agricultural Economics* 85 (5), 1249-1256.

Kahneman, D., Tversky, A., 1979. Prospect Theory: an analysis of decision under risk. *Econometrica* 47 (2), 263-291.

Kumbhakar, S., 2002. Specification and estimation of production risk, risk preferences and technical efficiency. *American Journal of Agricultural Economics* 84 (1), 8-22.

Lichtenstein, S., and Slovic, P., 1971. Reversals of preference between bids and choices in gambling decisions. *Journal of Experimental Psychology* 89, 46-55.

Long, J., and Freese, J., 2003. *Regression models for categorical dependent variables using stata*. A Stata Press Publication. STATA CORPORATION. College Station, Texas.

Loomes, G., and Sugden, R., 1982. Regret theory: an alternative theory of rational choice under uncertainty. *Economic Journal* 92, 805-24.

Mas Colell, A., Whinston, M., and Green, J., 1995. *Microeconomic Theory*. Oxford: Oxford University Press.

Mosley, P. and Verschoor., 2005. Risk Attitudes and the 'Vicious Circle of Poverty'. *European Journal of Development Research* 17 (1), 59-88.

Neumann, von, J., and Morgenstern, O., 1944. *The theory of games and economic behaviour*. Princeton: Princeton University Press.

Pindyck, R., Rubinfeld, L., 1998. *Econometric Models and Economic Forecasts*. New York: McGraw-Hill, Inc.

Quiggin, J., 1993. *Generalized expected utility theory. The rank dependent model*. Boston: Kluwer Academic Publishers.

Robison, L., Barry, P., Kliebenstein, J., and Patrick, G. 1984. Risk attitudes: concepts and measurement approaches, *Risk Management in Agriculture*. Peter J. Barry, ed. Ames IA: Iowa State University Press.

Rosenzweig, M., Binswanger, H., 1993. Wealth, weather risk and the composition and profitability of agricultural investments. *The Economic Journal* 103, 56-78.

Starmer, C., 2000. Developments in non-expected utility theory: the hunt for a descriptive theory of choice under risk. *Journal of Economic Literature*, *Vol. XXXVIII .* 332-382.

Tversky, A., Kahneman, D., 1992. Advances in prospect theory: cumulative representation of uncertainty. *Journal of Risk and Uncertainty* 5 (4), 297-323.

Wik, M., Holden, S., 1998. Experimental studies of peasant's attitudes toward risk in Northern Zambia. Discussion Paper #D-14/1998 Department of Economics and Social Science, Agricultural University of Norway.

Yaari, M., 1987. The dual theory of choice under risk. *Econometrica* 55, 95-115.

Yesuf, M. 2004. *Risk, Time and Land Management under Market Imperfections: Applications to Ethiopia*. Department of Economics, Göteborg University. PhD. Dissertation.

Appendix I: The type of hypothetical questions offered to the farmer

Choice1. If you are given the choice between A and B which option would you select?
1. A sure gain of Birr 500.
2. A risky prospect that offers a 75 percent chance of winning Birr 1000 and a 25 percent chance of winning nothing.

Choice2. If you are given the choice between A and B which option would you select?
1. A sure loss of Birr 500.
2. A risky prospect that offers a 75 percent chance of losing Birr 1000 and a 25 percent chance of losing nothing

Choice3. If you are given the choice between A and B which option would you select?
1. A sure gain of Birr 2000
2. A risky prospect that offers a 25 percent chance of winning 5000 Birr, a 50 percent chance of winning 2000 and a 25 percent chance of winning nothing.

Choice4. If you are given the choice between A and B which option would you select?
1. A risky prospect that offers a 25 percent chance of winning 5000 Birr and a 75 percent chance of winning nothing.
2. A risky prospect that offers a 50 percent chance of winning 2000 Birr and a 50 percent chance of winning nothing.

Appendix II Experimental Design and questionnaire

A hypothetical questionnaire was developed using 25 test interviews to ensure that the hypothetical questions would be interpreted correctly. All the interviewers had prior experience and received two days training. Because of their district background and two time contact with the farm households, we believe that the effect of interviewer bias could be minimized. In the experiment, subjects were offered with four sets of hypothetical choice, involving no real money payment (see Appendix I). A total of 398 subjects participated in the experiments. To minimize the order effects, the hypothetical questions were randomly arranged and randomly offered to the respondents. The hypothetical questions offered can best be understood by examining the pair of lotteries in Table I.

Table 1: Descriptive statistics of proportion of choice response in the lottery pairs by year.

Questions	Proportion safest		Safest Option		Riskiest Option	
	2001	2002	Mean	SD	Mean	SD
Choice1 S1: (500,1) vs. R1: (1000,0.75)	83.4	81.4	500	0	750	433
Choice2 S2: (-500, 1) vs. R2: (-1000,0.75)	49.7	56.8	-500	0	-750	433
Choice3 S3: (2000,1) vs. R3: (5000,0.25; 2000,0.50)		77.4	2000	0	2250	1785
Choice4 R4: (5000,0.25) vs. S4: (2000,0.50)		51.3	1000	1000	1250	2165

Note: (x, p) denotes the hypothetical gains x with corresponding probability p and zero otherwise.

As indicated in the data description section of this paper, S and R correspond to the safest and riskier choice respectively. We call the low variance lottery the safe option and the high variance lottery as the risky option. Foe example in the year 2001 about 83.4% of subjects chose the safest option.

Appendix III. Descriptive statistics of household characteristics

Variables	**Mean**	**Standard deviation**	**Min**	**Max**
Age of head	51.82	11.90	22	83
Family size	5.95	2.19	1	11
Head education dummy (=1 if literate)	0.37	0.48	0	1
Value of livestock	3596.94	3941.48	0	25200

POLICY MAKING IN A FEDERAL CONTEXT: VIEWS FROM THE REGIONS ON FUTURE AGRICULTURES IN ETHIOPIA[1]

Amdissa Teshome[2] and Stephen Devereux[3]

Acronyms

BoARD	Bureau of Agriculture and Rural Development
CAADP	Comprehensive Africa Agriculture Development Programme
CADU	Chilalo Agricultural Development Unit
DFID	Department for International Development
EEA	Ethiopian Economic Association
FGD	Focus group discussion
GMO	Genetically Modified Organism
HYVs	High Yielding Varieties
IDS	Institute of Development Studies
IRDP	Integrated Rural Development Programmes
KII	Key Informant Interview
MDGs	Millennium Development Goals
MPPs	Minimum Package Programmes
NEPAD	New Partnership for Africa's Development
ODI	Overseas Development Institute
PADETES	Participatory Demonstration and Training Extension System
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PRSP	Poverty Reduction Strategy Paper
SNNPR	Southern Nations Nationalities and People's Region
WADU	Wolaita Agricultural Development Unit

[1] A shorter version of this paper has been published in the Ethiopian Herald (Saturday, 23rd June 2007) entitled "Bottom up Policy Process: an agenda for Future Agricultures".

[2] Contact Address: PO Box 23478, Code 1000, Addis Ababa. Tel: 091 117 7069 Email: azconsult@ethionet.et

[3] Research Fellow, Institute of Development Studies, Brighton, UK S.Devereux@ids.ac.uk

Abstract

Policy-making in Ethiopia is generally characterised as 'top down'. This paper argues that a genuine bottom-up policy process is possible – and preferable. It describes a 4- step policy process that has been developed, piloted and applied in six regions of the country. The process also generated indicative ideas on the future pathways for agriculture.

Step 1 *of the process is consultation with selected communities in Tigray, Oromia, Amhara, Benshangul-Gumuz, Afar and SNNPR. A cross-section of community members were consulted on (i) future pathways for agriculture in their communities and (ii) cross-cutting issues such as education, gender and environment.* ***Step 2*** *is a validation and enrichment process with researchers, academics, practitioners in agriculture and other sectors in the six regions.* ***Step 3*** *is the dissemination process, whereby a variety of media are used to inform policy makers and the general public.* ***Step 4*** *is policy engagement and influencing.*

The consultations were carried out based on four broad pathways for agriculture. These are: (i) intensification (ii) diversification (iii) commercialisations and (iv) depopulation.

The findings suggest that:
(i) Although there has been a policy push since the 1960, **intensification** *has not led to sustained increases in productivity and production, primarily because of policy constraints: inadequate access to input and output markets and under-developed irrigation practises. The message is that the government should take intensification seriously and consider fertiliser subsidy at least on targeted basis.*

(ii) **Diversification** *has not received a major policy push in the past. Presently, there is evidence that diversification (within agriculture) has received policy attention (re: PASDEP) and is also practiced on the ground in selected regions.*

(iii) Like intensification, **commercialisation** *has been a policy agenda since the 1960s, but was more or less dropped during the Derg regime and is more recently high on the agenda. The unresolved policy dilemma is the contention between large commercial farms and smallholder farming. The present government has vowed to promote both. However, smallholders face numerous constraints (both supply and demand-side) to full integration into the market. The policy implication is that with commercialisation land consolidation becomes inevitable and the government should be prepared for this.*

*(iv) '*__Depopulation__*' is a process of easing pressure on rural land by creating opportunities elsewhere through small town development, migration in search of*

employment and urbanisation. This process is evident in some of the regions but less evident in others.

Among the cross-cutting issues examined, the relationship between education and agriculture was found to be the most complex. (i) Today's educated professionals largely come from a farming background but never went back to farming (the brain drain from agriculture). (ii) Tomorrow's educated professionals (youth and children) have no desire to go back to farming, thereby continuing the brain drain. (iii) Increased enrolment, particularly of girls, is welcome but it is adding to women's burden and in some regions the community rejected full-day education, even threatening to withdraw their children.

Policy recommendations include: (i) Government should adopt a genuine policy consultation process (such as that described in this paper) that leaves no-one out, and move away from 'conference style' consultations; (ii) some development goals are likely to contradict each other, and policy processes should articulate these contradictions and devise strategies for addressing them.

1. Introduction

A number of observers have described the policy making process in Ethiopia as strongly influenced by a long history of centralised, hierarchical systems of control under Imperial rule followed by nearly two decades of military rule by the Derg. The present government has made efforts to reverse this legacy. However:

> *"… in spite of significant political, administrative and financial decentralisation, the centralised and controlling legacy remains an important factor" (Halderman, 2004: 10).*

According to this observation, it is not easy to overcome a legacy in a short period of time. Future Agricultures, a learning consortium of local and international academics and researchers, has developed and tested an all-inclusive policy consultation process that, if scaled up, could change the top-down legacy. In the process of testing the model, indicative ideas for agricultural policy making have been generated. This article reports on this innovative process.

2. What is Future Agricultures?

The Future Agricultures Consortium is a coalition of three UK-based research institutions – the Institute of Development Studies (IDS), the Overseas Development

Institute (ODI), and Imperial College (University of London) – working with research partners in three focal countries in Africa: Ethiopia, Kenya and Malawi. The overall objective of the Consortium is to contribute to a revitalised debate around how to generate broad-based economic growth and poverty reduction through agriculture in Africa, through country-level lesson learning and engagement in national policy processes. The Consortium receives financial support from the UK Department for International Development (DFID).

Agriculture is the backbone of the economy of Ethiopia and is still regarded as the key pathway out of poverty. However, over the last 3-4 decades, the sector has been unable to realise its potential, leading to increased numbers of people becoming food insecure. In the words of the Ethiopian Prime Minister, Meles Zenawi (2000):

> *"The agricultural sector remains our Achilles heel and source of vulnerability. … Nonetheless, we remain convinced that agricultural based development remains the only source of hope for Ethiopia."*

Almost identical statements could be made about agriculture in Kenya, Malawi and many other African countries. The Future Agricultures Consortium aims to explore the policy debates around this paradox, particularly by consulting with farmers themselves, to generate ideas and draw lessons that could be applied to similar contexts across the continent. To this end, a series of regional consultations were planned and implemented. These consultations were driven by two main objectives:

- To develop and test a methodology to inform an all-inclusive, bottom-up policy process;
- To generate indicative policy ideas on alternative futures for Ethiopian agriculture.

3. The Framework for the Consultations

Before presenting the findings from the consultation process in Ethiopia, this section reviews two broader contexts within which the Future Agricultures Consortium work is located: an understanding of the reasons for the failure of past agricultural policies in Africa, and the idea that future agriculture can evolve along one or more "pathways" or scenarios.

3.1. The policy context[4]

Four broad approaches to agricultural policy formulation and implementation in Africa can be identified: "technical fixes", "market fixes", "policy fixes" and "livelihood scenarios".

Technical fixes

One diagnosis is that smallholders face binding ***"input constraints"***. They do not have access to adequate irrigation, high-yielding seed, inorganic fertiliser, draught power, credit, research and extension support, and this results in inadequate crop yields and keeps them in a "low input, low output" poverty trap. The recommended solutions are all about alleviating these input constraints: build more dams and irrigation schemes; enhance access to improved seed varieties (including HYVs and GMOs), subsidise fertilizer, provide micro-credit, deliver extension and training. In some cases these interventions have achieved the desired results – the Green Revolution in India is the most famous case – but in many cases they have failed.

The main problems with technical fixes are that they are based on simplistic "input–output" assumptions: push more inputs into the start of the production cycle and bigger harvests will automatically come out at the end of the season. This assumption fails to take account of the complex vulnerabilities that small farmers face, and it reflects a lack of social, political and institutional analysis that follows from relying on "expert" knowledge rather than the knowledge of the real experts –farmers themselves.

Market fixes

The "Washington Consensus" thinking of the 1980s was based on a different diagnosis. African agriculture was stagnating because of excessive ***state interventionism*** – unsustainable subsidies, incompetent parastatals, restrictions on trade – which was distorting markets and creating damaging disincentives to farmers and traders. The solutions advocated by the World Bank and others could be summed up in simple slogans – "Get the state out of agriculture"; "Get prices right"; "Get markets moving" – which required market liberalisation, abolition of agricultural parastatals, removal of input subsidies and promotion of the private sector.

Unfortunately, the agricultural reforms that were imposed on reluctant African governments often created more problems than they solved. Small farmers simply

[4] This section draws on an analysis first presented in Scoones, Devereux and Haddad (2005).

lost all the support from the state that they had depended on, and in many cases the private sector failed to emerge as predicted, either because the policy environment remained uncertain, or because of severe market failures associated with mass rural poverty and lack of essential infrastructure. Some analysts argued that liberalisation failed because of “sequencing errors”: basic institutions and infrastructure must be in place before markets can evolve to fill the gap left by the state and parastatals, but in much of Africa these preconditions were not met.

Policy fixes

A third diagnosis of the stagnation of agriculture focused on ***policy failures*** – government policies were either wrong or government implementation capacity was lacking, and when agricultural liberalisation failed the “experts” argued that this was because their advice was ignored or incorrectly applied. Numerous “policy fixes” have been introduced to correct for perceived policy failures, from “modernisation” and the Green Revolution in the 1960s; to Integrated Rural Development Programmes (IRDPs) and farming systems research in the 1970s; structural adjustment and liberalisation in the 1980s and 1990s; and numerous large-scale agricultural projects throughout the post-colonial period, often funded by donors and implemented by international NGOs, outside of Ministry of Agriculture activities. The new century has seen a revival of international attention on African agriculture, following a period of relative neglect, with major initiatives like Poverty Reduction Strategies (PRSPs), the Millennium Development Goals (MDGs), the New Partnership for African Development (NEPAD), and the Comprehensive Africa Agriculture Development Programme (CAADP).

Whether this latest round of initiatives will succeed depends largely on whether they avoid the mistakes of the past: Previous “policy fixes” failed because they introduced inconsistent experiments and contradictory “blueprints” across diverse agricultural contexts, because they failed to understand of the politics of policy processes in specific governance environments, and because they located the problems inside Africa, without acknowledging the external challenges that African farmers face, not least from unfair competition on global markets (e.g. heavy subsidies for Western farmers while subsidies to African farmers were abolished).

Livelihood scenarios

Finally, a more recent diagnosis suggests that policy “blueprints” and experiments have failed for numerous inter-related reasons: because the problems facing African agriculture were incorrectly diagnosed, because many governments lack political will to invest in agriculture (because of “urban bias”), because donors are inconsistent and constantly trying new ideas (rather than allowing enough time for policies to achieve results); and because the basic requirements for a thriving agriculture sector have been neglected (building roads, improving access to inputs and markets, investing in research and extension capacity, land reform).

This analysis highlights a need to put farmers first. Rural livelihoods must be understood as diverse, complex and constantly evolving. Agricultural policy must be developed out of local, context–specific analysis. Scenarios for future agricultural "pathways" should be constructed for particular groups of people living in particular places. Instead of telling farmers what to do, "experts" and policy-makers should listen to farmers, ask them about their problems, priorities and needs – and then think about how best to support them.

3.2. Pathways for agriculture[5]

There are four[6] broad pathways that African agriculture, including Ethiopian agriculture, has been following over the past years. These are:

- **Intensification:** Use of technology (inputs, irrigation) to increase yields on falling farm sizes.
- **Diversification:** Finding alternative sources of income both within and outside agriculture.
- **Commercialisation (s):** Market orientation as opposed to subsistence orientation of farm production.
- **"Depopulation":** Easing population pressure on land and other resources by migration, urbanisation and resettlement.

These pathways are associated with different combinations of growth and risk. That is to say, agricultural growth generated through any one of these pathways exposes communities to new kinds of vulnerabilities.

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[5] This section draws on ideas first presented in Devereux, Amdissa Teshome and Sabates-Wheeler (2005).

[6] Strictly speaking there are at least six pathways. This paper does not cover extensification and specialisation. Although Ethiopia has vast areas of arable land that are not cultivated, it is unlikely to extensify to a significant degree in the foreseeable future. The government's own research strategy document (Tsedeke Abate, 2007) states that the country has cultivated the amount of hectares that it can, given its financial and technological capabilities. Specialisation shares some common features with commercialisation and is therefore not treated separately here.

For example, other things being equal, intensification will lead to high growth through increased productivity and production. However, if farmers are not sufficiently integrated with markets, they will not be able to enjoy the full benefits of increased productivity thereby remaining vulnerable to market related shocks.

Diversification will move the farmer from high vulnerability to lower vulnerability (reduced risks). However, the small farmer will find it difficult to diversify sufficiently, due to shortage of capital (and perhaps labour). Figure 1 shows possible scenarios for the four pathways.
Commercialisation is the most likely pathway to lead to higher growth and low vulnerability. However, this is based on the assumption that once fully integrated with the market, farmers can withstand market related shocks.

Depopulation has a tendency to move households to higher growth and lower vulnerability, at least initially. However, vulnerability can creep back in as soon as the initial conditions that facilitated migration or resettlement fade away. There are cases where re-settlers from the Derg era are now requesting to be moved elsewhere – even back to where they came from – because the fertile land they moved to is degraded and can no longer sustain them.

Accordingly, it is possible to conclude that no single pathway could lead to high growth and low vulnerability. What is needed is a combination of pathways, as shown in Figure 2. To what extent has Ethiopia pushed each of these pathways in the past? What is the status at present? What is the prospect for the future? The next section presents the outcome of the regional consultations along these pathways.

Figure 1: The relationship between agricultural pathways, growth and vulnerability

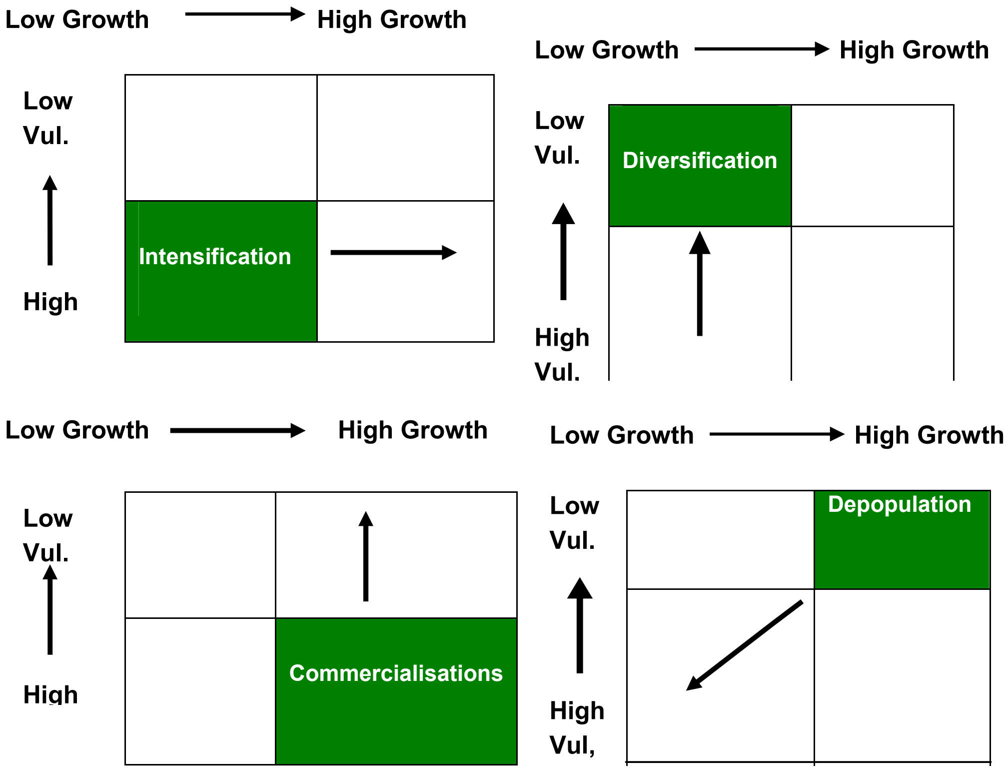
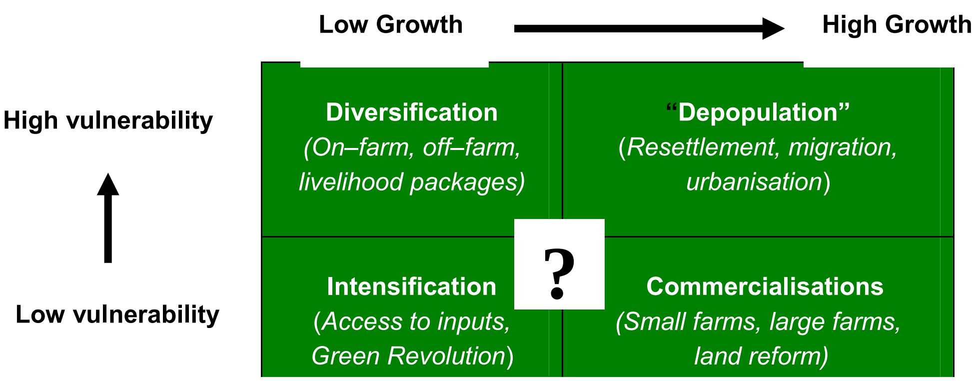


Figure 2: Combination of pathways



4. The Consultation Process, Method and Coverage

A 4-step policy dialogue process was developed, tested and applied.

Step 1	Community consultations
Step 2	Validate and enrich findings at regional workshop with researchers, academia and practitioners in various government bureaus
Step 3	Inform policy-makers, other stakeholders and the general public
Step 4	Engage with and influence the policy process

These steps were neither mutually exclusive nor linear, but instead were used in a dynamic and interactive manner. Applying these four steps, six regional consultations and one consolidated national workshop were completed between August 2006 and June 2007.

Focus group discussions (FGD) was the principal method of community consultations (**Step 1**) and a total of 77 FGDs were conducted in the six regions, involving close to 700 participants (see Table 1). Other tools such as key informant interviews (KII) and observations were also used. A cross-section of community members was consulted on the future of agriculture. These included “yesterday’s farmers” (elders), “today’s farmers” (adult male and female farmers), potential “future farmers” (youth and children), rural traders and commercial farmers.

Table 1: Community consultation coverage

Region	No. of Woredas	No. of FGDs	No. of participants
Tigray	3	11	87
Oromia	4	15	124
Amhara	5	24	216
Benshangul-Gumuz	3	8	78
Afar	3	7	55
SNNP	4	12	118
Total	**22**	**77**	**678**

The regional coverage had a national profile in the sense that Tigray, Oromia, Amhara and SNNPR are predominantly agricultural; Afar is predominantly pastoral and Benshangul-Gumuz is an emerging region. The selection of communities was purposive, based on criteria developed in collaboration primarily with Regional Food Security Coordination Offices, with input from bureaus of agriculture, research and academic institutions. The selection of communities was not statistically representative but attempts were made to take different livelihood systems in a region into account. The selection was designed to generate *indicative* ideas on the future of agriculture in each locality.

Following completion of community consultations, a 2-day regional workshop was conducted in each of the regional capitals to validate and enrich (**Step 2**) the *indicative ideas* generated from the community consultations. Regional researchers, academics, practitioners in agriculture and other sectors, as well as farmers, pastoralists and community representatives were present at these workshops, which attracted more than 150 participants (see Table 2).

Table 2: Regional workshop participants

Region	BoARD	Research/ Academic institutes	Donor/NGO	Regional President Advisors	Other sectors	Farmers/ pastoralists	Total
Tigray	16	6	3	1	2	3	31
Oromia	7	3	5	0	7	3	25
Amhara	9	11	7	1	6	2	36
Benshangul-Gumuz	10	5	3	1	7	2	28
Afar	7	0	2	0	5	2	16
SNNPR	8	7	3	1	1	2	22
Total	**57**	**32**	**23**	**4**	**28**	**14**	**158**
Percent	36.1%	20.2%	14.6%	2.5%	17.7%	8.9%	100%

Presentations at the EEA Conference and the national conference on Future Agricultures held in June 2007 were the beginning of a process of informing policy-makers, other stakeholders and the general public (**Step 3**) on the findings of the regional consultations. ‘

The national conference attracted about 90 participants from the federal and regional government offices, donors, NGOs and the private sector, as well as representatives of farmers and pastoralists from eight regions, and members of the Future Agricultures Consortium from Kenya, Malawi and the UK.

At the end of each regional workshop, a Future Agricultures Regional Working Group was established with a view to continuing the dialogue. Likewise, at the end of the national conference, a National Future Agricultures Working Group made up of volunteers from different organisations and the private sector was formed, with a view to taking forward the recommendations and sustaining the policy dialogue.

5. Findings From the Regional Consultations

Most of the discussions in the regional consultations focused on the four ‘pathways’ identified above for the future of agriculture in Ethiopia, but a number of ‘cross-cutting’ issues were also raised, including education, gender and the environment. This section summarises the key points raised under each of these topics.

5.1. Pathways for Ethiopian agriculture

Indicatives ideas for future agricultures were generated with respect to the four principal pathways for agriculture, namely intensification, commercialisations, diversification and depopulation.

Intensification

This is a pathway adopted under conditions of continued land fragmentation. It entails the use of modern inputs such as fertilizer, improved seeds and irrigation to get the maximum yield possible from a small plot of land.

In the case of Ethiopia, the average farm size in the highlands has been falling for many years and at the moment it is no more than 0.5 ha. In recognition of this fact, the country has followed the intensification path since the 1960s with the introduction of area development projects such as the Chilalo Agricultural Development Unit (CADU), Wolaita Agricultural Development Unit (WADU), the Minimum Package Programmes (MPPs), and more recently Participatory Demonstration and Training Extension System (PADETES).

During the consultations, it was found that some communities have begun intensifying their farming, particularly following the government’s drive to institutionalise water harvesting. For example, the following comments were put forward by a community in Amhara Region:

The community has become better aware of the use of water in its different forms, unlike the old days of dependence on seasonal rains. The use of irrigation in the form of river diversion (traditional and modern), ground water and ponds (individual and community) utilization has been intensified. As a result of these improved factors the farmers have been able to produce twice or three times a year [in Kobbo and Fogera]. In Fogera, areas that used to be waterlogged apparently with little production have now been converted to a large-scale rice production (Amhara Regional Report, December 2006).

Nonetheless, the rate of intensification has been very low across the country. It has not been possible to achieve the desired productivity on a sustainable basis. During the consultations, farmers indicated that fertilizers and improved seeds are (i) too expensive, (ii) untimely, and (iii) the delivery mechanism is not flexible.

The experts generally agreed with these points and added that as a result of these constraints, on average Ethiopia applies the least fertilizer per hectare by Sub-Saharan African standards.[1] The government's drive to introduce water harvesting schemes has gone a long way to raise farmers' awareness but the use of irrigation is still in its infancy.

What are the prospects for further intensification? The consultations generated possible ideas for addressing these constraints. To begin with, there was a consensus that the government should take intensification seriously. The most recent government research strategy document confirms this stand:

The agricultural scene of Ethiopia at present is such that most of the productive and accessible land that could be cultivated with the existing capital is already under production. Expansion into new areas of the remaining approximately two-thirds of the total available agricultural land is beyond the means of small-scale farmers, which means that research should focus on intensification – i.e. increasing productivity per unit area (Tsedeke Abate, 2007: 6-7).

The Government needs to improve smallholder access to fertiliser and seeds by, for example, (i) liberalising input marketing; (ii) reintroducing input subsidies, at least in a targeted manner; (iii) setting adoption targets based on ground realities; (iv) diversifying into high–value crops to make adoption economically viable for farmers.

[1] There are compelling evidences on the inadequate use of inputs by African farmers. For example, in Chapter 4 of the CAADP document, it is stated that Africa currently lags behind all other regions in agricultural productivity. The use of fertiliser is about 19 kg/ha per year, compared to 100 kg/ha in East Asia and 230 kg/ha in Western Europe. In terms of technology use, few farmers yet apply integrated pest management methods or any other pest control.

Intensification has negative environmental consequences that increase the vulnerability of communities to drought and other shocks. Attention should therefore also be given to environmental impact assessment.

Intensification was less relevant to the indigenous population of Benshangul-Gumuz because for the time being there is no demographic pressure on the land and farmers practice ‘shifting cultivation’, which they argued should be added as a “fifth pathway”.

> *In our region [Benshangul Gumuz] many farmers are practicing shifting cultivation, however so far nothing has been said about it. Therefore, shifting cultivations should be developed into a pathway (feedback during the national workshop, June 2007).*

Diversification

This pathway has two dimensions, namely diversifying within agriculture and outside agriculture (‘on-farm’ and ‘off-farm’). Historically limited policy attention has been paid to diversification in Ethiopia. More recently, there is a policy push for diversification as stated in the Plan for Accelerated and Sustained Development to End Poverty (PASDEP).[2]

During the regional consultations, the research team found several examples of diversification, both within and outside agriculture, in Amhara, Tigray and Oromiya. The awareness about the value of diversification among rural communities consulted was reasonably high. An example from Oromia illustrates this point:

> *[Diversification is the] production and sale of vegetable and fruits apart from the usual crop and livestock production. The livestock sector should focus on improving quality in fattening as well as selecting better breeds rather than focusing on the usual increase in numbers, particularly around Doni, Miesso and Adami Tulu. The size of farmland holding is declining due to increasing population numbers, which is affecting the livestock. Hence, we need to focus on maintaining milking cows, ploughing oxen, and few goats. Fattening the old oxen and selling and then replacing by younger oxen will give us the opportunity to use the difference for other needs. Small-scale rural trading, involvement in semi-skilled*

[2] A simple text search in the PASDEP draft document (58,672 words) produced 21 hits for “diversification”, which was much higher than “intensification” (4 words); “commercialization” (12 words); “migration” or “resettlement” (10 words) and “sedentarisation” (0 words). Though these figures are not definitive indicators of government priorities, they are indicative of a policy push on diversification (see Amdissa Teshome, 2006 www.future-agriultures.org).

activities and urban labour migration were mentioned as diversification strategies (Oromiya Regional Report, November 2006).

In the case of Tigray:

Rural communities started to diversify after the intervention of NGOs (mainly REST) in Soil and Water Conservation activities and the implementation of extension package programmes in 1985 [1993] and 1990 [1998] respectively. High-value products such as honey, vegetables, fruits, milk and milk products and livestock production have been introduced in many places. Ponds [Horoye], shallow wells and small-scale irrigation are becoming common in some parts of Tigray. Trade has become a newly emerging livelihood option and the role for women accordingly has significantly increased as a result of the diversification process (Tigray Regional Report, August 2006).

SNNPR is the most diversified region, in terms of ecology and crops produced, but is not as market oriented as community members and regional experts would like. Constraints to diversification include problems of accessing inputs and fragmentation of land.

The prospects for diversification are good, both in policy circles and in practice on the ground, at least in some of the regions consulted. Nonetheless, diversification needs to be speeded up by addressing the constraints and paying more attention to off–farm sources of income (e.g. trade and marketing, rural non–farm employment).

Commercialisations

This pathway goes back a long way in Ethiopia. There was a policy push in the 1960s, and more recently in the 2000s. During the regional consultations it was learned that there is an “eternal commercialisation dilemma”: the choice between large *versus* small farm commercialisation. Presently, the government is convinced it can promote both. However, small farmers face numerous constraints to commercialise. Researchers argue that commercialising smallholders is expensive; there are no economies of scale. Commercialisation may make land consolidation inevitable as more successful farmers push the less successful ones out of agriculture. Co-operatives offer an important route for smallholders to commercialise. Presently, the focus of cooperatives is on the traditional cash crops such as coffee. They need to expand into other marketable crops such as fruits and vegetables.

In the case of Benshangul Gumuz, large-scale commercial farms are preferred to the commercialisation of small farmers, for the simple reason that the relative abundance of land lends itself to commercial farming.

Commercialisation in SNNPR is hampered by:

> *market fluctuation, crop diseases and pests, high price of inputs such as fertilizer, small farm size, absence of irrigation schemes, absence of strong marketing cooperatives that give protection to the farmers, poor post-harvest storage facilities and techniques, lack of semi-processing industries (SNNPR Regional Report, March 2007).*

In the case of Oromia, the emerging flower farms (e.g. one located near Zeway town in Adami Tullu Woreda) are seen as good examples of specialised farms for commercialisation. The prevalence of an attractive investment policy has laid the foundation for flower farms in the region. During the consultations, it was pointed out that similar measures could promote fishery farms, as well as high value and marketable vegetables and fruits.

The farmers explained about the negative aspects of commercial farms that have in one way or the other affected the environment. As witnessed from the Adami Tullu flower farm, the community was not consulted and did not benefit sufficiently from the farm. In one focus group, they expressed their frustration as follows:

> "*Previously, when the farm was under a state farm, we had a comparative advantage particularly from the crop residue to feed our livestock. This doesn't exist today in any form. Moreover, pastures contaminated by the farm disposal have begun killing our cattle even though we have been compensated. The daily wage rate for our children is very low compared to the risk they face and the workload. In addition, we are not clear about the health risks that it might bring. We are in constant fear of possible risk as we have not been initially consulted and oriented about the benefits, the risks and its reduction (Oromia Regional Report, November, 2006).*

Depopulation

This pathway captures three closely related modes of population movement – namely urbanisation, resettlement and migration – all of which have been used as a means of easing pressure on agricultural land since the 1980s. In all the regional consultations, except Benshangul, depopulation in one form or another was considered inevitable.

There is a general consensus that the present figure of 85% agricultural population in Ethiopia is not sustainable and should not continue in future.

The government is concerned that 'depopulation' might lead to millions of rural people migrating in an uncontrolled way to urban areas, putting considerable pressure on urban resources and creating social problems, and this concern is appreciated. However, depopulation should not necessarily mean flocking to towns and cities. Expanding basic services to rural areas will create rural-based employment for the landless and school drop-outs, which serve a dual purpose – reducing pressure on agricultural land and reducing farmers' transaction costs. As one female farmer from a village in Amhara Region commented:

> *"You always talk about us going to urban centres. Why don't you bring the urban centres to us?"*

Depopulation was considered inevitable but also variable. Not all regions can depopulate at the same rate. In some regions (e.g. Tigray, Oromia and Amhara) there are good beginnings. Small towns are mushrooming and providing employment opportunities. In others where there is an overwhelming rural population and a low rate of urbanisation, it will take time to depopulate.

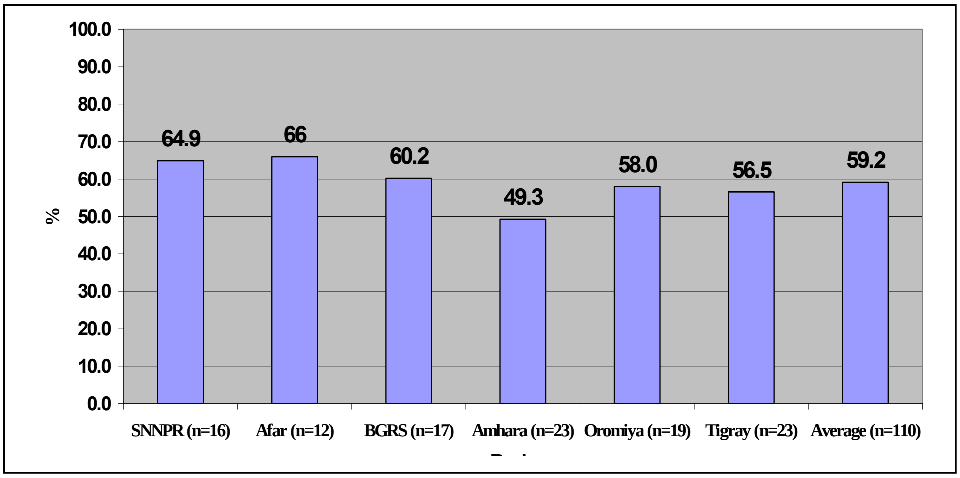
Historically, SNNP is the most experienced in this respect. People from Gurage, Wolayita, and Chencha have been migrating to Addis Ababa and other major towns since the 19th century (Worku Nida, 2006) to seek seasonal and permanent employment. One focus group participant from Meskan Woreda stated the following:

> *We have a history of migration since a long time. The major causes of migrations were shortage of land, low productivity of the soil, increasing number of population, drought and desire for better life [push factors]. The existence of strong support traditions among us is a pull factor for migration. Anyone that has succeeded in business in urban centres is expected to attract relatives or non-relatives to that area and business. In addition he or she has to send money back to relatives that need support (SNNPR Regional Report, March 2007).*

The SNNPR experience also indicated that nowadays migration is not paying as much as it used to. Remittances have declined and many people have gone back to their villages. Encouragingly, the returnees are engaging in various non-farm activities, using skills and working capital acquired during their stay in urban areas, to diversify the rural economy.

By way of generating indicative trends, regional workshop participants were asked what proportion of the population they believe will depend on agriculture in 25 years time. Figure 3 summarises the responses. The actual figures may not be as important as the discussion they generated in each region. The key point is that in every region, the proportion of people making a living from on agriculture is expected to decline, to anything between two-thirds (66% in Afar) to just under half (49% in Amhara). Given the high population growth rates in Ethiopia, and the current figure of 85% depending on agriculture, reducing this to an average of 59% across these six regions would imply that a major shift in rural livelihood systems is required in the next two decades – nothing less than a transition out of agriculture for millions of Ethiopians. Though challenging, this is by no means impossible. Countries as diverse as China, Morocco and Chile have reduced their agriculture-dependent populations over a similar time period (World Bank, 2004).

Figure 3: Percent of population expected to depend on agriculture in 25 years time



5.2 Cross-cutting issues

In addition to the principal pathways, cross-cutting issues were also examined during the consultations. These included (i) education and agriculture; (ii) gender and agriculture; (iii) environment and agriculture; and (iv) attitudes and agriculture.

Education and agriculture

The relationship between these two sectors was found to be complex, and a number of interesting observations were made regarding this relationship.

First, both the rural communities and the 'experts' concluded that lack of education is an inhibiter of technology adoption. Farmers in particular indicated that if they had some education they would probably not remain in agriculture, or they would do agriculture better than the way they have been doing it.

Second, the government's objective of replacing the current illiterate farmers with future educated farmers is well intentioned, but most children and youth with some level of education have no desire to stay in farming. On the other hand, children out of school indicated that they have no option but to remain in farming. This reinforces the older generation's view that it is lack of education that kept them in agriculture.
Third, today's parents, just like our own parents, see education as the way out of poverty for their children. So they are pleased by the increased access to education. However, the recent decision to introduce full-day education did not go down very well, particularly in Tigray, Amhara and Oromiya. Although labour requirements vary from season to season, children's labour is an important contributor to the farm. As parents begin to diversify economic activities, demand for labour increases. This was a hotly contested issue in Tigray and parents went to the extent of threatening to withdraw their children if full-day education were implemented.

Fourth, the benefits of girl's education are indisputable, but both girls and mothers stressed that it is adding to the mother's burden (see also 'gender and agriculture', below). Fifth, the most revealing finding was the fact that today's educated population, all of whom came out of rural areas, never went back to agriculture to combine their knowledge with land and labour.

"We were told education is a way out of rural areas and poverty; so we escaped!"

Agriculture has been "brain-drained". This trend is likely to continue, given that rural youth and children in the consultations did not show any interest in remaining in agriculture Today's children lack successful educated farmers that they can aspire to, and to use as role models.

Having said that, there are school drop-outs who have gone back to agriculture. But their innovativeness varied across regions and within regions. In food insecure areas of Amhara, they were found to diversify their income from various sources and are well linked to the market, with or without support from the extension system. In relatively food secure areas of Oromia, they were found to be satisfied with existing situation and took little or no steps to improve the situation.

What are the policy implications? The government has expressed its desire to replace the current illiterate farmers with literate farmers through formal education. If today's children and youth do not wish to stay in agriculture, then this policy may not succeed. Therefore, the government should introduce flexible forms of education (formal and non-formal) for today's farmers and design the extension system in such a way that it makes use of educated farmers. It should also investigate the reasons

(i) why school drop-outs perform differently in different regions – those regions that have successfully encouraged drop-outs to succeed in agriculture should share these lessons with those that have failed;

(ii) why the educationally successful do not wish to go back to agriculture – the government should encourage them to return to their homestead and contribute to the rural economy, not only in financial and material terms but also by transferring their knowledge and skills.

Gender and agriculture

The consultations found that all the pathways for agriculture increase women's burden. In farms that have been sufficiently intensified, women have to take part in land preparation, cultivation and weeding. On-farm diversification also divides existing labour among the various activities, adding to women's burden. As noted above, the importance of girl education is indisputable, but concerns were expressed from mothers and daughters alike that schooling has taken girls away from domestic duties and farm work, thereby increasing the workload of their mothers and other female relatives.

The policy implication is that these contradictions between development objectives should be analysed and articulated in policy documents. Practical labour-saving measures should be taken to ease women's burden.

Environment and agriculture

Progress has been made in watershed management approaches to environmental protection and in land reclamation, particularly in the food insecure areas where there is a history of food aid. However, there is a general consensus that enough has not been done to protect the environment in the relatively food secure high potential areas. If this trend continues, the so-called food secure areas will degenerate into food insecurity and this situation may not be easily reversed. Some regions proposed that 'sustainable environmental management' should be a pathway on its own.

Attitudes and agriculture
Ethiopia has a rich cultural and religious heritage, which is important to maintain the integrity of the nation. However, there was also a strong feeling that some aspects of these cultures and traditions have become bottlenecks for agriculture and are leading to resource and labour wastage.[3] The existing efforts to tackle harmful traditional practices should be intensified. Researchers and policy makers should work very closely with religious organisations and leaders, as well as clan leaders and elders, to devise effective strategies.

When one speaks of attitudes, rural communities often come to mind first. However, researchers and academics also need to re-examine their approach to investigating problems facing rural communities. In addition to formal research methods that are based on hard data, they need to adopt techniques that allow listening to rural communities. The 4-step process described in this article is an ideal way to go about it.

6. Conclusion and recommendations

The bottom-up policy process developed and tested as part of Future Agricultures work in Ethiopia has generated useful indicative policy ideas. Some of these ideas will require further investigation.

In addition to the specific recommendations that have been highlighted within the text, two broader lessons can be drawn from the policy process exercise.

First, top-down approaches are not dictated by God as the only way, or the best way, to design and implement policies, in Ethiopia or anywhere else. Genuine bottom-up policy processes are possible, they can yield important information and they can deliver more effective results. Therefore, the government should build genuine community consultation into the culture of policy–making, and it should move away from "conference style" consultation processes.

Second, the regional consultations have revealed that there is an unforeseen tendency for certain development objectives to contradict rather than complement each other. If these contradictions go unnoticed and unchecked, they could become

[3] There are a number of studies that support this finding. See for example, Sintayehu Kassaye (2006); Frank Ellis and Tassew Woldehanna (2005).

barriers to each other and stop or reverse real progress being made. Therefore, in addition to the usual “potentials and constraints” analysis, any conflicting objectives should be identified and articulated in Ethiopian policy circles. Strategies should be devised to resolve these contradictions.

References

Amdissa Teshome (2006) Agriculture, Growth and Poverty Reduction in Ethiopia: Policy Processes around the New PRSP (PASDEP), A paper for the Future Agricultures Consortium workshop, Institute of Development Studies, 20-22 March 2006, Brighton, UK (www.future-agricultures.org)

Amdissa Teshome, Alemtsehay Aberra, Assefa Tewodros and Gebrehiwot H/Mariam (August 2006) Future Agricultures Tigray Report, Mekele.

----------- Alemtsehay Aberra, and Moges Tefera (November 2006) Future Agricultures Oromia Report, Addis Ababa.

----------- Alemtsehay Aberra and Adane Tesfaye (December 2006) Future Agricultures Amhara Report, Bahir Dar.

------------ Teshome W/Mariam and Gebrehiwot H/Mariam (January, 2007) Future Agricultures Benshangul Gumuz Report, Assossa.

------------- Teshome W/Mariam and Zerihun Getu (April, 2007) Future Agricultures SNNPR Report, Hawassa.

Devereux, S. Amdissa Teshome and Rachel Sabates-Wheeler (2005) Too Much Inequality or Too Little? Inequality and Stagnation in Ethiopian Agriculture, IDS Bulletin, Vol. 32 No 2, Institute of Development Studies, Brighton.

Ellis, F and Tassew Woldehanna (2005) Ethiopia Participatory Poverty Assessment 2004-05, Ministry of Finance and Economic Development (MoFED), Development Planning and Research Department.

Halderman, H. (2004) The Political Economy of Livestock: Pro-Poor Policy Making in Ethiopia, Pro-Poor Livestock Policy Initiative (PPLPI) Working Paper, No. 19, FAO, Rome.

Meles Zenawi (2000), quoted in Stephen Devereux, Amdissa Teshome and Rachel Sabates-Wheeler (2005) Too Much Inequality or Too Little? Inequality and Stagnation in Ethiopian Agriculture, IDS Bulletin, Vol. 32 No 2, Institute of Development Studies, Brighton.

*NEPAD (2002) Comprehensive Africa Agriculture Development Programme, November 2002 (**http://www.google.com.et/search?client=firefox-a&rls=org.mozilla%3Aen-US%3Aofficial&channel=s&hl=am&q=CAADP&btnG=Google+%E1%8D%8D%E1%88%88%E1%8C%8B**)*

Scoones, I. Stephen Devereux and Lawrence Haddad (2005) Introduction: New Directions for African Agriculture, IDS Bulletin, Vol. 32 No 2, Institute of Development Studies, Brighton.

Sintayehu Kassaye (2006) Economic Culture of Tigray**,** Paper presented at the 4th International Conference on the Ethiopian Economy, Ethiopian Economic Association, June 10-12, 2006 (available on Conference CD).

Tsedeke Abate (2007) Focusing Agricultural Research to Address Development Needs: Directions for Agricultural Research in Ethiopia, Ethiopian Institute of Agricultural Research, Addis Ababa.

Worku Nida (2006) The Impacts of Urban Migration on Village Life: the Gurage case, Department of Sociology and Social Anthropology, Addis Ababa.

World Bank (2004) Case Studies of Agriculture Based Growth Strategies: Options and Trade-offs with Relevance for Ethiopia. Country Department for Ethiopia, Africa Region (www.worldbank.org).

AGRICULTURAL COMMERCIALISATION IN COFFEE GROWING AREAS OF ETHIOPIA

Samuel Gebreselassie[1] and Eva Ludi[2]

Abstract

The coffee sub-sector is very important to the Ethiopian economy – in 2005, coffee export generated 41% of the foreign exchange earnings – and provides income for approximately 8 million smallholder households. Policy attention to the sector was always considerable, and its importance has been renewed in the latest PRS, the Plan for Accelerated and Sustained Development to End Poverty (PASDEP). PASDEP puts forward a development strategy based on accelerated economic growth, part of which is hoped to be achieved via increased smallholder commercialisation and market integration.

This paper addresses commercialisation in selected coffee growing areas in Ethiopia. The objectives of the study were (i) to assess the scale of commercialisation in coffee growing areas and to detect household and farm characteristics which might explain variation in the levels of coffee commercialisation among households; (ii) to investigate whether or not, and under which circumstances, cash crop production might have, spillover effects on food crop production; (iii) to investigate farm productivity, labour intensity and consumption effects; and (iv) to draw policy implications and further research needs.

Agricultural commercialisation was found to be comparatively high in the studied Weredas (Districts). On the average, farmers marketed 84% of their farm production. Overall, coffee contributed 70% to the total value of output sold. There is, however, a high inter-household differentiation: the 25% highly commercialised smallholders generated over 95% of their cash income from coffee sales, while the bottom 25%

[1] Ethiopian Economics Association, Addis Abeba, Ethiopia.

[2] Overseas Development Institute, London, UK

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earned 63% of their cash income from selling food crops. About 72% of the variation in the level of commercialisation among households can be explained by the volume of production. Demographic and household factors, wealth and total farm size had no effect on the observed variation in the degree of coffee commercialisation among sampled households. A negative and significant association between the level of household coffee commercialisation and land productivity in non-coffee crops was found, indicating potential trade-offs between the production of coffee, the major cash crop, and other, mainly food crops. No evidence was found of increasing labour intensity as a result of increased coffee production. Household-level food consumption shows only an insignificant association with the level of coffee commercialisation.

Overall, the findings demonstrate the integrated nature of the farming system in coffee growing areas. Despite an overall high level of coffee commercialisation, diversified farming is a strategy pursued by the majority of the surveyed households. The study findings, however, suggest that further specialisation in coffee could enhance overall agricultural productivity.

Increasing smallholder coffee commercialisation is expected to be a viable pathway for agricultural development in coffee growing areas of Ethiopia if trade-offs in the production of coffee and non-coffee, largely food crops, can be minimised. Increased research and policy attention should be paid to the coffee sub-sector, which currently is characterised by low productivity, low coffee quality, low international coffee prices and high market risks.

1. Introduction – Coffee in the Ethiopian economy

Ethiopia produces and exports one of the best highland coffees in the world. The coffee sub-sector is very important to the Ethiopian economy, and generated about 335 million USD or 41% of the foreign exchange earnings in 2005 (NBE, 2006). The coffee sub-sector is also important in terms of providing income for a large number of households: it is estimated that between 7.5 and 8 million households depend on coffee for a considerable share of their income, and provides jobs for many more people in coffee-related activities (e.g. coffee processing, transporting or marketing). It is estimated that the sub-sector impacts on approximately 15% of the population, and around 20% of the land area (McMillan et al, 2003).

In Ethiopia, coffee is primarily cultivated by smallholders, either cultivating coffee on their own farms or picking semi-wild/wild coffee. Of the estimated 600,000 hectares of land cropped with coffee, over half is semi-forest/forest, or semi-wild/wild land. Approximately 235,600 hectares are under smallholder cultivation, (‘garden’ or ‘cottage’ coffee), which is generally inter-cropped with food staples. Smallholder coffee accounts for approximately 95% of total coffee production. There are about 20,000 hectares of plantation coffee, consisting mainly of state farms, but increasingly also of plantations under private ownership (McMillan et al, 2003).

Coffee growers in Ethiopia have been exposed to price fluctuations and impacts of unpredictable and uncontrollable shocks. Despite some improvement of producer prices in the past two years, domestic and world coffee prices have declined and remained very low for much of the late 1990s and early 2000s. The effect of this price decline was manifested in increasing poverty among coffee growers, who previously were able to reap good benefits from their coffee sales. At household level the impact of depressed prices has been considerable, leading to distress sales of assets such as cattle, or to uprooting coffee plants and replacing them with annual food crops (Oxfam, 2002) or cash crops such as *Chat*[3]. Other strategies included giving up traditional shade coffee production to create space for intercropping and income diversification (McMillan et al, 2003).

2. Government policy on agricultural commercialisation

Smallholders cultivate over 96% of the total agricultural land. The average smallholder cultivates less than one hectare of arable land, and consumes more than 65% of total production within the household (EEA, 2006). In many parts of the country, market orientation of smallholder family farms (measured either in terms of per capita market share, the volume of farm output supplied to markets or their profit motive) is limited. Agricultural markets are fragmented and not well integrated into a wider market system, which increases transaction costs and reduces farmers' incentives to produce for the market. Government policy - or the lack of it - has contributed to this general characteristic of the smallholder agricultural sector in Ethiopia. Agricultural commercialisation was not high on the policy agenda until recently, as Government rather prioritised ensuring food security and poverty reduction at household level.

The second PRS, the Plan for Accelerated and Sustained Development to End Poverty (PASDEP), formulates a more pronounced strategy towards smallholder commercialisation.[4] Commercialisation of agriculture and the growth of the non-farm

[3] Chat is a plant with stimulant properties.

[4] Some criticism has been directed towards the exclusive government focus on poverty reduction and food security at household level at the expense of a more balanced and broad economic growth strategy including urban development, increased agricultural commercialisation and labour productivity (Cour, 2003; Dessalegn Rahmato, 2005; Samuel Gebreselassie 2006).

private sector are two main thrusts of the initiative to accelerate growth for the next five years (2005/06-2009/10). PASDEP also recommends specialisation both at farm and community level, a shift to high-value crops, promotion of niche high-value export crops, a stronger focus on selected high-potential areas, supporting the development of large-scale commercial agriculture where it is feasible, and facilitating the commercialisation of agriculture, among others, through improved integration of farmers with markets - both local and global (MoFED, 2006).

Current Government policy on commercialisation focuses both on small and large farms. An earlier policy document published by the government in 2003 making reference to commercialisation (see Demese Chanyalew, 2006) has substantiated this strategy which revealed two broad paths for the commercialisation of Ethiopian agriculture: commercialisation of smallholder agriculture through market-led production, and commercialisation via the emergence, growth and expansion of modern agricultural enterprises. Despite the various challenges that could hinder further development (e.g. those related to the land policy, shortage of farm land, high population growth and lack of non-farm employment), some progress is being made in both cases. The second, large-scale, type of commercial farm is indeed emerging and expanding especially with investments in horticulture and floriculture.

Beyond marketing support, which is elaborated in more detail in PASDEP, government policy is not very clear on how the potential benefits of increased smallholder commercialisation could be maximised and the potential damage minimised. What is called for is a stronger focus on creating an enabling economic environment in which smallholders can take advantage of commercialisation opportunities and progressively move away from the widespread subsistence orientation towards a more viable and market-oriented smallholder sector.

The challenge for government policy is to identify and facilitate strategic pathways and driving forces of commercialisation. These include macro and trade policies, market reform, rural infrastructure improvement, and the development of a legal and contractual environment in which farmers and other actors along the value chain may cooperate. Moreover, policies and institutions are required to deal with the risks of policy and market failures, deficiencies in the knowledge and information of actors in production, processing and marketing at all levels, and household- and community-level complexities including shortage of farm land, high population growth, lack of alternative employment, and the challenges related to state ownership of rural land (i.e. inability to mortgage land and generate capital for its development, unfair and non-transparent land confiscation for large investments or public use, etc.). Policies and institutions related to these driving forces will strongly influence the nature and speed of the agricultural commercialisation process and the transformation of the current agricultural system.

This study does not focus on the broad policy debates with regard to smallholder commercialisation (for further details see Leavy & Poulton, 2007), but concentrates on the commercialisation of smallholder agriculture in Ethiopia's coffee growing areas. Smallholder coffee farming, which has been an important pillar of the Ethiopian economy for centuries, has been confronted with various problems both internal (e.g. weak markets, insufficient infrastructure, insufficient R&D, shortage of farmland) and external (e.g. global coffee price decline, increasing food and oil prices), which threaten the further expansion of a dynamic and commercially oriented smallholder coffee sub-sector.

3. Context, objectives of the study, conceptual framework and methodology

3.1 Context: Future Agricultures and Commercialisation(s)

Research on coffee commercialisation in selected Weredas was carried out in the framework of the **Future Agricultures Consortium** (FAC). FAC is a partnership between research-based organisations in Africa and the UK, with work currently focusing on Ethiopia, Kenya and Malawi.[5] The Consortium aims to encourage critical debate and policy dialogue on the future of agriculture in Africa. Through stakeholder-led policy dialogues on scenarios for agriculture, informed by field research, the Consortium aims to elaborate the practical and policy challenges of establishing and sustaining pro-poor agricultural growth in Africa. Current work focuses on three core themes:

- ***Policy processes:*** what political, organisational and budgetary processes promote or hinder pathways to pro-poor, agriculture-led growth? What role should different actors, including Ministries of Agriculture, have in this?
- ***Growth and social protection:*** what are the trade-offs and complementarities between growth and social protection objectives?
- ***Agricultural commercialisations:*** what types of commercialisation of agriculture both promote growth and reduce poverty? What institutional and market arrangements are required?

[5] For further information and news, see www.future-agricultures.org

The third theme is entitled commercialisation<u>s</u> (plural) to reflect the view that there are several possible types or pathways of commercialisation. Similarly, the plural in the Consortium's name (Future Agricultures) expresses a conviction that pro-poor agricultural development is complex and takes varied locally-specific forms.

As part of this overall programme of work, Future Agricultures (Ethiopia) co-organised a parallel session on *Commercialisation of Smallholder Agriculture* at the 2007 EEA Conference. This paper is one of four linked outputs from that session, the other three being:

- a thematic framework paper discussing the meanings and definitions of commercialisation from conceptual and international perspectives (Leavy and Poulton);
- a brief overview of the policy context and the available (alternative or complementary) pathways of agricultural commercialisation in Ethiopia (Sharp, Ludi and Samuel Gebreselassie); and
- an empirical paper on smallholder commercialisation in Ethiopia's tef-growing areas (Samuel Gebreselassie and Sharp), which closely parallels the present paper and draws on the same methodology and framework outlined below.

3.2 Objectives

The objectives of the study are

(i) to assess the scale of commercialisation in coffee (tef) growing areas and to detect household and farm characteristics which might explain variation in the levels of coffee commercialisation among households;

(ii) to investigate whether or not cash crop production might have, and under which circumstances, spillover effects on food crop production;

(iii) to investigate labour intensity and employment effects of coffee (tef) commercialisation;

(iv) to investigate whether or not increased coffee (tef) commercialisation can lead to increased overall farm productivity and to increase consumption (e.g. of food, cloths, education or health); and

(v) to draw policy implications and further research needs.

3.3. Conceptual framework: smallholder commercialisation in Ethiopia's coffee and tef areas

The study focuses on smallholder farmers producing coffee or tef, both important to the national economy, and both grown and marketed by smallholders for generations. Some contrasting and overlapping characteristics of these commodities are summarised in Table 1.

Table 1: Commodity choice - characteristics of coffee and tef

Coffee	Tef
Non-food	Food (high value)
High policy attention & intervention*	Limited policy attention & intervention*
Mainly small scale production, some large estates	Small-scale production
Productivity strategy:	Productivity strategy:
niche markets (speciality, organic), low chemical input	purchased fertilisers (and seeds)
Labour intensive with seasonal labour bottlenecks	
New institutions: Cooperatives and Unions	

*Research & Development, market support and control, etc.

Commercialisation of smallholder agriculture involves a transition from subsistence-oriented to increasingly market-oriented patterns of production and input use. Agricultural commercialisation is defined in terms of the degree of participation in the market. This can be measured either in terms of the total volume or proportion of output sold in markets, or the total volume or proportion of purchased inputs in total inputs utilised on the farm, or both. The vast majority of studies on smallholder commercialisation measure the level of commercialisation in terms of the proportion of output sold in markets. A value of zero would imply a totally subsistence-oriented households; the closer the index is to 100, the higher the degree of commercialisation[6] (for details see Leavy and Poulton, 2007).

[6] However, this index could be misleading: a farmer who grows only 1 bag of maize and sells that bag could be considered as more commercialised than the one who grows 50 bags of maize and sells 30 of them. Under ideal condition, the two measures (the total volume of crop sold and the proportion of crop sold) should be used together through development of a composite index.

Box 1: Household commercialisation and household coffee commercialisation indices

Household Commercialisation Index

HCI = $\dfrac{\text{gross value of all crop sales}}{\text{gross value of total crop production}} * 100$

Household Coffee Commercialisation Index

HCCI = $\dfrac{\text{gross value of coffee sales}}{\text{gross value of total crop production}} * 100$

3.4 Methodology

This paper is based on data collected in 2006 and early 2007. Quantitative data on production, consumption and marketing activities and resource ownership were collected from 160 farm households in four major coffee growing Weredas (Districts) in Oromia (Gomma and Gimbi Weredas) and Southern (Yirgachefe and Aleta Wondo Weredas) Regions. For the qualitative scoping study in early 2007, one Wereda was chosen purposively (primarily on grounds of logistics and accessibility, given severe limitations of time).

For the household survey, a stratified two-stage sampling design was employed within each Wereda. First, Kebele Associations (communities) found in the selected Weredas were listed and two associations were randomly selected. Then, in the second stage, twenty households were randomly selected from each Kebele for the interview. As the study aimed to look also at gender-related disparities on agricultural commercialisation, it was decided to include at least 25% female-headed households in the survey. The survey applied both a purposive and random sampling method. Using structured questionnaire, households were also interviewed about demographics, non-farm activities, asset holdings, and attitudes and perceptions about different issues related to the subject of the study. Interviewees and focus group members in the scoping study were identified through local contacts, based on purposive criteria provided by the researchers.

After preliminary analysis of the survey data, a qualitative scoping study was conducted in one surveyed coffee Wereda (Gomma), in February 2007. The purpose was to follow up some questions raised by the survey, and to identify important policy-relevant issues which had not yet been explored. The methods used were open-ended, semi-structured focus groups and individual interviews around the following themes:

- **Opinions and perceptions** – e.g. What do people consider the advantages and disadvantages of producing for the market, compared to producing for their own consumption?
- **Reasons for selecting specific strategies** – e.g. Why do some farmers sell more of their produce than others? What factors encourage or discourage increased market engagement (selling of outputs, buying of inputs)? What kind of people are succeeding in making a profit from farming? What kinds of support do farmers need from the government and other organisations, in order to increase their access to markets or to improve their terms of engagement with the market so that farming is more profitable for them? Do people *want* to sell more of their produce in the future? Why, or why not?
- **Employment effects** of different commercial crops – e.g. What kinds of people are employed on marketed crops? What type of work is done by local people, or by migrants? By men, women, or children? How much do they earn? What are the conditions of work? Are these considered good jobs, do people want to do them?
- **Changes over time** – e.g. What changes in farming and marketing conditions have people seen in their lifetimes? Has the market become more or less important for farmers than it was in the past? What hopes and expectations do they have for the future? Do they think farming in this area will become more market-oriented, and if so, what will the effects be?

Both descriptive and econometric methods were employed for the quantitative data analysis. Descriptive methods including measures of average and a one-way ANOVA were employed to disclose the scale of commercialisation of agriculture and to test the existence of any statistically verifiable difference among farmers operating at different levels of commercialisation. Results from the discrete one-way analysis were further examined through multivariate regression models which helped to predict the determinants of commercialisation and its impacts on the consumption and productivity of smallholders.

4. Survey Findings

4.1 Cropping pattern and crop mix

The average farm size in the study areas was about 1.2 hectare, of which on average 0.63 ha was under coffee. Survey data indicate that about three-quarters of the smallholders in the study areas planted coffee. Coffee is the dominant crop in the surveyed areas - no other crop occupies a similarly large area of the farm. About 38%

of coffee plots were intercropped with annual crops like maize, tef, wheat, peas, and vetch, and perennial food and cash crops such as Chat and *Enset*. When intercropped, coffee occupied only about one third of the plot. This result confirms earlier findings on the small sizes of coffee plots in Ethiopia. For instance, McMillan et al. (2003) found that 36% of coffee is grown on coffee plots less than 0.10 hectares, and another 59% is grown on plots between 0.10 and 1.00 hectares.

Next to coffee, *Enset* (false banana) and maize were grown by the majority of surveyed farmers. Other crops in the cropping pattern include spices, *Chat*, root crops, fruits and vegetables. Most of these non-coffee crops provide coffee growers with products that can be either consumed directly or marketed occasionally on local markets. *Enset,* which is planted by about half of the surveyed households, plays an important role in the livelihood strategies of coffee growers as it serve as an insurance crop, especially in times of coffee price declines or shortage of food grains in local markets, mainly because of its high productivity, resistance to drought and availability almost all year round.

Table 2: Cropping pattern among sampled coffee growing households (N=160)

Crop	Number of plots		Number of growers	% of growers	Average plot size under specific crop per grower (ha)
	Total	Per grower			
Coffee	346	2.8	123	77%	0.63
Enset	159	1.9	83	52%	0.40
Maize	275	3.5	78	49%	0.58
Fruits	171	3.2	54	34%	0.20
Chat	110	2.6	43	27%	0.34
Eucalyptus	57	2.8	20	13%	0.26
Vegetables	59	4.9	12	8%	0.40
N	160		160		

Despite a high degree of coffee commercialisation, crop diversification is an important livelihood strategy of farmers[7]. The average farmer cultivated four to six crops on a farm of about a hectare. Coffee, maize, *Enset* and different kinds of fruits were the most common crops in the cropping pattern. Diversified production reduces smallholders' vulnerability to market and production risks and provides them with the

[7] The high degree of household coffee commercialisation could obscure the widespread crop diversification that coexists in the farming system of the study areas. This is mainly due to our definition of agricultural commercialisation which, for the purpose of this study, is measured in terms of the value of output sold (but not in terms of the volume of marketed output or size of farm land planted by different cash and food crops).

opportunity to select a particular crop or crops in order to increase farm-generated income while improving household food security. Smallholders' simultaneous adoption of coffee commercialisation and crop diversification as household livelihood strategy could be a response to unreliable food markets, high transaction costs and risks associated with increased specialisation in coffee.

Despite apparently higher returns to land and labour from coffee production (see Table 4), farmers do not necessarily aim at higher degrees of coffee specialisation at the cost of a diversified cropping system. Results from a number of discussions held with farmers revealed that risks related to specialisation are considered to be too high. Coffee producers try to achieve as diversified an income portfolio as possible. It was pointed out that being highly specialised in coffee production (understood mainly in area terms, i.e. having all of the farm land under coffee) is mainly a result of insufficient land resources. Young farmers inheriting only a plot suitable for coffee cultivation are in a specifically vulnerable position and their high degree of specialisation is rarely by choice.

4.2 Coffee and agricultural commercialisation in coffee growing areas

Many factors have contributed to the commercialisation of smallholder agriculture. It started as farmers and village communities were incorporated into wider economic networks and political units, often in close relation with the development of infrastructure, expansion of long-distance trade and state formation and government intervention. Other factors including variation in ecological conditions which stimulated some degree of specialisation and favoured exchange, the external demand for foodstuff in urban and food deficit areas, migration of people, government policies and technological innovations which facilitated surplus production[8] have contributed to the commercialisation of agriculture (Hinderink and Sterkenburg, 1987).

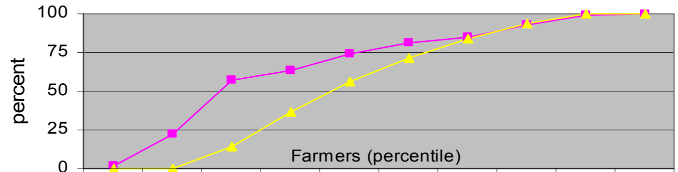
Households in the study areas are heavily dependent on coffee, both as a source of cash income and livelihood. Compared to the national average, they operate at a relatively high level of agricultural commercialisation. In value terms, the average farmer in the surveyed Weredas marketed about 84% of what he or she produced.[9]

[8] The Italian occupation of the country from 1936 to 1941 may also have played some role.
[9] Because the value of coffee is high compared to food crops produced by sampled households, the commercialisation index (measured in value terms) might be overestimated. In other words, if the

Ten percent of the sampled farmers operated at full commercial level, i.e. marketed 100% of their production. At the other end of the spectrum, about 4% of the surveyed farmers consumed all that they produced on the farm. Despite a high degree of commercialisation or market orientation, the value of marketed produce (per household) is small. Fifty-three percent of sampled households sold farm products worth 2,000 Birr or less, and the average household sold products worth only 586 Birr. Only 32% of farmers sold products worth 3,500 Birr or more.

Household coffee commercialisation was found to be high. The index of household coffee commercialisation, which is defined as the ratio of the value of coffee sold to the value of overall crop produced on the farm, ranged from zero (for 16 households or 10%) up to 100% (for 17 households or 10.6%) across the sampled households, with the mean value being 59%. There is a small variation in the degree of coffee commercialisation among surveyed Weredas (districts). In Gimbi and Gomma (both Oromia Region), the value of coffee sold comprised 66% and 63%, respectively, of the total value of output produced; whereas in Aleta Wondo and Yirgachefe (both Southern Region), the coffee commercialisation index is 53% and 56%, respectively.

Figure 1: Proportion of output sold and coffee contribution to total sale



	5	10	20	25	40	50	60	75	90	95
Proportion of output sold (%)	2	22	57	63	74	81	85	93	99	100
Coffee contribution to total sale (%)	0	0	14	37	56	71	84	94	100	100

Overall, coffee contributed 70% to the total value of output sold in the market by the average farmer. There is, however, a high inter-household difference in coffee's role as a cash earning crop. The top 25% of highly commercialised smallholders, for instance, generated over 95% of their cash income from coffee sales, while the 25% least commercialised households earned only 37% of their cash income from coffee and the remaining 63% from sales of non-coffee food crops like maize. The data

commercialisation was measured in terms of the output farmers supplied to markets, the figure could be closer to the national average.

suggest that some of the farmers are producing food crops to sell to their fellow farmers who are highly commercialised in coffee production.

A single-equation regression model specifying sales as a function of production (see Box 2) indicates a significant and positive association between production and amounts sold, both measured in value terms. The regression coefficient of 0.75 indicates that for a unit increase in the value of production, earnings from sales go up by 0.75. The high coefficient of determination (r^2=0.72) demonstrates that about 72% of the variation in sales can be explained by the volume of production.

Box 2: Sales - production relationship among sampled households

$Y_i = 1{,}710 + 0.75X_i$
$t = (2.20) \quad (19.23)^*$
$P = (0.03) \quad (0.00)$
$R^2 = 72.1$

Despite a high degree of commercialisation, farmers pointed out that diversification (of both crops grown and income sources) is an important livelihood strategy in view of reducing risks. This strategy is feasible because of a diverse agro-ecological environment, and necessary because of high risks resulting from unpredictable climatic, economic and socio-political events. Because coffee is a high-value crop compared to other food and non-food cash crops, it can generate a cash income that otherwise can not be achieved. This could be one explanation why, despite declining and highly fluctuating prices for coffee for the past decade, farmers in the survey areas did not uproot coffee trees. Nonetheless, coffee growers allocated a substantial portion of their land to low risk, but also low value food crops as a hedge against price risks related to coffee, despite some short-term financial loss.

4.3 Characteristics and comparison of highly and less commercially-oriented farmers

One issue for this study was to investigate the effect of farm-size on the level of commercialisation, or whether farm households with smaller farms commercialise disproportionately less than those with larger farms. Results from the bivariate statistical analysis indicate that the total farm size owned and cultivated by the surveyed farmers was not important to explain observed variation in household coffee commercialisation. More important was the proportion of land planted with coffee. This result highlights two points: (i) the homogeneity of farm sizes among surveyed households, which makes the probability of commercialisation among different farmers comparable, and (ii) the difficulty smallholders face to expand their coffee and non-coffee (notably food crop) production simultaneously.

Table 3 highlights the importance of demographic and household factors for the level of coffee commercialisation. The degree of coffee commercialisation was higher among households with smaller families, households headed by female and older managers. Households with a higher commercialisation level were smaller (average 5.1 members) compared to than those with a lower commercialisation level (average 5.8 members). About 12% of highly commercialised households were headed by female managers compared to 4% among the least commercialised. Similarly, the mean age of heads of households with a high coffee commercialisation level was 51, compared to 46 years of the head of a household with a low commercialisation level. However, none of these observed differences was statistically significant. That is, neither the demographic and household factors considered (gender, age, and family size) nor farm size had any significant effect on the observed variation in the degree of coffee commercialisation among sampled households.

Focus group discussions with young and elder male farmers and female farmers revealed that young farmers often only receive one plot with coffee trees from their fathers when they set up their own household. Female headed households obtained their land either during the land distribution during the Derg regime or after the death of their husbands. Women in the focus group discussion mentioned that they leased out crop land because of labour restrictions (women are not allowed to use oxen for ploughing), but kept land under coffee as they could more easily employ labourers during coffee harvest than for other field-work related tasks. The higher level of commercialisation among female-headed households and households with younger heads could thus be explained by their specific land ownership and labour availability situation.

Another key issue is whether household coffee commercialisation had any association with wealth-related variables. The bivariate statistics in Table 3 indicate that highly commercialised households are generally better off in terms of ownership of various non-farm assets (e.g. radio, type of house, non-farm assets), though these differences were not statistically significant. Similarly, household coffee commercialisation was not associated with gross per capita crop and non-farm income, though descriptive statistics indicate that per capita income among households operating at a higher level of commercialisation was high. Despite the high probability of reverse causality between smallholder's wealth and their engagement in potentially risky farming activities such as coffee production, the lack of statistically significant associations in the study areas could contradict evidence from elsewhere that commercialisation in non-food crops increases agricultural income. A multivariate regression model was carried out to verify some of these results from bivariate analysis, and this is discussed later in the paper.

Table 3: Household characteristics by degree of Coffee commercialisation

	Household coffee commercialisation (Coffee commercialisation = value of coffee sales divided by value of total crop production)				
	<20% (Low)	**21-60% (Medium)**	**61-80% (High)**	**≥80% (Very high)**	**F-test**
Total cultivated land (ha)	1.12	1.23	1.41	1.09	0.83
Proportion of land allocated to coffee (%)	34	50	54	57	2.77**
HH size (adult equivalent)	5.75	5.34	5.71	5.12	0.86
Age of household head	46	47	52	51	1.16
Sex of household head (% male)	96	92	87	88	0.62
HHs with radio/tape recorder (%)	4	8	20	19	1.61
Number of rooms in house	2.8	2.7	3.3	2.9	0.68
HHs with corrugated iron roof on house (%)	60	73	53	72	0.97
Non-land farm asset ownership (Birr)	688	766	761	1,745	1.38
Labour intensity (person-days/ha)	115	153	147	134	1.02
Share of hired labour (%)	14	16	12	11	0.13
HH commercialisation index (see Box 1)	74	70	91	98	11.58***
N	26 (20%)	26 (20%)	15 (11%)	64 (49%)	

*, ** and *** denotes statistical significance at 1, 5 and 10%, respectively.

Although the difference in ownership of non-land farm assets (mainly livestock and farm tools) among the four groups of farmers operating at different levels of coffee commercialisation is not statistically significant (see Table 3), the least commercialised coffee growers owned only 40% of what the highly commercialised coffee growers owned. This positive relationship between household coffee commercialisation and asset ownership could indicate a positive effect on smallholders' capacity to invest or own more assets. However, the cause-effect relationship could be either way. A high degree of commercialisation in coffee might generate sufficient cash income to allow coffee growers to invest some of this income in assets. An alternative explanation could be that because a high level of commercialisation bears significant market and price risks, coffee growers are forced to acquire assets which can be easily liquidated to finance subsistence needs in times of low coffee prices.

Even though agricultural commercialisation is expected to improve the level of farm employment in terms of labour intensity, this did not clearly emerge from our study. Compared to farm households operating at the highest or lowest level of coffee commercialisation, labour intensity was highest among households with a medium commercialisation level (see Table 3). The bivariate statistics indicate that farmers operating at a high level of coffee commercialisation demand 17% more labour (measured in person-days) per hectare of farm land than those operating at the lowest level of coffee commercialisation. This difference, however, is not statistically significant. Explanations for this could be that farm sizes in general and area under coffee in particular are so small that only limited extra-household labour is required even if the area under coffee is increased. The percentage of hired (non-household) labour used also appears higher in the medium and low commercialisation groups (see Table 3), although again the finding is not statistically significant. Results from the qualitative scoping study, however, raise some different aspects of the employment issue. Extra-household labour demand during peak seasons (e.g. harvesting, processing and selling red coffee cherry, and land preparation and harvesting of grain crops) was mentioned as a constraint to the further expansion of coffee production. A vibrant rural labour market exists in coffee growing areas, with seasonal workers from neighbouring areas migrating to coffee growing areas during peak labour times. Female household heads, however, mentioned that they face increasing difficulties in recruiting sufficient (migrant) labourers during peak times. One reason could also be that young local farmers prefer to work in coffee processing facilities (e.g. washing stations) or to migrate themselves to other areas in search of employment. Further research is needed to establish employment effects – positive and negative – of increased levels of commercialisation of coffee growing households.

Survey data indicate that participation in the credit market is high among the least commercialised households, but that they received on average small loans only. About 60% of the least commercialised farmers had taken loans averaging Birr 376, while only 30% of the highly commercialised households took loans averaging Birr 561 (Table 4). This difference suggests the positive role of a high degree of coffee commercialisation in reducing the need for borrowing (as shown in the lower percentage of households borrowing money), while enhancing the capacity to borrow larger sums.

Table 4: Productivity and loans among coffee growers operating at different levels of coffee commercialisation

	Household coffee commercialisation (Coffee commercialisation = value of coffee sales divided by value of total crop production)				
	<20% (Low)	21-60% (Medium)	61-80% (High)	≥80% (Very high)	F-test
Land productivity in coffee (kg/ha)	225	546	602	450	2.8**
Gross margin in the production of non-coffee crops (Birr/ha)	1,813	1,504	1,479	911	4.35***
Share of purchased food (%)[A)]	73	78	78	72	0.23
HHs taken loan (% yes)	60	54	47	31	2.71**
Average amount of money borrowed (Birr)	376	514	486	561	0.16
N	26 (20%)	26 (20%)	15 (11%)	64 (49%)	

*, ** and *** denotes statistical significance at 1, 5 and 10%, respectively.

[A)] As the survey was conducted towards the end of the cropping season, the reported expenditures on basic food (here expressed as a percentage of total consumption) for one week prior to the survey may overestimate the annual average.

4.4. The relation between commercialisation and productivity

The survey data show a positive and significant association between household coffee commercialisation and revenue per hectare of farm land under coffee. Households with a high degree of coffee commercialisation harvested twice as much coffee (in value terms) as those operating at the lowest level of commercialisation. The findings, however, do not indicate whether the high level of commercialisation is a result of higher coffee yields, or whether those farmers, who (for reasons unknown at the moment) harvested higher yields per unit area were better able to operate at a higher level of commercialisation than farmers achieving a lower coffee productivity[10]. Despite this difference in coffee productivity among different households, coffee yields were found to be generally low, on average about 471 kilograms per hectare. Low yields in combination with potential price risks can be assumed to encourage coffee growers to cultivate a wide array of non-coffee products to support their livelihoods.

[10] It is proposed to further investigate this finding especially with a view of identifying the factors behind this wide gap in coffee yields in the study areas, as this would enable the formulation of targeted support strategies, extension systems and policies for farmers to improve their coffee productivity.

In terms of land productivity of non-coffee crops, the reverse relationship was found. The least commercially-oriented producers achieved double the land productivity of households with a high level of coffee commercialisation (Birr 1,813 compared to Birr 911 per hectare). These results imply a lack of synergy between the production of coffee and other, largely subsistence food crops. Coffee growers' apparent inability to achieve higher crop productivity simultaneously in both crops (coffee and non-coffee) could imply the limitation of generating cash from coffee production that can be used productively in non-coffee crops and this may be attributed to shortage of farm land that could make optimal and profitable use of non-land resources on both crops difficult or impossible. The results could also indicate that farmers who are unable to achieve high coffee productivity (for reasons unknown at the moment) are forced to specialize (and invest more labour/capital) in non-coffee crops. Further research is needed in this complex and important area.

Although a high level of specialisation in either coffee or non-coffee crops is advantageous, relatively speaking, overall agricultural productivity could be enhanced if surveyed households specialised more in coffee production. In other words, further coffee commercialisation could improve agricultural productivity in the study areas. However, coffee growers opted for a high degree of diversification (on average 40% of farm land was planted with non-coffee crops). At the same time, despite declining and highly fluctuating prices for coffee for the past decade, farmers in the survey areas did not uproot coffee trees and kept on the average 60% of their land under coffee. This is consistent with evidence from previous studies (e.g. Tadesse Kuma, 2006) on the low probability of smallholders expanding their coffee acreage because of the high opportunity cost of land for the production of non-coffee crops.

4.5 Household income and income diversification

Household income is relatively high in coffee growing areas compared to the national average[11]. Household income in the study area averaged Birr 5,408 and varied between Birr 6,829 and Birr 4,048 among households operating at the high and low coffee commercialisation level, respectively. A higher level of coffee commercialisation was associated with higher overall per capita income and higher income from coffee production. Households in the lowest coffee commercialisation category received the lowest income (about 25% less than the average household,

[11] According to a recent study by the EEA the average household and per capita income for rural Ethiopia was Birr 3,303 and 540, respectively (EEA, 2006).

see Table 5) and this may be associated with the large proportion of low-value food crops in their crop mix.

Crop farming contributes 90% to the household income in the study areas, while the remaining income comes from livestock, remittances or aid, and agricultural and non-agricultural employment (see Table 5). Household income from non-agricultural employment was on average 7.4%, which is very low even compared to the national average. A recent publication from the World Bank (2007) indicates that about 24% of rural income in Ethiopia is generated from non-farm income sources[12]. Despite this low level of income diversification, the structure of household income is very similar among different households and was neutral to the level of coffee commercialisation.

Table 5: Household income and income sources

	Household coffee commercialisation				**Average**
	low <20%	**medium 21-60%**	**high 61-80%**	**Very high ≥80%**	
Total household income (Birr)	4,048	6,429	6,829	5,228	5,408
Per capita income (per adult equivalent) (Birr)	704	1,204	1,196	1,021	1,003
	Contribution of various income sources (%)				
Crop farming (coffee and non-coffee crops)	94.8	93.0	91.8	91.8	90.4
Coffee					70.0
Livestock*	-3.7	2.9	0.9	0.5	0.5
Remittances and aid	0.1	0.0	0.1	2.0	0.7
Agricultural employment -	3.0	0.6	0.0	1.6	1.0
Non-agricultural employment	5.8	3.5	7.2	4.1	7.4

* Income from livestock includes income from sale of livestock products, livestock and livestock renting minus any expense for purchase of livestock.

The average household income seems insufficient to satisfy the minimum consumption expenditure for food and basic non-food items. The average per capita income of about Birr 1,000 is close to the Birr 995 the Government of Ethiopia fixed a decade ago (in 1995/96) as the point of reference for rural poverty. Once again, the lowest per capita income was observed among the least commercially-oriented households, implying the importance of coffee in household income, at least in years

[12] According to the World Bank, this level of non-agricultural income is very low when compared to countries like Bangladesh (52%) or Ghana (43%), though close to Uganda (26%). The report recommends policy makers to increase this low rate through the creation of opportunities for non-farm activities.

when coffee prices remain stable or are high. However, despite their low level of income, the least commercially-oriented households could be better off in terms of coping with shocks, as they have a substantial income from (low-value) food crops and are thus able to minimize long-term vulnerability associated with the risks of fluctuating coffee prices and unreliable food markets.

5. Econometric evidence – Multivariate regression analysis

An econometric model was developed with the intention of identifying factors that lead some coffee growers to operate at a higher level of commercialisation than others. The household coffee commercialisation index measures the ratio of the value of coffee sold to the total value of crops produced on the farm. This index ranges from zero (for 10% of the cases) up to 100% (for another 10% of the cases), with a mean value of 59%. Ordinary least square estimation was used to identify factors affecting household coffee commercialisation. A two-stage OLS was used to determine the effects of coffee commercialisation on the land productivity of non-coffee crops and household food consumption. Households' coffee commercialisation was used as regressor variable for the regression models on productivity of non-coffee crops and household food consumption. As the decision to plant coffee or non-coffee crops (notably maize, which is grown by most coffee growers) is made in different growing seasons, the probability of having a close relationship between the two is limited, and hence, it is not necessary to use an instrumental or proxy variable. The three equations below represent the theoretical framework of the determinants of commercialisation and its impact on productivity of non-coffee crops and food consumption.

The **household coffee commercialisation index** function is

(1) $C_i = a_0 + a_1X_i + u_i$ (i=1, …..,140 households)

and the **productivity of non-coffee crops** function is:

(2) $Y_i = b_0 + b_1X_i + b_2C_i + v_i$

and the **food consumption** function is formulated as

(3) $Z_i = d_0 + d_1X_i + d_2C_i + w_i$

where C_i, Y_i and Z_i are the household coffee commercialisation index, the gross value of non-coffee output per hectare and the per capita food consumption (in value terms), respectively; X_i is a vector of exogenous household and location variables; u_i, v_i and w_i are residual terms. Definitions of the specific exogenous and endogenous variables and their expected signs are presented in Annex 1.

Household level synergies between coffee and non-coffee crops (or spillover effects of the former on the latter) are measured by the effect of the endogenous variable C_i on the productivity of non-coffee crops, Y_i. Similarly, regression estimate of C_i (from equation 3) will highlight the effect of household coffee commercialisation on household food consumption.

5.1 Econometric results

Determinants of coffee commercialisation (Model 1)

Household and demographic factors like age, sex and literacy of the household head and dependency ratio were not important to explain household-level differences in coffee commercialisation. This result is not unexpected as coffee cultivation is an intergenerational business where coffee farm and knowledge is transferred from parents to children, and decisions to change the crop mix (i.e. uprooting coffee trees and replace the area previously under coffee with annual crops) is not something which is easily and quickly done, as considerable investments would be sacrificed. On the other hand, investment decisions such as planting coffee trees, which have a long gestation period, can not easily and quickly be made to reflect changing household characteristics. Similarly, no causal association was found between the level of coffee commercialisation and most of the wealth-related factors, including non-land farm assets and quality of housing. This is an interesting finding, as it could be hypothesised that households which operate at a higher level of commercialisation would be in a better position to invest in assets.

By contrast, the proportion of land allocated to coffee is an important determinant of household-level coffee commercialisation (see Annex 2). Other factors held constant, as the proportion of land allocated to coffee is increased by one unit (one hectare), the coffee commercialisation index is predicted to increase by 53%. On the other hand, the total size of cultivated land is statistically insignificant. This may be due to the small size of farms and the egalitarian nature of its distribution among households. Other studies (e.g. von Braun, 1994) also confirm that farm size does not limit the level of commercialisation or market participation, especially in farming systems where export crops dominate.

Even though coffee is a relatively labour intensive crop, family labour size (expressed in adult labour equivalent) had a negative though only slightly significant effect on coffee commercialisation. The result could be explained by the fact that current farm sizes could be too small to provide full employment. Household labour supply could exceed annual on-farm labour requirements, and thus raise consumption more than production. This might then have a negative effect on the degree of coffee commercialisation. Important to consider here is the distinctive seasonal labour demand related to coffee production. Peak labour demand is observed during the harvesting season, which lasts for approximately 3 months. Ripe coffee cherries have to be picked immediately, and on most farms, family labour availability alone is insufficient to accomplish the task. Most farmers, except those with only a few coffee trees, reported in focus group discussions that they depend on hired labour during the harvesting season. The model presented above would thus need to be constructed in a different way to capture these seasonality effects.

Other factors that statistically affect household coffee commercialisation are market dependence for food, per capita expenditure on clothes and shoes (lagged variable), total value of output, participation in the credit market, degree of participation in the credit market, and land productivity in non-coffee crops. Regression results indicate that household coffee commercialisation is negatively associated with productivity in non-coffee crops. This finding substantiates the earlier result showing a positive association between the level of commercialisation in non-coffee crops and farmers' productivity in these crops; and by implication, the lack of complementarity in the production of coffee (cash) and non-coffee, predominantly food corps.

The analysis found that as the value of farm produce increases, so does the degree of coffee commercialisation. This is not surprising as coffee is a high value, largely marketed crop. The positive and significant impact of the value of farm outputs on the level of household coffee commercialisation implies that households with a high farm income rather followed a commercially-oriented strategy, while a more subsistence-oriented production strategy is rather practiced by households with a low income. One could also argue, however, that farmers with a low overall farm income are seriously constrained in pursuing a more commercially-oriented strategy and have thus no other choice than to largely produce for their own consumption. In order to determine the direction of this relationship, deeper analyses of available data and additional data collection, including qualitative investigation, will be necessary.

The econometric results also suggest that participation in credit markets may be associated with farmers' production orientation. Participation in the credit market, and the degree of participation in the market (measured in terms of the value of loans), had a significant statistical impact on the probability of commercialisation, with participation being negatively, and the extent of participation being positively related. Households participating in the credit market had a 10% lower probability of being commercially-oriented than farmers not participating in the credit market (controlling the effect of other factors). On the other hand, the capacity to borrow larger sums of money is found to be positively associated with a high degree of coffee commercialisation[13].

Determinants of productivity in non-coffee crops and food consumption (Model 2 & 3)

Like many developing countries, Ethiopia is pursuing a policy of supporting increased production of export or cash crops in parallel with expanding production of food crops mainly destined for domestic consumption. However, a simultaneous attainment of these goals is not easy, especially as trade-offs have to be expected. There are various arguments about how the two relate to each other and how the production and productivity of one might affect the other. The choice between domestic food crops, on the one hand, and cash crops (especially non-food cash crops predominately meant for exports) on the other hand, is a subject of considerable debate among agricultural economists as well as policymakers.

Most literature dealing with commercialisation of smallholder agriculture considers the effect of commercialisation on the welfare of small farmers and the potential synergies between cash and food crops (e.g. Govereh and Jayne, 1999, Hinderink and Sterkenburg, 1987, von Braun and Kennedy, 1994). Despite much well-documented evidence on agricultural commercialisation and the development of markets and trade that accompany commercialisation, smallholder commercialisation featuring high value non-food crops has frequently been criticised in African contexts as having a negative effect on food production and food security (Govereh and Jayne, 1999). Unreliable food markets and the risk of high food prices limit the degree of specialisation in non-food crops and give rise to the non-separability of smallholders' production and consumption decisions, which hinders agricultural commercialisation in the smallholder sector.

[13] However, there could be an endogeneity or two-way association between the level of coffee commercialisation (the dependent variable) and coffee growers' access to credit, as coffee usually serves as a collateral or guarantee for credit.

Nonetheless, studies from a range of African countries demonstrate potential synergies between investments in cash crops and food crop production (Strasberg et al, 1999, von Braun and Kennedy, 1994). Based on experience in 78 countries over the period of 1968 to 1982, von Braun and Kennedy (1994), for instance, found that growth in acreage under cash crops was positively associated with growth in staple food production. Many countries that achieved positive growth rates in basic food production also had positive growth rates in non-food cash crop production and vice versa (von Braun and Kennedy, 1994). However, these country-level findings do not necessarily reflect realities at household level. Country-level analysis can take account of the effect of area expansion under crops (in different parts of a country) and overall productivity growth, whereas household level analysis is strictly related to the complementarity or trade-off between cash and food crops at household and village levels, where possibilities for expansion of farm size are limited.

Despite recent Ethiopian Government policy encouraging the production of both export/cash and food crops, there is no study that ascertains the complementarity or trade-off between the two goals in a given farming community and how to strengthen the complementarity, if any exists. The present study tried to examine this in selected Ethiopian coffee growing areas. Specifically, the study tried to look at the effect of household coffee commercialisation on productivity of non-coffee crops and food consumption of farm households. Results from the regression model highlight the lack of complementarity between the level of coffee commercialisation and productivity in non-coffee (largely maize and *Enset*) crops at household level. On the contrary, the relationship is negative (significant at 10%). Each additional percentage increase in the coffee commercialisation index was associated with a decline in the value of non-coffee crop production (per hectare) of Birr 44 (or about 3% of mean productivity levels). Similarly, increasing the proportion of land allocated to coffee would lead to a decline in productivity of non-coffee crops. Econometric evidence suggests that as the proportion of land devoted to coffee production increases by one unit, productivity in non-coffee crops declines by Birr 137 per hectare, *ceteris paribus*.

Although the paper supports the assumption that cash cropping provides a direct stimulus to household income, it does not substantiate the further hypothesis that coffee production has an indirect positive effect on the productivity of other crops (by, for example, relaxing credit-related constraints on the purchase of fertilizers and other inputs). This could be attributed to two factors: first, it could be caused by the severe shortage of farm land which does not allow smallholders to grow both crop types in an economically feasible or optimal way. Second, as one major objective of growing non-coffee crops is to insure coffee growers against unexpected coffee price declines, economic factors alone are not sufficient to explain the integration of coffee and non-coffee crops by sampled households. In other words, their reasons for growing non-coffee crops are not influenced by the level of productivity of coffee, but by other aspects such as attitude towards risk and the need to smooth income levels over the year.

The findings from our study areas thus differ from findings from several other African countries where potential synergies between cash-crop investment and food crop production were identified. Studies from Mali and Senegal, for example, show that the presence of commercially viable cash crops such as cotton and groundnuts had positive spillover benefits for smallholder food production in selected regions[14]. These spillover benefits included increased adoption of fertilizer on food crops which was made possible via cash crop input delivery channels. Producers of cash crops are assured of a relatively secure financial income which improves their liquidity problems and hence enables them to overcome capital constraints to hire additional labour, purchase inputs during planting periods and invest in productive assets such as draft oxen and traction equipment (Goetz, 1993, Strasberg et al, 1999).

Farm and family sizes were found to have an insignificant effect on the productivity of non-coffee crops. However, the land-labour ratio (which measures the size of farm land relative to available labour) had a significant and positive effect on the productivity of non-coffee crops. Other factors held constant, households who own more land but have fewer labourers were more productive than those who own less land in relation to labour. This result reinforces earlier findings on the importance of farm land in the study areas as a major limiting factor to achieving higher productivity, production and market integration.

One of the key debates associated with the expansion of smallholder commercialisation of cash or export crops relates to its impact on food consumption and food security of smallholders. In this study an attempt was made to test the hypothesis that increased household coffee commercialisation could increase household demand for and consumption of food. Although the direction of the impact of household coffee commercialisation on household food consumption was positive as expected, the relationship was not significant (see Annex 2, last column). There is no evidence to support the argument that commercialisation has negative welfare effects among smallholders in the study weredas. However, the insignificant effect of

[14] The positive effects of commercialisation for household food security are greatest when incremental income and employment from commercialisation are concentrated among the malnourished poor (Von Braun and Kennedy, 1994).

household coffee commercialisation on food consumption does not correspond to evidence from elsewhere[15]. Based on a set of country-level comparative studies of commercialisation schemes led by IFPRI in the mid-1990s, von Braun and Kennedy (1994), for instance, claimed that commercialisation could be associated with improved nutritional status of farmers[16].

6. Conclusions and implications

The process of commercialisation involving non-food cash crops carries substantial risks for smallholder farmers, in relation to the market and prices of both cash crops and staple food crops. As witnessed recently in Ethiopia, the capacity of small coffee growers to withstand the adverse effect of a drastic decline in international coffee price is limited. Coffee price declines have an immediate effect on their livelihood through the shortage of cash income or savings to buy fertilizers (mainly used for food crops), clothes, medicines or food. Because of a lack of institutional arrangements to insure or minimise the high risk of price fluctuations and high costs and risks in the food marketing system, small coffee growers in the study areas usually follow a diversified production pattern. Even in the studied Weredas, where agro-ecological factors are highly favourable for the production of the best quality coffee, growers usually do not allocate more than 60% of their total land to coffee. This strategy of diversification might have supported and insured smallholder coffee growers during the recent unprecedented and long-term decline in the world market price for coffee. However, this benefit is not without its cost. Coffee growers forego income that might accrue to them if they shifted their crop mix more towards coffee, a comparatively high value crop.

In the study areas, coffee is the major source of cash income and employment that enables smallholders to meet their cash requirements. Coffee production also has a multiplier effect that could lead to increased demand for food and services in the local economy leading to higher levels of monetisation (of the local economy) and its integration into the wider economy.

[15] However, readers should keep in mind the difference of this household-level study from results emerged from country-level studies.

[16] Regression results indicate that household food consumption measured in terms of per capita food consumption was positively affected by farm size, per capita income and accumulated wealth of the household (measured in terms of the type of roof). Age of the household head and dependency ratio had a negative impact on household food consumption (see Annex 2). .

This paper investigated the scale of agricultural commercialisation in selected major coffee growing areas, the effect of the level of smallholders' coffee commercialisation on the productivity of non-coffee crops and food consumption of household members. The emerging picture indicates the benefits of attempting to address the risks and market failure aspects necessary to make increased coffee commercialisation a viable pathway for agricultural development in coffee growing areas of Ethiopia. The following policy implications are derived from the findings discussed above.

Policy implications

(i) Minimising the trade-offs in the production of coffee and non-coffee crops, especially in the short- to medium-term. To improve the complementarity of coffee and other crops, the productivity of food crops needs to be increased first; secondly, risks associated with specialisation in coffee and reliance on markets for purchasing food need to be minimised. That makes interventions in food markets necessary, leading to improved reliability and reduced price fluctuations. It may also need interventions in the coffee market towards reducing price fluctuations and increasing coffee prices, and developing institutional mechanisms enabling smallholder coffee producers to insure against price and market risks in the coffee market.

(ii) In the longer run and once food markets are better developed, stronger policy attention is needed towards promoting specialisation in coffee and increasing its productivity, which is currently very low in comparison to international levels. Improved productivity is expected to lead to higher levels of specialisation in suitable coffee growing areas.

(iii) Support towards developing the non-farm sector should be strengthened, as there is structural under-employment in coffee growing areas and substantial employment generation via increased coffee commercialisation cannot be expected.

Implications for further research

In general, the data presented in this paper indicate the benefits of further smallholder commercialisation in coffee growing areas and thus provide support for the current government policy aiming at increased smallholder commercialisation and support of the agricultural export sector. However, they also show the existence of major limits to further commercialisation at household levels or specialisation in coffee production in the selected Weredas. One hypothesis is that limitations to further commercialisation are linked to the structure of the food crop market. Findings from the qualitative field work support this hypothesis, as farmers repeatedly pointed out that risks related to high levels of commercialisation and specialisation are too high to abandon a diversified farming system. Not enough, however, is known about the relationship between markets for food and cash crops and how they influence the investment decisions of smallholder farmers in coffee growing areas.

It also became apparent that findings with regard to labour intensity and employment effects of coffee commercialisation from the qualitative and the quantitative field work are somewhat contradictory. More research into (a) effects of commercialisation on employment and (b) potential limitations to further commercialisation because of labour availability seems appropriate.

References

Befekadu Degefe and Berhanu Nega (eds), (2003). The Role of Urbanization in the Socio-Economic Development Process. Ethiopian Economic Association, Addis Abeba.

Cour, Jean-Marie (2003). A Demo/economic Analysis of Long-term Structural Changes in Ethiopia: In Berhanu Nega and Befekadu Degefe (2003): The Role of Urbanization in the Socio-Economic Development Process. EEA/Ethiopian Economic Policy Research Institute, Addis Abeba, Ethiopia.

Demese Chanyalew (2006). Policies for Commercial Transformation of Ethiopian Agriculture. In Edilegnaw Wale, Demissie G/Michel, Bezabih Emana and Tassew W/hanna (eds): Commercialisation of Ethiopian Agriculture. Proceedings of the 8th Annual Conference of the Agricultural Economics Society of Ethiopia. Agricultural Economics Society of Ethiopia, Addis Abeba.

Dessalegn Rahmato (2005). From Heterogenity to Homogeniety: Agrarian Class Structure in Ethiopia since the 1950s. Paper presented at conference on ‘Land and the challenge of sustainable development: a public dialog’, co-hosted by Forum of for Social Studies (FSS), the Ethiopian Economic Association (EEA) and the Agricultural Economics Society of Ethiopia (AESE), held on August 5, 2005, Hilton Hotel Addis Ababa.

EEA (2006). Evaluation of the Ethiopian Agricultural Extension with Particular Emphasis on the Participatory Demonstration and Training Extension System (PADETES), Addis Abeba.

Goetz, S. J. (1993). Interlinked Markets and the Cash Crop Debate in Land-abundant Tropical Agriculture. Economic Development and Cultural Change 41, 343-361.

Govereh, J., T.S. Jayne and James Nyoro (1999). Smallholder Commercialisation, Interlinked Markets and Food Crop Productivity: Cross-Country Evidence in Eastern and Southern Africa. Department of Agricultural Economics and the Department of Economics, Michigan State University.

Govereh J. and T.S. Jayne (1999). Effects of Cash Crop Production on Food Crop Productivity in Zimbabwe: Synergies or Trade-offs? Department of Agricultural Economics and the Department of Economics, Michigan State University.

Hinderink, J. and J. J. Sterkenburg (1987). Agricultural Commercialisation and Government Policy in Africa. Monographs from the African Studies Center, Leiden.

Leavy, J. and C. Poulton (2007). Commercialisations in Agriculture: A Typology. Paper presented at the 5th International Conference on the Ethiopian Economy. Addis Abeba, June 2007.

McMillan, M., Assefa Tigneh, Yohannes Agnofir, Kibre Moges and Amdissa Teshome (2003). ETHIOPIA: Trade and Transformation Challenges. Agriculture and Trade Diagnostic Trade Integration Study. Annex 8, Volume 2, Addis Abeba, Ethiopia.

MoFED (2006) A plan for Accelerated and Sustained Development to End Poverty (PASDEP) (2005/06-2009/10). Volume I: Main Text. Addis Ababa. Ministry of Finance and Economic Development.

NBE (2006). Quarterly Bulletin, Vol. 21, No.2. Addis Abeba, Ethiopia.

Oxfam (2002). Crises in the Birthplace of Coffee. Oxfam International Research Paper. September 2002.

Samuel Gebreselassie (2006). Intensification of Smallholder Agriculture in Ethiopia: Options and Scenarios. Paper Prepared for the Future Agricultures Consortium Meeting at IDS, Brighton, 20-22 March 2006.

Strasberg, P.J., T.S. Jayne, T. Yamano, J. Nyoro, D. Karanja and J. Strauss (1999). Effects of Agricultural Commercialisation on Food Crop Input Use and Productivity in Kenya. MSU International Development Working Paper No. 71. Department of Economics, Michgan State University.

Tadesse Kuma (2006). Coffee Marketing Chain and Producers Price in Ethiopia. Paper Presented at the 9th Annual Conference of Agricultural Economic Society of Ethiopia, April 2006, Addis Abeba, Ethiopia.

von Braun J. (1994). Production, Employment, and Income Effects of Commercialisation of Agriculture. In: Joachim von Braun and Eileen Kennedy (eds) (1994). Agricultural Commercialisation, Economic Development and Nutrition. The Johns Hopkins University Press, London.

World Bank (2007). Ethiopia: Accelerating Equitable Growth. Country Economic Memorandum. Part I, Report No. 38662-ET. Poverty Reduction and Economic Management Unit, Africa Region. April, 2007.

Annex 1: Description of variables included in the econometric models and expected relationship

Independent variables	Dependent variables		
	Model 1:	Model 2:	Model 3:
	Coffee commercialisation	Productivity in non coffee crops	Per capita food consumption
	Anticipated sign		
Household resources			
Total farm size (ha)	+	+	+
Family labour size (man-equivalent)	+	+	--
Characteristics of household head and household			
Age (years)	+	+	?
Sex (dummy, 1= if head is male, otherwise = 0)	-	-	?
Literacy (dummy, 1= if head is able to read & write, otherwise 0)	?	?	?
Household dependency ratio (ratio of children/old persons to working age persons)	-	-	-
Household asset ownership or wealth			
Non-land farm asset ownership (Birr)	+	+	+
Number of living rooms	+	+	+
Type of roof (dummy, 1=corrugated iron sheet, 0=otherwise)	+	+	+
Household income and expenditure			
Per capita farm income (gross farm income)	+	NA	NA
Per capita non-farm income	NA	+	+
Total output produced	+	+	--
Share of agriculture in total household income (proxy for non-farm activities or specialisation in agriculture)	?	+	+
Variable expenses per hectare of land	+	+	--
Per capita expenditure for clothes and shoes (lagged variable)	+	--	--
Per capita food consumption	+	--	--
Others			
Household coffee commercialisation index	NA	+	+
Market dependence for food (Proportion of purchased food seven days prior to the survey)	?	?	?
Land productivity in coffee	+	?	?
Land productivity in non-coffee crops	NA	NA	?
Participation in credit market - hhs taken credit for consumption (dummy)	?	?	?
Degree of participation in credit market (measured in terms of the amount of cash borrowed for consumption)	?	?	?
Specialisation in coffee (% of land allocated to coffee)	+	NA	?
Specialisation in non-coffee production (% of land	NA	+	NA
allocated to non-coffee crops)	+	+	NA
Labour intensity (person-days/ha)			

NA=Non-applicable

Annex 2: Econometric Model Results on determinants of coffee commercialisation, productivity of non-coffee crops and food consumption

	Model 1 Determinants of coffee commercialisation		Model 2 Determinants of productivity in non-coffee crops		Model 3 Determinants of food consumption	
	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat
Dependent variable Independent variables	Value of coffee sales / total value of crops produced (%)		Value of non-coffee crop production / ha		Per capita food consumption (Birr / adult equivalent)	
Farm size (ha)	0.701	2.97	-1235.9	1.13	240.34	2.61***
Family labour size (ME)	-0.025	1.00*	790.4	1.19	--	--
Family size (AE)	--	--	--	--	-185.94	3.31
Land-labour ratio	--	--	995.4	2.26**	--	--
HH coffee commercialisation index	--	--	-44.16	1.68*	1.68	0.94
Age of family head (years)	0.221	0.85	298.49	5.08***	-10.78	1.99**
Sex of family head (dummy)	0.422	0.58	-226.72	0.71	-116.52	0.50
Literacy of family head (dummy)	0.056	0.66	467.13	2.26**	178.32	1.26
Labour intensity (person-days/ha)	-0.01	0.49	2.59	0.53	--	--
Use of purchased inputs (Birr/ha)	-0.013	1.33	3.46	1.07	--	--
Non-land farm asset ownership (Birr)	0.364	0.35	9.05	0.28	--	--
Number of living rooms	0.407	0.53	--	--	124.12	2.39**
Type of roof	0.194	0.22	--	--	144.13	1.03
Market dependence for food	-0.19	1.77*	-7.75	0.33	--	--
Proportion of land allocated to coffee	0.533	3.66***	--	--	--	--
Proportion of land allocated to non-coffee crops	--	--	-137.46	3.66***	--	--
Lagged per capita expenditure on cloth and shoe	0.055	1.77	--	--	--	--
Dependency ratio	-0.07	0.17	--	--	-415.85	2.18**
Total value of output	0.00	1.81*	0.01	0.56	--	--
Participation in credit market (dummy)	-0.108	1.65*	--	--	--	--
Extent of participation in credit market	0.182	0.98*	--	--	--	--
Land productivity in coffee crops	--	--	--	--	0.00	0.55
Land productivity in non-coffee crops	-0.001	3.03***	--	--	0.00	1.58
Per capita income	--	--	--	--	0.11	2.67**
Share of agriculture in total income	--	--	--	--	-0.65	0.29
Constant	6.67	0.16	-2457.72	0.30	1527.46	2.07**
Adj. R-square	38%		36%		45%	
N	98		99		81	

*, **, and *** denotes statistical significance at 10%, 5% and 1% level, respectively

COMMERCIALISATIONS IN AGRICULTURE

Jennifer Leavy[1] and Colin Poulton[2]

1. Introduction

Accelerated growth in agriculture is seen by many as being critical if the MDGs are to be met in Africa. Although there are debates about the future viability of small farms (Hazell et.al. 2007), the official policies of many national governments and international development agencies accord a central role to the intensification and commercialisation of smallholder agriculture as a means of achieving poverty reduction. According to this thinking, smallholder agriculture is uniquely positioned to deliver broad-based growth in rural areas (where the vast majority of the world's poor still live). However, others fear that strategies for commercialising agriculture will not bring benefits to the majority of rural households, either directly or (in the view of some) at all. Instead, they fear that efforts to promote a more commercial agriculture will benefit primarily large-scale farms. At best, the top minority of smallholders will be able to benefit.

In this paper, therefore, we discuss what is meant by the commercialisation of agriculture, emphasising the different pathways that commercialisation can take. We also examine what needs to be done if agricultural commercialisation is to be inclusive, bringing benefits to a large proportion of rural households.

The potential benefits of commercialisation and engaging in trade are well documented. These include stimulating rural growth, which poor people can gain from directly, for example through: improving employment opportunities (depending on the labour intensity of crops grown); increasing agricultural labour productivity; direct income benefits for employees and employers; expanding food supply and potentially improving nutritional status. So-called multiplier effects encompass increased demand for food and services in the local area (von Braun and Kennedy, 1994).[3]

[1] Institute of Development Studies, Brighton
[2] School of Oriental and African Studies (SOAS), University of London
[3] For work on multipliers and growth linkages see Delgado et al (1998)

But what does commercialisation mean? What does it mean to be commercialised? What kinds of commercialisation are good for the poor? Conversely, under what circumstances are poor people likely to be bypassed in favour of larger farmers and unable to take advantage of new opportunities? Governments have clear ideas of what they would like to achieve in creating and supporting a thriving agricultural sector, not least in the name of enabling agriculture-based economic growth. But do these programmes have the right focus in terms of poverty reduction? What informs them and what are the implications? Are appropriate mechanisms in place for effective implementation, including the right enabling environment and adequate and timely service delivery? What are the policy processes behind a successful pro-smallholder commercialisation policy?

This paper aims to engage in alternative perspectives of agricultural commercialisation to shift thinking and ways of framing the debates, arguing for a diverse range of commercialisations, locally specific trajectories, and differentiated engagement with domestic and export markets. The overarching question here is how to translate pro-smallholder commercialisations policy into practice. Growth-poverty reduction linkages for smallholder farmers through commercialised agriculture do not lie along just one or two channels, and indirect (or multiplier) effects are also key, especially those through labour markets.[4] Focusing on crops, the paper attempts to get away from the idea that there is one, ideal commercial agriculture, following a linear path to some clearly defined end point.[5] Hence the plural: commercialisation***s***. This also allows for concepts of commercial agriculture that go beyond simple distinctions often made, such as those between 'food' and 'cash' crops.

Drawing on existing literature, the paper sets out a framework for describing the different kinds of commercialisation that co-exist. It attempts also to give a sense of what might be emerging in relation to this framework, in terms of diverse forms of commercialisation that respond to distinct livelihood needs and local contexts. This allows a time dimension, in terms of dynamics and future scenarios, and moves away

[4] See also: Pretty et al (1996) on sustainable agriculture's links to food security and strengthening rural economies; Swaminathan (1995); IDS work on labour exchange in Northern Province, Zambia (White et. al., 2005). The Commission for Africa report (2005) also cites family farms as the primary source of jobs in Africa, commercialisation of family-farms has important multiplier and employment creation effects going beyond the farm itself. For example, increasing employment in formal and informal trade can have far-reaching poverty reduction effects, giving the example of Benin where poor rural women make up 90 percent of informal traders.

[5] Livestock, aquaculture and other forms of agriculture are not within the scope of this paper, although the arguments presented here is equally valid for these and other sub-sectors.

from any presumption of a singular type of transition to a particular type of 'commercial' agriculture. This framework can be used to pose questions for empirical studies and to examine potential implications of different policy options, in terms of implementation as well as outcomes.

2. What are Commercialisations?

Policy discourses around agricultural commercialisations tend to separate producers into different types of farm (small farms, large farms) growing different types of crops (food crops, cash crops) with simple distinctions made between 'subsistence' and 'commercial' or 'export' agriculture. Lack of clarity about what commercialisation actually means may give rise to misconceptions, evoking certain fears that can obstruct the passage of policy into practice. Work by the Future Agricultures Consortium in Ethiopia has identified fears that commercialisation means, amongst other things[6]:

- A focus on non-food crops
- Squeezing out the smallholder farmer
- Expropriation of land, displacement
- Dispossession of peasants
- Increased food insecurity
- Capitalism
- Mechanisation, modernisation
- Capital intensity, rather than labour intensity

In other words, there is a fear that commercialisation essentially means promoting change that is in the interests of larger, more powerful players to the detriment of smallholder farmers.

a. *Defining Commercialisation*

i. Production for Market

Writing on commercialisation highlights a number of aspects to what it means to be commercialised. However, the lynchpin of most, if not all, definitions of agricultural commercialisation is the *degree of participation in the (output) market*, with the focus very much on cash incomes[7]. One dictionary definition gives a spatial dimension,

[6] See Sharp K, E Ludi and S Gabreselassie (2007).
[7] For example, Pingali (1997), von Braun (1995), among others.

describing commercial agriculture as "the growing of crops for sale outside the community" (Encyclopaedia, Colombia University Press). The first question is whether a farm or household sells any of its crop output. After this, some studies consider the degree of commercialisation in terms of amount of crops sales (volume, income). Thus, for example, Integrated Rural Development Program (IDRP) studies in Northern Province, Zambia define commercialised farmers as those who sell more than 30 bags of maize per annum (Sugiyama, 1987; Kakeya and Sugiyama, 1987). However, a better approach is to consider the percentage of crop production marketed by a farm or household. Thus, Strasberg et al (1999) suggest the following simple household crop commercialisation index (CCI):

CCI=(gross value of all crop sales/gross value of all crop production)x100.

Whilst there are computational difficulties, we note that there is no reason in principle why this should not be extended to include livestock (on both the numerator and denominator). However, we do not pursue this idea further here.

A value of zero for the CCI signifies total subsistence, whilst a CCI value approaching 100 indicates higher degrees of commercialisation i.e. a greater percentage of crop production marketed. A big advantage of this approach is that commercialisation is treated as a continuum, thereby avoiding crude distinctions between "commercialised" and "non-commercialised" farms.

This simple index is open to criticism. One possible criticism is that it makes no meaningful distinction between a farmer who produces just one bag of maize and sells that one bag, and one growing fifty bags of maize who sells thirty of them. On the basis of the CCI, the first farmer, with a CCI of 100, would appear to be more commercialised than the second, who has a CCI of 60. There is some validity to this criticism, as this caricatured example shows. However, for reasons that will become clearer below, in practice there are few tiny farms that sell all of their output (at least, at lower levels of economic development) and similarly few large farms that do not sell most of theirs.

A related criticism concerns "distress" sales, i.e. crop sales by poor households straight after harvest because they are desperate for cash. Where it is food that is being sold, the household may then be forced to buy back the same (or indeed a greater) quantity of food later in the year when the price is much higher. In this case, the crop sale raises the CCI, but is in no way indicative of increasing household welfare. Survey evidence suggests that 10-15% of southern and eastern African rural households are *both* net food deficit (over the course of a typical year) *and* nevertheless sell a proportion of their food output soon after harvest (Jayne et.al. 2006, Poulton et.al. 2006). This shows that there is some substance to this criticism and that interpretation of any empirical results based on the CCI needs to take the phenomenon of “distress” sales into account.

What the CCI does very effectively is to bring subsistence food production to the centre of discussions about commercialisation. CCI falls below 100 to the extent that households devote their land, labour and capital resources to the production of food for own consumption, rather than to the production of crops (food or otherwise) for sale to the market. We discuss the reasons for the persistence of subsistence food production in more detail later in the paper. Even at this early stage, however, it is worth making the point that strategies for agricultural commercialisation should start by seeking to understand why households produce food for own consumption and then to create the conditions that will help them over time to devote less of their resources to this activity.

ii. Additional Dimensions to Agricultural Commercialisation

Whilst the degree of participation in the output market lies at the heart of most definitions of agricultural commercialisation, some literature does address other dimensions of commercialisation (see, for example, the discussion in von Braun and Kennedy 1994). Here we briefly note three additional dimensions.

First, there is the degree of participation in input markets. As farms become more commercial, they tend to rely less on own-produced inputs (e.g. manure, retained seed) and services from mixed farming systems (e.g. animal traction) and instead depend more on markets to supply their inputs (improved seed, inorganic fertiliser, crop protection chemicals) and services (mechanised equipment for ploughing, planting, weeding, harvesting etc – either hired/rented or purchased). Thus, on the input side we might define commercialisation as:

ICI = value of inputs acquired from market/ agricultural production value

As is well illustrated by Pingali (1997), commercialisation on the input side is likely to proceed in tandem with the degree of participation in output markets. We, therefore, do not consider this dimension further in this paper.

Second, it is observed that, as farms become more commercialised, they rely increasingly on hired labour, with family labour focusing more on supervisory and managerial tasks. This may be linked to the opening up of other opportunities for the family's labour elsewhere in the economy. As farm production becomes increasingly business-oriented, rather than a matter of survival, some family members may choose to work in other occupations, with the remaining members hiring in workers to accomplish the necessary tasks. Alternatively, where commercialisation is associated with farm consolidation (see below), additional hired labour may be required to cope with an expanding cultivated area. Note, however, that where farm consolidation is driven by rising real wages elsewhere in the economy, this will also encourage mechanisation (Pingali 1997), such that the increase in total labour input into the farm is limited.

An interesting case of reliance on hired labour at an early stage of agricultural development is provided by the top smallholder producers of cotton in Tanzania and Zimbabwe. These devote half to two-thirds of their land to cotton production and typically rely heavily on hired labour for most tasks related to cotton cultivation. Family labour thus has primarily a managerial role in cotton. However, family labour represents the dominant labour input into the household food production activities, which occupies most of the remaining land on the farm. In this case, the total area of land cultivated is too great for the household alone to supply labour. At the same time, attractive off-farm opportunities for family labour are limited, so family labour is still supplied on the farm. The distribution of this labour between crops reflects intra-household decision making and division of labour arrangements, but also again highlights the significance of subsistence food production within agricultural commercialisation processes.

So far we have considered labour hire as an indicator of commercialisation. However, another strand in the literature sees the form of labour used (family vs hired) as an important determinant of comparative advantage in crop production. We return to this in section 4.

Third, some writing on commercialisation highlights the importance attached to the profit motive within the farm business as an indicator of commercialisation. Thus, Pingali and Rosegrant (1995: 171) state that:

"Agricultural commercialization means more than the marketing of agricultural output, it means the product choice and input use decisions are based on the principles of profit maximisation. Commercial reorientation of agriculture occurs for the primary staple cereals as well as for the so-called high value cash crops. On the input side, commercialization implies that both traded and non-traded inputs are valued in terms of their market value"

This is a useful nuance within discussions on commercialisation. As will be discussed below, risk minimisation, rather than profit maximisation, is an important driver of subsistence production. The phenomenon of "distress" sales, discussed above, provides a good example of sale of crops that is not driven by a profit motive, but rather a short-term survival need. Decisions to supply labour off-farm can also have both "push" and "pull" motivations (see below).

iii. Broader (Household-Level) Concepts of Commercialisation

Looking beyond purely the agricultural activities of a household, von Braun and Kennedy (1994) propose a measure of integration into the cash economy, which they define as:

ICE = value of goods and services acquired through cash transactions/ total income

Alternatively, we might consider a household commercialisation index, where:

HCI = gross income from all market sources / total income

A livelihoods perspective reminds us that, even in rural Africa, many households obtain half or more of their income from non-farm sources (Reardon 1997, Ellis 2000)[8]. For policy makers, an important note of caution is that seeking to increase the market orientation of the agricultural production of households whose comparative advantage lies in non-farm employment may be a fruitless task.

Broadly speaking, the non-farm income of rural households may be derived from casual labour hire, wage employment, private business activity (self-employment) or remittances. There may be complementarities between such activities and agricultural production, for example where non-farm activities are conducted mainly in the dry season or where small land holdings are insufficient to absorb all of the household's labour, but they may also compete (Reardon 1997). Can pursuit of these activities be considered as commercialisation? This question takes us beyond the

[8] We are interested here in all activities other than agricultural production undertaken by the household on its own account. These include both casual labour hire on the farms of others ("off-farm", but not "non-farm") and small business activity such as processing or handicraft making ("non-farm") that is conducted on the household's own property.

scope of the current paper. However, we offer the following brief observations before returning to our main theme of *agricultural* commercialisation.

First, there are important ongoing debates as to whether rising off-farm income shares in rural Africa reflect pull (opportunity) or push (survival) factors (see, for example, Bryceson 1999, Ellis 2000, Dorward 2003). Whilst, for some households, dependence on non-farm employment may be as much about survival as about comparative advantage, there are other households (e.g. those with above-average educational attainment, but limited land holding) for whom non-farm employment makes more sense as an income maximising strategy than producing agricultural products for market.

Second, we note that hiring out labour onto other farms rarely accounts more than a small fraction of total off-farm income in a community or area (Reardon 1997, Otsuka and Yamano 2006). This is generally low return work. However, there can be exceptions. Maertens and Swinnen (2007) show that employment on large-scale export horticulture enterprises represents a "pull" opportunity for many rural households in the relevant part of Senegal. In the 1990s smallholder export horticulture developed in Senegal. However, in the latter part of that decade, the inclusion of smallholders within the supply chain was increasingly challenged by the private grades and standards introduced by importers in the major European markets. The industry reoriented itself towards estate production, while retaining a minority of its original smallholder outgrowers (the top producers). It has subsequently grown to the point where the total number of people employed by the industry (estate workers plus remaining outgrowers) far exceeds the total number of outgrowers contracted prior to the reorganisation. Maertens and Swinnen (2007)'s analysis of household survey data divides the population of the export horticulture production zone into three categories: those who have remained as outgrowers, households with one or more member employed on the new export horticulture estates[9] and households with no direct connection to the industry. It shows that those who have remained as outgrowers are the best off. However, households with one or more member employed on the horticulture estates are significantly better off than households with no direct connection to the industry. Moreover, many of the households with one or more member employed on the horticulture estates would not qualify as outgrowers. Whilst they have similar education levels to outgrowers, they have less land and

[9] In the light of discussions elsewhere in this paper, it is, however, worth noting that, whilst estate farm workers derive more than one third of their income from agricultural wages, own-farm agriculture is the main source of income in the area. On average across the sample, two thirds of household income is derived from own farming.

fewer non-land assets. Because of the relatively inclusive nature of estate employment[10], Maertens and Swinnen (2007)'s simulations indicate that poverty levels in the area are lower under current arrangements that they would have been even had the contract farming form of organisation been able to continue.

When we consider the competitive strengths and weaknesses of different modes of agricultural organisation in section 4, we might note the following lesson from the Senegal horticulture example. The direct poverty reduction potential from a particular example of "commercial" agriculture is a function of the rate at which the enterprise can grow, its labour intensity (and the type of labour employed) and the returns to labour achieved. In general, although labour intensity varies considerably by crop (with horticulture amongst the most intensive labour users), smallholder agriculture uses labour more intensively than large-scale estates. However, in the Senegal example, the competitive advantages of the estate mode of organisation outweighed the labour intensity advantage of smallholder production, enabling more poor households to obtain higher returns through wage employment on estates than they could through own production.

Even this, though, may only be part of the story – an essentially static comparison. Work on ethical trade and working conditions on commercial farms (see Smith et al, 2004; Tallontire et al, 2005; among others) emphasises *quality* of employment. It calls for a more sophisticated approach to poverty that recognises that enabling smallholders to stay and work in their communities could be more poverty reducing than supporting large scale commercial farms in a fiercely competitive global market place (characterised by downward pressures on prices and increased concentration in markets over time) that offers only low paid, insecure work. Returning to the central theme of this paper, a key issue, of course, is whether smallholder households are forced off their land to make way for expanding estate production or whether sufficient land is available for them to co-exist with estate producers, hiring out some of their labour at the same time as pursuing their own (food and other) production activities.

Third, available evidence suggests that, in Africa, access to non-farm income is unequally distributed, with better-off households acquiring a higher share of their income from non-farm sources than poorer households (Reardon 1997). In absolute terms, the differences are even greater. The diversity of returns from different non-

[10] Migrant families are, however, under-represented as estate employees.

farm activities indicates the presence of barriers to entry into some activities, with education and access to capital the two most commonly cited ones.

Our discussion about employment on commercial farms notwithstanding, the evidence from reviews such as Reardon (1997) and Otsuka and Yamano (2006) is that it is ultimately growth in non-farm activities within an economy that drives major falls in poverty. At first sight, this appears to call into question the importance of agricultural intensification and commercialisation to growth processes in Africa. However, this is a premature conclusion. There is some debate as to whether, in a predominantly rural economy, agricultural commercialisation is required to create the initial conditions for growth in manufacturing and service sectors. Haggblade et.al. (2007) argue that the causality can vary by specific case and context. However, even where growth in manufacturing and service sectors responds primarily to external (non-agricultural) demand, Otsuka and Yamano 2006 argue that agricultural intensification may be necessary to permit households to invest in the education necessary to obtain the available employment opportunities. Consistent with the emphasis in this report on food access as a constraint to commercialisation, they note that food insecurity may also discourage investment in non-farm activities: "… according to the long-term panel studies in Asia, increased agricultural income, mostly generated from the Green Revolution, was a major source of funds to invest in children's schooling in the early years, which later led to the choice of lucrative non-farm occupations by children. The last finding raises questions about the sources of investment in children's schooling in Sub-Saharan Africa. In practice, many African farm households lack the financial resources to send their children beyond primary school. The Asian experience strongly suggests that it is the Green Revolution that must be realized to initiate the structural changes towards increasing investment in human capital and greater participation in non-farm activities in Sub-Saharan Africa. Indeed, without increasing crop income and improving food security in Sub-Saharan Africa, farmers will not be able to afford to send their children to schools *and allocate more time to non-farm activities*." (2006, p30, emphasis added)

a. Processes of Commercialisation

For food production systems, Pingali and Rosegrant (1995) describe farmers' level of market orientation using three classifications: "subsistence systems", "semi-commercial systems" and "commercial systems" (Table 1). Each classification has different farmer objectives, sources of inputs, product mix and household income sources, echoing our discussion above of the multiple dimensions of commercialisation.

At first sight, this typology presents a rather linear trajectory that sees farmers, indeed agriculture sectors, progressing, over time, from subsistence through a state of semi-commercialisation to a commercial system with clearly defined characteristics along the four criteria – each one captured on a scale or hierarchy. The transition is described thus: “as economies grow, households shift away from traditional self-sufficiency goals and towards income and profit-oriented decision making, so farm output is accordingly more responsive to market trends. The returns to intensive subsistence production systems that require high levels of family labor generally decline relative to production for the market with predominant use of hired labor. The proportion of farm income in total household income declines as family members find more lucrative non-agricultural employment opportunities” (Pingali and Rosegrant, 1995: 172-173).

Table 1: Characteristics of food production systems with increasing commercialisation

Level of Market Orientation	Farmer’s Objective	Sources of inputs	Product mix	Household income sources
Subsistence systems	Food self-sufficiency	Household generated (non-traded)	Wide range	Predominantly agricultural
Semi-commercial systems	Surplus generation	Mix of traded and nontraded inputs	Moderately specialised	Agricultural and non-agricultural
Commercial systems	Profit maximisation	Predominantly traded inputs	Highly specialised	Predominantly non-agricultural

Reproduced from Pingali and Rosegrant (1995)

Table 1 is a simplification, but it neatly captures some important dynamics. One critique is that it focuses only on those who remain in agriculture, even if there is recognition that even these households will have other income sources beyond agriculture. Those who exit agriculture altogether - either because they specialise in non-farm activities or migrate out of rural areas altogether or end up largely as providers of wage labour to remaining farms – may be a minority at early stages of rural development, but grow to become the majority as both agricultural commercialisation and broader economic development proceed. Moreover, as shown by Otsuka and Yamano (2006), once growth in non-farm employment takes off, this can have a more dramatic impact on poverty reduction than even agricultural growth.
We might also observe that the path sketched out around Table 1 - developed principally in relation to Asia - applies largely to systems that start out as smallholder dominated. Bimodal systems (like those in Latin America and much of Southern and Eastern Africa) may have a quite different trajectory.

b. Specialisation and Diversification

Table 1 above associates the agricultural commercialisation process with a move from production of a very diverse product mix to a more specialised production enterprise. Production decisions are increasingly shaped by market forces in conformity with comparative advantage, rather than by a desire to spread risks in the context of highly imperfect markets.

However, once again, progress is unlikely to be linear. In particular, at the earliest stages of agricultural development, commercialisation may well be associated with diversification. There may be two reasons for this. The first is that diversification in market-oriented crop (and livestock) enterprises may be an important way to spread market-related risks, given both market imperfections and volatility and the lack of other mechanisms for either ensuring against such risks or smoothing consumption when they occur. Leavy (2007) on Zambia and Gabreselassie et al (2007) on Ethiopia provide examples of households deliberately diversifying their market-oriented crop and livestock enterprises, rather than expanding a single enterprise, when they accumulate the resources to do so.

The second reason is that initial production of crops for market – especially non-food crops – represents diversification away from production of basic foods for home consumption. Heltberg (2001:3) observes that, “[s]mallholders produce market-destined crops *in addition to* the subsistence food crops they are growing anyway” [11]. In this case, the inconclusive nature of measuring commercialisation in terms of degree of specialisation can be illustrated using a Herfindahl index. If a farmer starts by allocating 90 per cent of land to maize and the remaining 10 per cent equally to ten minor crops, the Herfindahl index is 0.811. If the farmer then switches to allocating 45 per cent each to maize (cultivated more intensively) and cotton, and only grows five other minor crops on the remaining 10 per cent, the Herfindahl index drops to 0.41. According to Heltberg, the degree of diversification has increased. According to Pingali (Table 1), the farmer has moved from a "wide range" of crops (eleven) to being "moderately specialised" (seven), with almost half of cropped area now planted with the clear intention to produce for market. Both views of the same shift are defensible.

According to Heltberg (2001:3), the tendency to add cash crops to existing food production activities can be attributed to the “urge for food self-sufficiency in

[11] See also Omamo 1998(a) and (b)

environments of large transaction costs and high risks found in many sub-Saharan African (SSA) countries". This contrasts with the belief of economic historians that "gains from specialisation are a key driving force in economic growth" (see North 1991; cited in Heltberg 2001). Heltberg concludes:

"Commercialization and diversification are therefore associated, at least at initially low levels of commercialization. This implies that smallholder agricultural commercialization may not yield the expected gains from specialisation and economies of scale, and that it will not, in itself, be a prime engine of agricultural productivity growth. Nevertheless, commercialization is important as a livelihood strategy, source of cash income to farmers, and export revenue to the country, and worth promoting on those grounds." (Heltberg 2001: 3).

We agree strongly with the emphasis placed here on "food self-sufficiency in environments of large transaction costs and high risks" and that one should not expect specialisation to occur until food markets function much better than they do in most of Africa today. However, we caution against the conclusions drawn on the grounds of economies of scale. Firstly, in section 4 we discuss the evidence on the competitive strengths and weaknesses of smallholder vs commercial farms. There is very little evidence for economies of scale in agricultural *production* in low wage economies, although there may well be economies of scale in marketing and quality assurance (these are both information-related). Secondly, the expected gains from smallholder agricultural commercialization may not come primarily from the realisation of economies of scale. Instead, they arise when households are freed from producing food for own consumption, often in agro-ecological conditions that are far from ideal, and feel able instead to produce crops in which they have a clearer comparative advantage. Thus, von Braun and Kennedy (1994:3-4) write that:

"Subsistence production for home consumption is chosen by farmers because it is subjectively the best option, given all constraints. In a global sense, however, it is one of the largest enduring misallocations of human and natural resources, and, due to population pressure and natural resource constraints, it is becoming less and less viable."

3. Making Agricultural Commercialisation as Inclusive as Possible

Several studies indicate factors that the authors consider important in distinguishing commercialised from non-commercialised growers and/or factors that affect "farmers' decisions to become more integrated in the market" (vonBraun, 1995:189). So-called "exogenous" determinants of commercialisation identified by these studies include:

population change, availability of new technology, infrastructure, market creation, macro and trade policies.

We do not have time to discuss all of these in detail. However, in this section we discuss certain critical conditions that need to be in place if efforts to promote agricultural commercialisation are to benefit a large proportion of smallholder agricultural producers.

a. Market Access

Given the centrality of participation in output markets in our definitions of commercialisation, **market access** is obviously crucial to commercialisation.[12] Market links bring broader benefits to poor people in rural areas, and there is plenty of evidence for this (see Dercon and Hoddinott, 2005, among others). However, households have different relations to markets because of costs associated with market transactions. The key is enabling farmers to access markets for their produce – as evidenced by the various 'making markets work for the poor' initiatives that emphasise market access as a major pathway out of poverty and the need to link farmers better up to new markets (DFID, Asian Development Bank, Commission for Africa report 2005; SIDA, 2003; World Bank World Development Report 2000/2001 chapter 10 making markets work better for poor people; Almond and Hainsworth, 2005, USAID). These stress the importance of agricultural growth, but also highlight infrastructure development as necessary to improve access to new markets as well as bringing other benefits to improve welfare overall.

Other aspects of the current orthodoxy include better market information, strengthening farmer organisations and promoting contract farming. However, while many measures implemented in support of increasing market access have value in their own right, there are still questions around who participates. Will it still only be the top few percent of farmers who respond, especially if on the whole smallholders cannot either buy their food reliably and cheaply from a market or intensify their own production?

Successes in various initiatives that fall under the banners of 'making markets work' for poor people and 'linking farmers to markets' have been mixed. Case studies from the DFID/ADB joint initiative focusing on financial, labour, and agricultural markets,

[12] For example, Heltberg's study of smallholder farmers in Mozambique finds "to stimulate commercialisation the most important factors appear to be improved access to markets and information, risk reduction, capital accumulation" (Heltberg, 2001).

and public private partnerships encompass contract farming schemes and other measures to encourage value chain participation by smallholder farmers, mainly in East and South-East Asia.[13] Contract farming schemes implemented in Cambodia encompass production of oranges, vegetables, rubber, tobacco and rice, with the aim to provide to/ achieve for smallholder farmers: price information; new technologies; lower costs of entering market; and access to credit. Of three schemes, two failed (CEDAC, an NGO supported scheme, and AADA, under a local farmer association) because of weak market linkages – even though AADA managed to increase productivity 5-fold. The third scheme - Angkor Kasekam Roungroeung (AKR) – is a rice contract farming scheme of more than 1,000 households. Benefits of the scheme have been to increase specialisation and the adoption of new production methods, as well as access to a stable market and secure income. Participating farmers received higher prices than in the market and on the whole felt that they were better off as a result. However, the scheme has excluded poorer farmers with smaller farm sizes.

A study by Minten, Randrianarison and Swinnen (2005) of smallholder farmers contracted to supply local supermarkets describes how smallholder farmers under micro-production contracts, have received extensive farm assistance and supervision to help them meet the high quality standards and food safety requirements demanded by European supermarkets. Under the scheme almost 10,000 vegetable farmers in Madagascar are now producing for this market. Benefits of the scheme include higher welfare, greater income stability and shorter lean periods. However, local supermarkets do not demand the same high quality and are reticent about contracts that emphasise higher quality standards.

The contracting farm households tend to be considerably higher educated than the average Malagasy household: "The households that have contracts with the firm are: 64% of them had finished primary schools, and only 1% of them did not do any studies at all. This compares to almost half of the national population that is analphabet" (Minten et al, 2005:9). An area under contract is restricted to 0.01 hectare, but given relatively short production cycles there can be many different contracts on the same plot over the course of the year. Usually there is only one contractor per household, and contractors can have only one contract at a time, but multiple household members can have contracts concurrently. Households also subcontract land to people outside the household.

[13] For more information see: Cambodia: http://www.dfid.gov.uk/pubs/files/mmw4p/agcambodia.pdf.; Vietnam: http://www.dfid.gov.uk/pubs/files/mmw4p/agvietnam.pdf .

On a much smaller scale, smallholder farmers in South Africa have been supplying a local SPAR supermarket, while SPAR supports and maintains market access. The initiative is underpinned by South Africa's Agricultural Black Empowerment (AgriBEE) Policy, introduced in 2004. These smallholder farmers are classified as emerging farmers, and meet 30% of the store's demand for fresh produce, supplying cabbages and spinach and other vegetables. However, its reach is limited in that this amounts to only 27 farmers in total (Louw et al, 2006), especially given that there are about 3 million small-scale farmers in South Africa, mainly settled in communal areas and farming only 14 per cent of agricultural land, compared with 46,000 commercial farms who produce 95 per cent of marketed surplus on 86 per cent of agricultural land (Sautier et al, 2006: 9). Participation of small scale farmers in contract farming is still very limited.

These cases illustrate that while market access initiatives are valuable with many benefits to participating farmers, in practice relatively few are able to participate in what, on the whole, tends to be niche markets. That only the top few percent of smallholder farmers can actually benefit highlights the limitations of conventional thinking if it is decoupled from support for staples development. This is always going to hold back their ability to diversify out.

b. Access to Staple Foods: Food Markets and/or Food Production

It is now a well-attested fact that the majority of smallholder households in Sub-Saharan Africa are net deficit in food production terms and that only a minority sell any food staples at all in an average year[14]. Illustrating this for the case of Kenya, Nyoro et.al. (1999) found that around 70% of households in the high potential maize zone were net sellers of maize, but in none of the other six major agro-ecological zones in their survey did the proportion of net seller households exceed 30%. Yet, almost all households grow staple foods and, in most cases, they devote the majority of their land area to them. It is thus not uncommon for studies of food crop marketing to find that the top 10% of producers account for 50% or more of marketed surplus. Similarly, studies of cash crop systems tend to find that, within a given area of smallholder producers, it is the larger farms that engage more heavily in cash crop production (especially where larger farms also equate to higher land:labour ratios), leading to similar distributions of cash crop sales.

[14] One of the first articles in the literature establishing this was Weber et.al. (1988).

This subsistence orientation persists because rural food markets in Africa are risky and subject to wide seasonal price variations. In this context small farm households are rational to prioritise the growing of subsistence food crops, even when growing other crops for market would yield a higher mean return in a normal year. In this section we develop this argument further. The corollary of this argument is that the expansion of commercial agriculture will generally have to go hand in hand with investments that increase the productivity of food staples.

There are two main strands of literature that investigate the relationship between subsistence and commercial agricultural production amongst smallholders. The first concerns the impacts of cash crop production on food security and nutrition. NGO and other critics of the promotion of cash crops have argued that cash crop production absorbs women's labour and may also justify men taking over land previously controlled by women. It thereby diverts these resources from food production for household consumption. Meanwhile, the resulting income is controlled by men, who prioritise personal consumption (e.g. of alcohol), marrying other wives or investment in fixed assets, rather than providing for the household's immediate food and nutritional needs.

A seminal work in this literature is von Braun and Kennedy (1994). Summarising across their case studies, they found that households that invest in cash crops rarely sacrifice food security to do so. Specifically:

- Farms adopting new "commercial" crops or technologies often devote a considerably smaller share of their land to food crops for own consumption than do non-adopters. In absolute terms, the area that they devote to food crops for own consumption may also be smaller. However, they generally achieve higher yields in their food crop production. As a result, per capita production of food for own consumption was as often higher for adopters than for non-adopters as vice versa.
- technologies generally lead to higher calorie intake, although the increase is less than proportional due to increased non-food expenditure shares and a preference for more expensive calories (good for other aspects of nutrition). "Any negative tendencies to spend less for food because of loss of income control by women or because of increased involvement in market (cash) transactions are generally small and are more than compensated for by increased incomes due to commercialization" (p78).
- There is "no evidence for an adverse effect on child nutrition from increased commercialisation, even when income is held constant" (p46). Equally, though, child health indicators rarely improved, despite higher incomes, as (aside from

food) additional incomes were rarely spent on items with short-run health benefits. The authors argued that increased incomes should be combined with public action to deliver improved health outcomesHigher incomes as a result of adoption of new “commercial” crops or

Whilst this first strand of literature examines the impact of commercial agricultural production on the food security of those who have already engaged in it, the second considers whether household concerns about food security act as a constraint to adoption of commercial agriculture. Specifically, if food markets are unreliable, inefficient or highly volatile, it is argued that farm households will prioritise feeding themselves and hence will only cultivate very small quantities of crops intended for sale if they expect to experience a food deficit (Fafchamps, 1992; Jayne, 1994). Thus, under production conditions better suited to oil crops than to grains, Jayne (1994) found that, “Controlling for differences in household assets and location, grain-surplus households in five semi-arid regions of Zimbabwe were found to cultivate 48% more oilseed crops for the market than their grain-deficit neighbours" (p388).

Some evidence for this food-security-as-constraint-to-commercialisation view is also found in the studies reported by von Braun and Kennedy (1994). Thus, whilst several of the authors in that volume calculated that returns to land and/or labour were significantly higher under cash cropping than under food production for own consumption, adopting households generally devoted only 40% or less of their land to the new “commercial” crops or technologies, which was less than they continued to devote to subsistence food crops. Meanwhile, the smallest farms in the study areas were under-represented in cash crop schemes for various reasons, including both administrative selection (where this occurred) and their own choice.

The case study by Peters and Herrera (1994) neatly summarises why smallholders in Malawi plant on average around 80% of their land to maize. Prices of purchased maize are both high and unpredictable in the annual “deficit period” (December-January). However, in addition to this there are strong taste preferences for local maize varieties pounded in a traditional way and there are cultural reasons as to why cash resources within the household tend to get exhausted more readily than retained food stocks, hence making the latter more reliable as a food security reserve.

The Mozambique study by Heltberg and Tarp (2002) also highlights the importance of staple food production to agricultural commercialisation. Thus, in their regressions to explain the extent of participation in agricultural output markets, the single most important variable was the mean level of maize yield achieved in the district concerned. This could indicate that maize was readily available for purchase in the districts concerned or that individual households in such districts were able to devote land and labour to crops other than staple foods because they were also able to ensure a reasonable supply of food through own production.

Of course, the two aspects of the relationship between cash crop production and subsistence food production are not mutually inconsistent. Indeed, if adoption of a cash crop only occurs when concerns related to food security can be allayed, then non-negative outcomes of cash crop production on food security are likely to be observed.

More recently, Pandey et.al. (2006) have carefully investigated the role of upland rice in the farming systems of the northern uplands of Vietnam. Yields of upland rice are lower than for lowland rice, so households that have both upland and lowland plots tend to plant less upland rice in their upland plots[15], which are better suited to higher value cash crops (tree or horticultural crops) or even maize (a cash crop in this context). In more accessible areas, households can also readily obtain rice through the market from nearby lowland areas, so also produce less upland rice. However, in more remote areas, households cannot rely on obtaining reasonably priced rice through the market and hence plant a much higher proportion of their plots to upland rice. Within the subset (210 households) of their household survey dataset that did not have lowland rice plots, Pandey et.al. (2006) show that higher upland rice yields are associated with a lower proportion of total area planted to upland rice and a higher proportion planted to cash crops. In a similar vein, Poulton and Ndufa (2005) found that, within three subdivisions of Siaya and Vihiga districts in western Kenya, households that achieved higher maize yields in the long rains season had more diversified cropping patterns (away from maize) in the short rains season, controlling for farm size.

Pandey et.al. (2006) argue that, “Rice productivity improvement can thus be an important strategy for escaping from poverty while assuring food security. Improvements in household food security can thus facilitate and reinforce the process of commercialization rather than negating this process, as is believed in some policy circles. [Contrary to these same beliefs] ... a more gradual approach that is based on enhancing food security first before launching a major commercialization progam for uplands is likely to be more successful in bringing about the desired change (von Braun and Kennedy 1994). Examples abound where commercialization programs

[15] Some upland rice is, however, still typically planted, as it is harvested before lowland rice and is available in time for consumption during the main lean period, September-November.

that did not give due consideration to food security have performed poorly in the uplands of Vietnam and elsewhere." (p77).

In the context of Vietnam, intensification of staple food production for home consumption may be a prerequisite for diversification into commercial agriculture principally in less accessible areas that cannot rely on food purchase from the market. However, basic infrastructure and transport is better in much of Vietnam than in most of Sub-Saharan Africa, whilst local food markets are also generally better developed (assisted by greater population density and the fact that the nation as a whole is rice surplus). In Sub-Saharan Africa, intensification of staple food production for home consumption may be a prerequisite for widespread diversification into commercial agriculture in many areas - not just the more "remote" ones.

We note, however, that policies to promote staple intensification amongst food deficit households with small-medium land holdings, as a means to eventual diversification into production of other crops for market, are likely to be different from policies to (further) expand staples production amongst existing surplus producers. Thus, policies that raise the price of food staples should provide incentives for the latter to further expand their production, but will only worsen the trap that the former find themselves in, reducing the already scarce cash that they have to buy improved seeds or fertiliser. In areas of average or higher agro-ecological potential, but poor market development, a system of input vouchers for staples production might assist diversification into higher value crops, if accompanied by other interventions to simultaneously promote such alternative crops[16]. However, in semi-arid areas significant staples intensification may always be too risky for producers to contemplate. In such cases, widespread commercialisation of agriculture might only come with improved market access, allowing both purchases of staples and opportunities to sell crops more suited to local growing conditions. The Machakos area in Kenya may be illustrative here (Tiffen et.al. 1994).

c. Asset Accumulation

Intuitively, differences in asset holdings are likely to be a big determinant of who responds to incentives to commercialise. This is confirmed by empirical evidence, such as Heltberg's 2001 study of smallholder farmers in Mozambique, which identifies capital accumulation as an important stimulus to commercialisation. In this

[16] The challenge of providing a coordinated package of support measures to both promote staples intensification and simultaneously assist diversification should not be underestimated, however.

section we discuss the key assets for rural households: land, plus livestock and equipment.

i. Land

Jayne et.al. (2003) present evidence from five countries of southern and eastern Africa (Ethiopia, Kenya, Mozambique, Rwanda and Zambia) of land holding patterns amongst smallholder households in the 1990s, based on nationally representative rural household surveys. Average land holding sizes per household have fallen by one third to one half since the 1960s, as populations have risen (see also Ellis 2005). Contrary to some stylised facts about the relatively egalitarian nature of land distribution within communal tenure systems, Jayne et.al. (2003) also demonstrate that there is considerable inequality within land holdings – at least as great as in Asia at the onset of the Green Revolution. Only about a third of this inequality can be explained by inter-village effects (for example, differences in agro-ecological potential and local population densities); the remainder is within-village inequality. Observable household variables, such as demographic structure and livestock holding (see below) explain a further 12-20% of total observed variation. Jayne et.al. (2003, p267) suggest that "institutional and governance factors operating within local systems for allocating land" may account for some of the remaining inequality. Thus, for example, the first clans and families to settle an area commonly receive larger land allocations than later arrivals, whilst other studies indicate that those related to the chief responsible for land allocation receive larger allocations than those without such links.

Jayne et.al. (2003) show that around 25% of households in all five surveyed countries have access to less than 0.1 ha of land per capita – near landless. They also show that income per capita rises sharply as land holding rises from this level to 0.25 ha per capita (and more gradually thereafter). In other words, whilst households with lower land per capita obtain a higher share of their income from non-farm sources than households with a greater land endowment[17], this is insufficient to compensate for lower land holdings in a predominantly agricultural economy.

Jayne et.al. (2003, p254) comment that "the poor generally lack the land, capital and education to respond quickly to agricultural market opportunities and technical innovation". Thinking specifically about land, we argue that small land holdings interact unhelpfully with poorly developed food markets to keep poor households

[17] Jayne et.al. (2003) also examine the relationship between share of non-farm income and total income per capita and find that this is positive in all countries except Ethiopia – a finding that is broadly consistent with that of Reardon (1997).

focused on the production of (often low value) staple food crops. Thus, at any given yield level, a household with lower land per capita has to devote a higher proportion of its land to food production if it is to achieve a given level of self-sufficiency. There is then less land available, if any at all, for production of higher value crops for market.

We note at least two effects of small land sizes on agricultural commercialisation. Firstly, in the absence of efficient food markets, households with smaller land sizes have to be assisted to achieve higher staple yields before they will begin to devote land to production of higher value crops for market[18]. Secondly, lower land per capita means that they will able to benefit less (in absolute terms) from their commercialisation efforts.

These points are illustrated by Table 2, which is derived from action research carried out in Siaya and Vihiga districts of western Kenya in 2001-2005. Land holding sizes in these districts are tiny, such that in a 2005 survey the 75th percentile household only had access to around 0.6ha, albeit land that could be farmed in two seasons per year. (This works out at 0.18ha per capita – below the threshold of 0.25ha per capita highlighted by Jayne et.al. 2003). Table 2 considers possible outcomes from agricultural intensification efforts that permitted an intensification of maize production in the long rains season, so as to permit diversification into other crops in the short rains. In the project in question, intensification of maize production was being promoted through provision of technical advice plus a credit scheme that assisted households to acquire improved maize seed and inorganic fertiliser. Production of soybean was being promoted for cash, food and soil fertility benefits, whilst planting fast growing "improved fallow" tree species on small parcels of land helps restore soil fertility as well as producing firewood, poles or fodder. Kales provide additional cash income. In the "best case" scenarios shown in Table 2, maize and bean yields for the 75th percentile farm are double those recorded by the actual 2005 project survey.

According to Table 2, the 75th percentile farm household could satisfy all its maize requirements at these enhanced yields (per capita consumption requirement is about 140kg per person p.a.) and devote 80% of its land area to crops other than maize during the short rains season. However, its income per capita from farming activities alone would still only be around half of the international poverty line of US$1 (PPP terms), meaning that it would require non-farm activities to take it out of poverty. Meanwhile, with lower expected yields, as very poor households are rarely early adopters of new technological packages, the 25th percentile farm household would

[18] Note that higher yields for staples also raise the returns to their production, which may discourage diversification into other crops.

not satisfy its maize requirements, so would be likely to continue devoting most or all of its land to maize and beans for home consumption.

Jayne et.al. (2003) acknowledge that there are few easy solutions to the problem of limited land access for many African smallholder households. In both Malawi and Ethiopia land redistribution programmes to enforce a floor level of land holding per farm household are periodically floated in policy dialogues. Less radical would be efforts to stimulate land rental markets within customary tenure systems (see Crookes and Lyne 2003 for an example from KwaZulu-Natal) or investment in irrigation. What is clear is that efforts to stimulate intensification and commercialisation amongst farm households with small landholdings will require significant coordination across several services and markets: provision of technical advice; supply of both improved maize seed and alternative high value crops; supply of fertiliser and a mechanism for making it affordable to poor households (either credit or subsidy), and some form of linkage to a market for higher value produce. This may be achieved in a project setting, but is a formidable challenge for regular development administrations (see section 5). Moreover, the continued absence of a replicable seasonal credit model for small-scale, semi-subsistence farm households in Africa suggests that intensification and commercialisation amongst farm households with small landholdings might only be feasible where the state is willing to invest in a fertiliser subsidy as a way of overcoming the affordability constraint.

Even then Table 2 suggests that efforts to promote commercialisation should focus on reaching households with middling land holdings[19], on the assumption that better endowed households are likely to adopt promising technological packages fairly readily. According to Jayne et.al. (2003), the long-term hope for poorer households with tiny land holdings is that eventually agricultural growth will stimulate growth in non-farm employment opportunities. Until then, such households may best be assisted through some form of social protection intervention (e.g. public works programmes, cash transfers, possibly also including fertiliser subsidies as social protection).

[19] The figures cited by Jayne et.al. (2003) show mean land holdings amongst smallholder households ranging from 0.16ha per capita in Rwanda to around 0.6ha per capita in Zambia.

Table 2: "Best Case" Agricultural Incomes for Representative Farm Households in Western Kenya

	75th percentile Farm		25th percentile Farm	
Cropping Pattern (ha)	**Long Rains**	**Short Rains**	**Long Rains**	**Short Rains**
Maize/Beans (intercrop)	0.42	0.12	0.2	0.2
Soybean	0.06	0.24		
Kales	0.12	0.12		
Improved Fallow		0.12		
Total (ha)	0.6	0.6	0.2	0.2
Assumed Yields (t/ha)				
Maize (intercrop)	3.0	1.5	1.37	0.7
Beans (intercrop)	0.6	0.4	0.29	0.2
Soybean	1.5	1.5		
Kales	5.0	5.0		
Family Size	6.5		4.0	
Maize Production per person p.a.	222kg		104kg	
Net Income per person / day:				
KShs	16.63		3.78	
US$ PPP (current)	0.47		0.10	

Source: adapted from Poulton and Ndufa (2005)

- *Animal Traction*

Another asset that greatly assists smallholder households to respond to market opportunities is animal traction (livestock plus the relevant equipment). Animal traction allows farmers to respond quickly to rains, thereby increasing yields, and to cultivate more land (assuming that they have access to it[20]). In addition, livestock ownership can provide manure for soil fertility, to the benefit either of staples intensification or of cash crop productivity. West African cotton sectors provide an excellent example of a virtuous circle of cash crop production and animal traction investment, with profits from cotton being reinvested in animal traction to the benefit of both food production and cash crop productivity (Savadogo et.al. 1998). Historically, cotton sector policy in West Africa has promoted animal traction adoption, with the result that 30-40% of farm households are considered fully equipped for animal traction use (weeding as well as planting). By contrast, in southern and eastern African cotton sectors, fewer households are equipped even to

[20] Jayne et.al. (2003) found that landholdings both per household and per capita were strongly associated with livestock ownership. The causality could work both ways here.

plough with their own equipment. “Top end” producers in the different regions achieve similar yields, but the much greater proportion of fully equipped producers in West African cotton sectors goes a long way towards explaining the much higher average yields achieved by these sectors as compared with southern and eastern Africa.

3. Which crops and markets?

It is clear that - contrary to the fears described in Section 2 that commercialisation means large scale, export-oriented farming, and essentially changes that favour larger, more powerful players to the detriment of smallholder farmers - commercialisation as measured by something like the CCI could be relevant for any size of farm and any market. What is important is that farmers benefit from participating wherever the opportunities are and will respond to any market opportunities that are available. This does not mean exclusively export markets. Indeed, staples markets in SSA are estimated to be worth US$50 billion per annum and growing at 4 per cent per annum (Diao et.al. 2003) [21]. Further, in reality large-scale and smallholder have different strengths, which give each of them advantages in producing certain crops.

a. Competitive strengths and weaknesses of different farm types

Often, different modes of commercialised agriculture exist side-by-side and interact with each other.[22] These include:

- Small-scale farmers:
- Small-scale ‘non-commercial’ farmers – might sell some produce but do not or can not make their entire living from farming (Type A);
- Small-scale commercial farmers – tend always to have been market-oriented and make a living from selling their output (Type B);
- Emerging commercial farmers – small-scale investors, often farming as a secondary activity;[23]
- Large-scale ‘business’ farming.

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[21] In a study of maize pricing and policy in Kenya, Jayne et al (2001) also state the case for diversified crop production: “productivity growth in agriculture is likely to be a precondition for injecting purchasing power into rural areas and hence stimulating demand and employment growth in the broader economy. But this will require viewing agricultural income growth as deriving from many crops. Important regional differences suggest that tailoring policies with their regionally dis-aggregated impacts in mind can lead to improved outcomes” (2001: 25).

[22] See for example, White et al (2006) on Zambia, Cromwell et al (2005) on Malawi; Sharp et al (2007)’s Future Agricultures work on Ethiopia.

[23] See work on “New actors in rural land markets” Ouedraogo (2006); Toure and Seck (2005). Work under he Future Agricultures Consortium by Amdissa Teshome, exploring young peoples’ aspirations in relation to the agriculture sector suggest that this is the type of farming that many young rural people, the sons and daughters of farmers themselves, would hope to be farming in the future.

Table 3: Competitive strengths and weaknesses of different farm types

	Smallholder farmers		Small Investor-farmers	Large-scale farming
	Type 'A'	Type 'B'		
Land	*	**	**	**
Finance / Credit		*	**	***
Inputs: access/ purchase	*	*	**	***
Skilled labour: access		*	**	***
Unskilled labour: motivation, supervision	***	***	**	*
Contacts/networks	*	**	**	***
Market knowledge	*	**	***	***
Technical knowledge	*	**	***	***
Product traceability and quality assurance			*	***
Risk management	*	*	**	***

* = poorly positioned (no star is worse!); *** = well-positioned

A long-standing literature (see, for example, Binswanger and Rosenzweig 1986) observes that different farm types have different advantages and disadvantages when it comes to production and marketing. Some of these are summarised in Table 3. Crudely speaking, the competitive advantages of smallholder farms are centred on their low-cost supply of (generally) highly motivated family labour, whereas large-scale farms face lower costs in most other input and output market transactions.

Table 4 takes the analysis in Table 3 one stage further and assesses the likely competitiveness of different farm types in different crops and markets, given the technical and economic requirements of different crops and the demands made by different markets. This is an area where the predictions of theory and actual experience of commercial competitiveness tally quite closely.

One implication of this sort of analysis is that the dominant type of farm that is observed during agricultural commercialisation will depend at least in part on the types of crops being promoted (in turn, a function of agro-ecological conditions and market opportunities) as well as the markets being targeted. Large-scale farms might flourish because they are the most appropriate mode of commercialised agriculture for particular crops and markets in which the country or region has comparative advantage – not necessarily because there is a large farm bias in policy. Equally, a country or region may do well in two product groups (say, coffee and export horticulture in Ethiopia), with smallholder production systems dominating in one and large farms dominating in the other.

Table 4: Predicting Competitiveness of Farm Types in Different Crops and Markets

	Smallholder farmers		**Small Investor-farmers**	**Large-scale farming**
	Type 'A'	**Type 'B'**		
food staples (local/national/regional markets)	✓	✓		?
high value crops, e.g. horticulture (local/national/regional markets)		✓	✓	
low value export commodities, e.g. cassava, soya, grains				?
horticulture exports		?	?	✓
traditional export commodities		coffee, cotton, tea, groundnuts	✓	sugar, tea, tobacco

4. Documentation versus implementation

However, there may also be other reasons why large farms are seen to do better than smallholder farmers.

Given the diversity of policies at the national level care should be taken when making generalisations. It is necessary, however, to consider how policy narratives, given their in-built assumptions about the way things work, translate in implementation.

At the national level, Poverty Reduction Strategy Papers (PRSPs) are one component of an array of policy instruments and strategies for poverty alleviation and economic development. It is not clear from various PRSP documents (Ethiopia, Kenya, Malawi, among others) that they do in fact focus – either explicitly or implicitly – on large-scale/ estate export-led agriculture to the exclusion of small-scale farmers. Most PRSPs see the commercialisation of peasant agriculture as a key pillar of rural development. It is fair to say, however, that most current government policy, backed by donors, appears to promote an essentially dualistic agricultural system, through supporting large commercial farms on one side and the 'small farm sector' on the other.

How policy objectives translate into policy actions is important – a point also made in recent reviews of the rural focus of PRSPs and PRSCs (Poverty Reduction Support Credits).[24] These found the seeming neglect of rural issues in PRSPs to be "not so much the lack of policies targeting the rural productive sectors but rather the nature and reach of those policies" (Cromwell et al, 2005:3)[25].

a. Commercialisations in Policy Discourse

More often than not large farm bias may develop in practice even though policy appears to be pro-smallholder on paper. Why does even the best-intentioned policy not lead to smallholder development in practice? Interventions that actually arise can differ from the stated policies that are supposed to shape them for various reasons, including: i) Individual officials or politicians do not believe pro-smallholder rhetoric of policies (but it is difficult to find evidence for this); and ii) Large-scale farms can prosper when a basic enabling environment (Macroeconomic stability, banking sector, trunk infrastructure, political support for private enterprise, R&D) is in place, as they are able to source critical services themselves. By contrast, smallholders require pro-active service provision, and this is an implementation issue. Smallholders need to be provided with a range of pre- and post-harvest services (market intervention and linkages, extension advice, finance schemes, input markets, capacity building for farmer organisations). None of these will be entirely private sector driven under current conditions in SSA, there nearly always has to be some state role if not in service provision then in its regulation. Thus, where state capacity is lacking, large-scale farms may still perform whilst smallholder systems languish. This is different from a pro-large scale bias, but the outcomes may not look that different. Large-scale farms are also able to prosper even with a non-performing Ministry of Agriculture, while smallholders need the services that the Ministry of Agriculture is supposed to be responsible for.

In some instances, implementation can reflect the priorities of elites, so national governments, and resources allocated to pro-poor activities, do not reflect MPRS

[24] See for example, World Bank (2005). A Review of Rural Development Aspects of PRSPs and PRSCs, 2000-2004.

[25] The study, which examines three PRSPs: Malawi, Nicaragua and Vietnam, also notes the seeming lack of hard evidence of what actually has been or is being implemented (page?). See also Shepherd and Fritz (2005).

priorities (see Chirwa et al, 2006 on Malawi). Taking Malawi as an example, there is a tendency towards seeing the agricultural sector as principally dualistic in nature with the estate sector on the one hand, and small farms on the other. Small farms are further subdivided by type into: commercial small farms (about 10 per cent of small farms); small farmers with commercial development potential (about 50 per cent), and severely resource constrained small farmers (about 40 per cent). For this bottom cadre of small farms the policy focus is on social safety nets, with little indication of how this links to broader economic growth efforts (Cromwell et al, 2005).

b. Pro-smallholder policies on the ground

What are the components of pro-smallholder policies on the ground? In the class of smallholder farmers, there is usually a 'top' group that tends to make a profit. For example, in West African cotton systems this is, unusually, 40 per cent of smallholder farmers, but fewer than 10 per cent in Southern and East Africa. What is required for such smallholder participation? There needs to be considerable action on the ground, otherwise only the large scale farmers and the top 10 per cent or so are going to participate and benefit from opportunities. If people are not proactively enabled to get involved then there will always be a bias towards the top end. This leads us to question severely the equality of the focus of policy. Actions to encourage smallholder commercialisations could include:

<u>Attention to food crops</u>. Precarious rural food markets mean that farm households, rationally, will prioritise feeding themselves over selling their crops, even if growing other crops for market would yield a higher mean return in a normal year. Empirically, once a household's food security needs have been met only then does it make sense to invest in producing for the market. The upshot here is the expansion of commercial agriculture would need to be complemented by investments to increase the productivity of food staples, rather than focusing solely on policies that incentivise those already growing a surplus (such as increasing the price of food staples) but only serve to penalise those households who will experience this as a further drain on scarce cash resources.

<u>Pro-actively encouraging asset accumulation processes</u>, for example through promoting investment in animal traction, to create a virtuous circle between cash cropping and assets (see, for example, Savadogo et al., 1998);

<u>Making markets work for poor farmers in poor areas</u>, making the most of and creating market opportunities that are relevant to local producers without resorting to

ideological or preconceived ideas about export versus domestic production, or high potential compared with less favourable areas. Localised opportunities have real potential to improve household incomes and food security.

Which markets do present the best opportunities to smallholder farmers? There is an ongoing debate about the relative importance of export and domestic markets for African agriculture. The arguments for paying adequate attention to domestic market opportunities are: 1) size of domestic markets, boosted by both population growth and urbanisation (estimated at $50 billion compared with a combined total of just over $8 billion for agricultural trade over the period 1996-2000; Diao and Hazell, 2004); 2) much less restrictive quality standards and requirements within domestic markets (relatively more smallholder-friendly) compared with export markets; and 3) from a growth perspective, the additional multipliers that come from lowering food prices.

Smallholder vs large-scale farming: These have their relative strengths, for smallholders these lie in labour motivation and supervision; for large-scale, commercial farms their advantages are associated with access to market information, extension advice, finance, inputs, fixed costs, and output market linkages. There are also questions around the extent to which one can provide quality assurance and traceability in a cost-efficient way within smallholder systems compared with larger scale operations. Supermarkets and other players in export markets tend to favour the latter.

The relative strengths of different farm types/systems mean that one system tends to perform better in some crops (e.g. smallholders in labour intensive crops where quality assurance and traceability are not yet important) and the other in others. We should not assume that all crops are the same any more than we assume that all farms are. This is an area where the predictions of theory are well borne out by actual experience. It may be difficult to fight the thrust of large farms in some cases. In others, smallholders will do just as well as large farms or better. So in terms of what a government is to encourage and support, there needs to be in the mix crops that are not all “large farm crops”.

We must also remember the degree of heterogeneity within smallholder systems. Realistically not all smallholder farmers are going to be participating. There will be some people for whom it is just far too risky to grow cash crops and buying food.

c. How do we ensure that pro-smallholder policy documents lead to pro-smallholder policy on the ground?

If there is a disparity between pro-smallholder agriculture policy on paper and what is happening in practice, then we need to identify the channels for policy to reach smallholders on the ground. What do smallholder farmers need to support them in stepping up production for the market that works with and enhances what they are already doing, given that most farmers do sell at least some proportion of their output and the different routes open to farmers to sell into markets.

i. Enabling environment

Creating a good enabling environment is rarely enough for a strong smallholder sector to spontaneously take off. An enabling environment for the agriculture sector, most of it centrally provided, includes:

- Macro-economic stability, favourable real exchange rates;
- Reasonably strong banking sector, not just city-focused;
- National investment promotion policy;
- Core infrastructure;
- Research & Development;
- Political support of private enterprise;

Getting all of these rights might be enough for large-scale agriculture and/or agribusiness development, which might in turn facilitate some smallholder involvement. However, smallholder commercialisation also requires much more active service provision, most of which has to be organised at decentralised (e.g. regional) level.

ii. Service delivery

Service delivery includes provision of:

- Finance schemes;
- Extension advice;
- Input markets/systems;
- Market information and linkages;
- Capacity building for farmers' organisations;
- Asset accumulation of farmers.

Service delivery is crucial. Large commercial farms have the infrastructure (internet, transport, clout) to sell output successfully as long as the enabling environment is there. By contrast, someone has to bring it to smallholder farmers, otherwise only large scale farmers are able to take advantage of this enabling environment. Within contract farming schemes some of these services may be provided by agribusiness, but not usually capacity building for independent farmers' organisations and not the support for asset accumulation or staples intensification highlighted above[26] – these still have to be provided somehow, and can be critical to the impact of contract farming on livelihoods and poverty. Moreover, contract farming is not appropriate for all crops – for example those for which independent local markets exist - and in these other cases all the services listed above have to provided independently if they are to exist at all.

Decentralised/ regional service provision is essential, and is especially important in the domestic sector. But even national export markets still need some implementation at regional (within-country) level. These points to coordination at the local level to give smallholder farmers the package of services they need. Co-operatives and farmers groups have potential roles both as service providers and as participants in local policy processes (such as in advocacy and coordination), but who promotes these groups? In many cases, too much external pressure for the formation of farmer organisations can lead to weak groups forming in response to initial incentives – not strong, independent groups (Stringfellow et.al. 1997).

iii. Policy Processes

Creating a good enabling environment and ensuring sufficient, timely and efficient service delivery is crucially dependent on policy processes. How are governments/ ministries of agriculture working to provide and support these, given the distinctions between enabling environment and service delivery?

The enabling environment is not only central, but is handled almost exclusively (perhaps with the exception of R&D) by ministries other than Agriculture – the now common observation is that Ministry of Finance handles more policy relevant to agriculture than the Ministry of Agriculture (see also Cabral and Scoones, 2006). However, if Ministry of Agriculture is not actively committed to ensuring that services are provided to smallholders, then the likelihood is they will not be (with the partial exception of contract farming schemes noted above), and large-scale farms can develop where the Ministry of Agriculture is ineffective. Historically, Ministries of Agriculture have seen their role to be that of providing services – which have rarely reached more than a tiny minority of largely privileged, well-connected farmers. Instead, their role should be to support decentralised service provision and local level

[26] Historically, WCA cotton systems were again an exception to this rule, as the whole rural development effort in the cotton zones was mandated to the cotton company. (This is ceasing with liberalisation/reform).

coordination mechanisms (effectively, providing a technical input into processes that are actually focused on local government).

This points to reorienting Ministries of Agriculture – specifically, to maintain strong state capacity but, as a recent Future Agricultures paper on policy narratives in African agriculture suggests: “refocus attention on key roles – including investment in state-led reforms to help create the structural conditions for kick-starting the agricultural economy” (Cabral and Scoones, 2006, p32). This means on-going investment in coordination and intermediation functions. Of course, such a shift to substantial state function for ministries is not trivial. A change in agricultural governance setting, against many vested interests, is certain to be challenging in terms of organisation and capacity, not to mention politically. But if we want to see agricultural commercialisation policy that reflects and promotes pathways that are truly pro-poor, pro-smallholder and pro-‘development’, governments and donors need to move beyond rhetoric to actually recognising and supporting channels and environments through which smallholder farmers can and do participate.

References

Albu M and A Griffith (2005) Mapping the Market: A framework for rural enterprise development policy and practice. Practical Action Markets and Livelihoods Programme. June 005. www.bdsknowledge.org

Almond F R and S D Hainsworth eds. (2005) Beyond Agriculture – making markets work for the poor: proceedings of an international seminar. 28 February – 1 March 2005, Westminster, London, UK. Crop Post-Harvest Programme / Practical Action.

Bellemare M F and C Barrett (2006) An ordered tobit model of market participation: evidence form Kenya and Ethiopia. American Journal of Agricultural Economics. 88(2): 324-337.

Binswanger, H. and M. Rosenzweig (1986). "Behavioural and Material Determinants of Production Relations in Agriculture." *Journal of Development Studies* **22**(3): 503-539.

Bryceson, D. (1999). African Rural Labour, Income Diversification and Livelihood Approaches: A Long-Term Development Perspective. Leiden, Afrika Studie Centrum.

Chirwa E W, J Kydd and A Dorward (2006) Future Scenarios for Agriculture in Malawi: Challenges and Dilemmas. Paper presented at the *Future Agricultures Consortium* held at the Institute of Development Studies, Sussex, 20 – 21 March 2006.

Cromwell E, C Luttrell, A Shepherd and S Wiggins (2005). Poverty Reduction Strategies and the Rural Productive Sectors: Insights from Malawi, Nicaragua and Vietnam. ODI Working Paper 258, November 2005. London: Overseas Development Institute.

Crookes, T. and M. Lyne (2003). "Efficiency and Equity Gains in the Rental Market for Arable Land: Observations from a Communal Area of KwaZulu-Natal, South Africa." *Development Southern Africa* **20**(5): 577-591

Dercon S and J Hoddinott (2005) Livelihoods, Growth, and Links to Market Towns in 15 Ethiopian Villages IFPRI Food Consumption and Nutrition Division. FCND Discussion Paper 194 July 2005. IFPRI Washington DC

DFID (2000) Department for International Development Making Markets Work Better for the Poor A Framework Paper Economic Policy and Research Department and Business Partnerships Department. November 2000

Diao, X., and P. Hazell. 2004. Exploring Market Opportunities for African Smallholders. 2020 Africa Conference Brief No. 6, International Food Policy Research Institute, Washington, D.C.

Diao, X., P. Dorosh and S. Rahman (2003). *Market Opportunities For African Agriculture: An Examination Of Demand-Side Constraints On Agricultural Growth*. Development Strategy and Governance Division Discussion Paper No.1, IFPRI, Washington DC, September 2003, http://www.ifpri.org/divs/dsgd/dp/papers/dsgdp01.pdf.

Dorward, A. (2003). Modelling Farm-Household Livelihoods in Malawi: Methodological Lessons for Pro-Poor Analysis. Paris.

Dorward, A. R., J. G. Kydd, J. A. Morrison and I. Urey (2004). "A Policy Agenda for Pro-Poor Agricultural Growth." *World Development* 32(1): 73-89.

Dorward, A., N. Poole, J. A. Morrison, J. Kydd and I. Urey (2003). "Markets, Institutions and

Technology: Missing Links In Livelihoods Analysis." *Development Policy Review* 21(3): 319--332.

Dorward, A., S. Moyo, G. Coetzee, J. Kydd and C. Poulton (2001). *Seasonal finance for staple crop production: problems and potential for rural livelihoods in sub Saharan Africa*. Working paper, DFID Policy Research Programme project 'Diverse income sources and seasonal finance for smallholder agriculture: applying a livelihoods approach in South Africa'. Wye, Imperial College.

Doss, C. R., W. Mwangi, H. Verkuijl, and H. de Groote. 2003. *Adoption of Maize and Wheat Technologies in Eastern Africa: A Synthesis of the Findings of 22 Case Studies.* CIMMYT Economics Working Paper 03-06. Mexico, D.F.: CIMMYT.

Ellis, F. (2000). Rural Livelihoods and Diversity in Developing Countries. Oxford, Oxford University Press.

Ellis, F. (2005). Small Farms, Livelihood Diversification and Rural-Urban Transitions: Strategic Issues in Sub-Saharan Africa. The Future of Small Farms: Proceedings of a Research Workshop, Wye, UK, June 26-29th 2005, International Food Policy Research Institute.

Fafchamps, M. (1992). "Cash Crop Production, Food Price Volatility and Rural Market Integration in the Third World." *American Journal of Agricultural Economics* **74**(1): 90-99.

Goetz, S J (1992) A Selectivity Model of Household Food Marketing Behavior in Sub-Saharan Africa. American Journal of Agricultural Economics May 1992 444-452.

GOM (2002) Malawi Poverty Reduction Strategy Paper, Government of Malawi April 2002.

(IMF 2006 Malawi Poverty Reduction Strategy Paper progress report. 2004/2005 Annual Review Report).

Haggblade, S., P. Hazell and T. Reardon (2007). Transforming the Rural Nonfarm Economy: Opportunities and Threats in the Developing World. Baltimore, Johns Hopkins University Press

Hazell P, C Poulton, S Wiggins and A Dorward (2007). *The Future of Small Farms for Poverty Reduction and Growth.* IFPRI 2020 Discussion Paper 42. International Food Policy Research Institute, Washington DC, May 2007.

Heltberg R (2001 mimeo) Commercialization and specialisation in Mozambican Agriculture. Institute of Economics, University of Copenhagen, 2 January 2001.

Heltberg R and F Tarp (2002) Agricultural Supply response and povetry in Mozambique. Food Policy 27(2002) 103-124.

Jayne, T. (1994). "Do High Food Marketing Costs Constrain Cash Crop Production? Evidence from Zimbabwe." *Economic Development and Cultural Change* **42**(2): 387-402.

Jayne, TS, T Yamano, J Nyoro and T Awuor (2001) Do Farmers really benefit from high food prices? Balancing rural interests in Kenya's maize pricing and marketing policy. Tegemeo working paper 2B, April 28,2001.

Jayne, T., T. Yamano, M. Weber, D. Tschirley, R. Benfica, A. Chapoto and B. Zulu (2003). "Smallholder Income and Land Distribution in Africa: Implications for Poverty Reduction Strategies." *Food Policy* **28**(3): 253-275.

Jayne T, B Zulu and J Nijhoff (2006). "Stabilizing food markets in eastern and southern Africa." *Food Policy* **31(4)**: 328-341.

Key N, E Sadoulet and A de Janvry (2000) Transactions Costs and Agricultural Household Supply Response. American Journal of Agricultural Economics 82 (May 2000): 245-259.

Kydd J (2002). Agriculture and Rural Livelihoods: Is Globalisation Opening or Blocking Paths out of Rural Poverty? Network Paper No. 121 (January 2002) Agren Agricultural Research and Extension Network. ODI: London.

Maertens M and J Swinnen (2007) "Trade, Standards and Poverty: Evidence from Senegal." Paper prepared for the 106th EAAE seminar on "Pro-poor development in low income countries: Food, agriculture, trade, and environment", Montpelier, 25-27th October 2007.

North D C (1991) Institutions. *Journal of Economic Perspectives* **5**(1) 97-112.

Nyoro, J., M. Kiiru and T. Jayne (1999). Evolution of Kenya's Maize Marketing Systems in the Post-Liberalization Era. Workshop on Agricultural Transformation in Africa, Nairobi.

Omamo S W (1998a) Farm-to-Market Transaction costs and specialisation in small-scale agriculture: explorations with a non-separable Household model. Journal of Development Studies **35**:152-163.

Omamo S W (1998b) Transport Costs and smallholder Cropping choices: An Application to Siaya District, Kenya. American Journal of Agricultural Economics **80**(1) 116-123.

Otsuka, K. and T. Yamano (2006). *The Role of Rural Labor Markets in Poverty Reduction: Evidence from Asia and East Africa*. Background Paper Prepared for World Bank World Development Report 2008, Foundation for Advanced Studies on International Development, Tokyo, October 2006.

Ouédraogo S (2006), *New actors and land acquisition around Lake Bazèga, Burkina Faso*, IIED, London, Issue Paper 13

Pandey, S., N. Khiem, H. Waibel and T. Thien (2006). Upland Rice, Household Food Security and Commercialization of Upland Agriculture in Vietnam. Los Banos, Philippines, International Rice Research Institute.

Peters, P. and M. Herrera (1994). Tobacco Cultivation, Food Production and Nutrition Among Smallholders in Malawi. Agricultural Commercialization, Economic Development and Nutrition. J. von Braun and E. Kennedy. Baltimore, Maryland, The Johns Hopkins University Press**:** 309-327.

Pingali P L and M W Rosegrant (1995) Agricultural Commercialization and diversification: processes and policies. Food Policy 20(3) 171-185.

Pingali, P. L. (1997). "From subsistence to commercial production systems: the transformation of Asian agriculture." *American Journal of Agricultural Economics* **79(2)**: 628 - 634.

Poulton, C. and A. Dorward (2003). *The Role of Market Based Economic Development in Strengthening Food Security*. Paper prepared for the ODI Southern Africa Forum on Food Security, June 2003. London, Overseas Development Institute.

Poulton C, J Kydd, S Wiggins and A Dorward (2006). "State intervention for food price stabilisation in Africa: can it work?" *Food Policy* **31(4)**: 342-356.

Poulton, C. and J. Ndufa (2005). *Linking Soil Fertility and Improved Cropping Strategies to Development Interventions: Final Technical Report Annex A*. Report submitted to DFID Natural Resources Systems Programme, Imperial College London / Kenya Forestry Research Institute, Wye, October 2005

Poulton C, G Tyler, A Dorward, P Hazell, J Kydd, M Stockbridge (2006). All-Africa Review of Experiences with Commercial Agriculture. Summar Report. First draft, Impercial College London.

Pretty J N, J Thompson, F Hinchcliffe (1996) Sustainable Agriculture: Impacts on Food Production and Challenges for Food Security IIED GATEKEEPER SERIES No. 60

RATES (2003) Maize market assessment and baseline study for Ethiopia. Regional Agricultural Trade Expansion Support Program. Nairobi, Kenya. July 2003.

Reardon, T. (1997). "Using Evidence of Household Income Diversification to Inform Study of the Rural Non-farm Labour Market in Africa." World Development 25(5): 735-748.

Savadogo, K., T. Reardon, et al. (1998). "Adoption of Improved Land Use Technologies to Increase Food Security in Burkina Faso: Relating Animal Traction, Productivity and Non-Farm Income." <u>Agricultural Systems</u> **58**(3): 441-464

Sharp K, E Ludi and S Gabreselassie (2007) “Commercialisation in Ethiopia: Which Pathways?” Future Agricultures Consortium Paper, presented at EEA Conference, 8th June 2007.

Shepherd A and V Fritz (2005) Key issues in sharpening the rural production focus of Poverty Reduction Strategy Processes: Literature Review for IFAD Issues Paper. Overseas Development Institute, London.

Smith, S., Auret, D., Barrientos, S., Dolan, C., Kleinbooi, K., Njobvu, C., Opondo, M., and Tallontire, T. (2004) 'Ethical Trade in African Horticulture: Gender, Rights and Participation', IDS Working Paper 223, Brighton: Institute of Development Studies.

Strasberg Paul J., T. S. Jayne, T Yamano, J Nyoro, DKaranja, and J Strauss (1999) Effects Of Agricultural Commercialization On Food Crop Input Use And Productivity In Kenya. MSU International Development Working Paper No 71, 1999.

Stringfellow, R., J. Coulter, T. Lucey, C. McKone and A. Hussain (1997). Improving the Access of Smallholders to Agricultural Services in Sub-Saharan Africa: Farmer Cooperation and the Role of the Donor Community. London, Overseas Development Institute.

Swaminathan, M.S. 1995. Population, environment and food security. *CGIAR Issues in Agriculture 7*. CGIAR, Washington, DC.

Tallontire, A., Dolan, C., Smith, S., and Barrientos, S. (2005) Reaching the Marginalised? Gender, Value Chains and Ethical Trade in African Horticulture' *Development in Practice* 15 (3 and 4): 559-571

Tan S F and B Gueye (ed) (2005) Portraits of family farming in West Africa. Issue paper no. 134 IIED Drylands Programme March 2005

Tiffen, M., M. Mortimore and F. Gichuki (1994). <u>More People, Less Erosion: Environmental Recovery in Kenya</u>. Chichester, John Wiley and Sons.

Toulim C and B Gueye, “Transformations in West African agriculture and the role of family farms” by Camilla Toulmin and December 2003, IIED Issue Paper 123.

Touré O and Sidy Mohamed Seck (2005) *Family and Commercial farming in the Niayes area of Senegal,* IIED, London, Issue Paper 133

USAID (2004) Agriculture Strategy *Linking Producers to Markets* U.S. Agency for International Development July 2004.

Von Braun (1995) Agricultral Commercialization: impacts on income, nutrition and implications for policy. Food Policy 20(3): 87-202.

Von Braun, J. & Kennedy, E. (eds.) (1994) *Commercialization of Agriculture, Economic Development and Nutrition*¸ John Hopkins Press, Baltimore, MD.

Weber, M., J. Staatz, J. Holtzman, E. Crawford and R. Bernsten (1988). " Informing Food Security Decisions in Africa: Empirical Analysis and Policy Dialogue." *American Journal of Agricultural Economics* **70**(5): 1044-1052.

White H, J Leavy, M Mulumbi, G Mulenga, Venkatesh Seshamani (2005) *Rural labour markets in Africa: a channel for pro-poor growth? preliminary findings from a research project in Northern Province, Zambia*. discussion draft. IDS Mimeo.

COMMERCIALISATION OF SMALLHOLDER AGRICULTURE IN MAJOR *TEF*-GROWING AREAS OF ETHIOPIA[1 *]

Samuel Gebreselassie[2] and Kay Sharp[3]

1. Introduction

1.1 Commercialisation(s) in Ethiopia

Commercialisation of agriculture is a central pillar of current poverty-reduction policy in Ethiopia, and one of the core research themes of the Future Agricultures Consortium. Future Agricultures' thematic work on agricultural commercialisation has observed that in various countries different modes of commercialisation co-exist and interact with each other (Leavy and Poulton 2007:17): hence the plural term, commercialisation***s***. In Ethiopia, we suggest that the following existing categories of farmer could benefit from and contribute to market-oriented agricultural growth, representing four different possible "pathways" for commercialisation policy.

1. Smallholder family farms

- Farmers in remote, drought-prone or low-potential areas, generally regarded as "subsistence-oriented" but in fact interacting with markets as both buyers and sellers. The policy challenge posed by these farmers is to improve their terms of engagement with markets, as well as raising productivity and diversifying livelihoods. (Type A)
- "Traditionally" market-oriented small farmers producing crops partly or wholly for sale alongside crops for their own consumption. Such farmers tend to be in locations with favourable growing and marketing conditions, and to focus on specific high-value commodities. (Type B)

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[2] Research Fellow, Agriculture and Rural Development Division, Ethiopian Economic Policy Research Institute (EEPRI), Addis Ababa (sgebreselassie@eeaecon.org).

[3] Research Fellow, Rural Policy and Governance Group, Overseas Development Institute, London (k.sharp@odi.org.uk)

2. Small investor-farmers

- Individuals or small groups of partners, often educated and urban-based; sometimes agricultural professionals with a background in government or development agencies or former state farms; often investing in farming as a secondary activity. These farmers are referred to in World Bank terminology as “emerging commercial farmers”, suggesting an expected trajectory towards larger-scale agri-business. However, we suggest that they are in fact a separate category. In Ethiopia they have only started to re-emerge in the last few years, when access to land for such investments has been made possible.

3. Large-scale “agri-business”

- Generally capital-intensive enterprises (though they can also generate employment); private or state-owned. Examples are export-oriented horticulture and floriculture.

The first phase of empirical work on agricultural commercialisation(s) in Ethiopia has focused on the “Type B” smallholders, that is farming households who are established growers of highly marketable crops, in areas already well-linked to markets. Two commodities were selected for the study: coffee and tef. Both are important to the national economy, and both are grown and marketed by millions of smallholders. Some contrasting and overlapping characteristics of the two crops are summarised in Table 1.

As part of this programme of work, Future Agricultures (Ethiopia) co-organised a parallel session on *Commercialisation of Smallholder Agriculture* at the EEA’s 2007 Conference on the Ethiopian Economy. This paper is one of four linked outputs from that session, the other three being:

- a thematic framework paper discussing the meanings and definitions of commercialisation from conceptual and international perspectives (Leavy and Poulton);
- a brief overview of the policy context and the different (alternative or complementary) pathways of agricultural commercialisation in Ethiopia (Sharp, Ludi and Samuel); and
- an empirical paper on smallholder commercialisation in Ethiopia’s coffee-growing areas, which closely parallels the present paper (Samuel and Ludi).

Table 3: Commodity choice - characteristics of coffee and tef

Coffee	Tef
Non-food	Food (high value)
Primarily export market	Primarily domestic market
High policy attention & intervention *	Limited policy attention & intervention* (until recent years)
Large and small scale production	Small-scale production
Productivity strategy: niche markets (speciality and organic), low chemical inputs	Productivity strategy: intensification through purchased inputs (fertiliser and seeds)
Labour intensive with seasonal labour bottlenecks	
New institutions: Co-operatives and Unions	

** i.e. research and development, market support and control, etc.*

1.2 Objectives

Within the context outlined above, the objectives of the study are:

- to assess the current scale of commercialisation in tef-growing areas, and to detect household and farm characteristics which might explain variation in the levels of commercialisation among households;
- to investigate whether or not increased commercialisation among tef farmers is associated with increased overall farm productivity and consumption (e.g. of food, clothes, education or health);
- to investigate the labour intensity and employment effects of tef commercialisation; and
- to draw policy implications and further research questions for Future Agricultures' ongoing work in Ethiopia.

This paper reports on the first round of quantitative data analysis, supplemented by some insights and queries from qualitative fieldwork.

Tef in the Ethiopian economy

Tef *(eragrostis tef)* is a nutritious small-grained cereal, related to millet, which originates in Ethiopia and is thought to have been domesticated by Ethiopian farmers between 3 and 6 millennia ago. It fetches the highest market price of any food grain in Ethiopia and is the preferred staple cereal for the majority of consumers, both urban and rural. *Enjera* (a thin, pancake-like bread), the traditional national food and still the daily staple for most of the population, requires tef flour.[4]

Farmers' preference for growing tef is not only due to this sustained consumer demand. The crop has a wide altitude range, and its resistance to diverse biotic and abiotic stresses makes it "low-risk" for cultivation (Hailu et al., 2000). It also stores well, since the very small size of the grain makes it resistant to post-harvest damage by insects. Among Ethiopia's 11.3 million small grain farmers, about 46% (5.2 million) grew tef in 2005/06 (CSA, 2006). This makes tef the second most widely-grown annual crop after maize, which was cultivated by 6.8 million farmers. During the same year, tef was grown on over 2.24 million hectares which is a little over one fifth (21%) of the total land planted to grains. The average farmer cultivated tef on 0.43 hectare, on which he or she produced 4.2 quintals [5], implying an average yield of 9.8 quintals per hectare.

In the current policy push for smallholder commercialisation, tef is one of the selected priority crops under the Ministry of Agriculture and Rural Development's 2004 master plan for enhanced market-oriented production.[6] Government support to producers, in terms of agricultural extension services, has grown substantially in recent years: in 2005/06 a little over one million tef growers (21% of the total) participated in the ongoing extension program and received free technical advice, as well as guaranteed access to modern farm inputs like fertilizers, herbicides and improved seeds. In terms of area, 560,000 hectares (25% of the total area planted with tef) was under the extension programme (CSA, 2006).

The national production of tef has increased tremendously over the last twenty years, from 11.8 to 21.8 million quintals (a rise of nearly 85%). However, this encouraging performance is mitigated by the context of high population growth and poor conditions in the base year. *Per capita* production grew only by 23% (1.9% per year) over the same period, and has never exceeded 30 kg. [7] It is also a matter of concern that most (64%) of the growth in production is attributable to area expansion, while improved yields contributed only 12%. [8] This indicates the enormous difficulty of achieving

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[4] In lean times and poorer households, tef is often eked out by mixing it with cheaper grains. However, some proportion of tef is essential for the proper fermentation of the *enjera* batter.

[5] 1 quintal (Q) = 100 kg.

[6] The other priority crops in the master plan are wheat, barley, lentil, chickpea, fava and haricot beans, cotton, sesame, coffee and spices. Source: MoARD (FAC key informant interview).

[7] Per capita national production of all grains was 183 kilogram in the same year (2005/06).

[8]This is despite the availability of tested tef technologies (seed varieties) that could double the existing yield level. The Ethiopian Agricultural Research Institute reported the existence of high yielding varieties even in

broad-based agricultural productivity growth, which is critical to lift the majority out of poverty. Moreover, yield-induced growth in production is essential to allow agriculture to release land for increasingly important but competing activities such as urban and industrial development, and to prevent agriculture from expanding into forest and other unsuitable land (a threat to the long-term sustainability of the farming system).
Tef is particularly interesting in the context of smallholder commercialisation and food security, since it has high value as both a cash and a food crop. Many poorer farmers with suitable land grow it almost entirely for sale, using the proceeds to buy cheaper staples; although, as they become more prosperous, they may retain more for their own consumption. It is grown entirely by smallholders, and has been actively marketed for many generations. Until recently its market was almost wholly domestic, within Ethiopia (and formerly Eritrea): however, a promising niche export market is now developing in Europe and America, based on tef's increasing reputation as a "super-grain", being gluten-free and high in protein and calcium as well as micronutrients such as iron and B vitamins. A Dutch website is currently marketing it (under a profit-sharing contract with the Ethiopian authorities) as "the grain that makes you stronger".

Study areas and methodology

Four major tef-producing weredas were purposively selected as the study areas, based on statistical evidence of the dominance of the crop in the local farming system. Two of the weredas (Ada'a Lome and Bacho) were in Oromia Region, and two (Dejen and Enemay) in Amhara Region. Primary data were collected through a household survey and qualitative fieldwork.

For the household survey, a stratified two-stage sampling design was employed within each wereda. First, all Kebele (sub-district) Associations in the selected weredas were listed, and two were randomly selected. Secondly, twenty households were randomly selected from each kebele (giving a target sample size of 160 households in eight communities). Since the study aimed to investigate gender-related disparities in agricultural commercialisation, the sample was stratified by gender of the household head in order to ensure the inclusion of women farmers. The survey thus applied both purposive and random sampling methods. The actual numbers of female and male respondents are shown in Table 2 below.

2000. There are tef varieties (like DZ-01-974, DZ-01-354 and DZ-Cr-37) which can yield up to 28 quintals under farm conditions and 32 to 46 quintals under experimental conditions. This exceeds the recent best performance (9.7 quintals) by over 3 times (Hailu et al., 2000).

A structured household questionnaire was used to collect quantitative data on production, consumption, and marketing of farm produce, as well as demographics, resource ownership, and off-farm activities. The survey was carried out in 2006, and collected data on the preceding agricultural year (the 1997/98 E.C. production cycle, i.e. March 2005 to February 2006).

Table 4: Survey respondents by gender (household heads)

Wereda	Female	Male	Total	% FHH
Ada'a Lome	10	28	38	26%
Bacho	4	35	39	10%
Dejen	1	40	41	2%
Enemay	5	32	37	14%
Total	20	135	***N=155***	13%

Both descriptive and econometric methods were used to analyse these household data. Descriptive methods including measures of average and a one-way ANOVA (analysis of variance) were employed to disclose the scale of commercialisation of agriculture and to test the existence of any statistically verifiable difference among farmers operating at different levels of commercialisation. Results from the discrete one-way analysis were further examined through multivariate regression models which helped to predict the determinants of commercialisation and its impacts on the consumption and productivity of smallholders.

For the purposes of this paper, the degree of household commercialisation is measured by a simple index defined as the ratio of the gross value of all crop sales to the gross value of all crop production.

Household Crop Commercialisation Index

HCI = (gross value of all crop sales / gross value of all crop production)*100

This index measures the extent to which household crop production is oriented towards the market. A value of zero would signify a totally subsistence-oriented household: the closer the index is to 100, the higher the degree of commercialisation. However, it is recognised that this measure has its shortcomings. The index value itself could be misleading, since a farmer who grows only one bag of maize and sells that bag (HCI = 100) would appear more commercialised than one who grows 50 bags and sells 30 (HCI = 60). It also neglects other components of farm output (such as livestock), the degree of market reliance for inputs, and broader dimensions of commercialisation such as profit motivation and engagement with labour markets. A detailed discussion of these conceptual and measurement issues can be found in Leavy and Poulton (2007).

Following preliminary analysis of the survey data, an exploratory qualitative study was conducted in one of the surveyed tef weredas, Ada'a Lome, in February 2007 (towards the end of the marketing season for tef). This wereda was chosen from among the study areas on grounds of logistics and accessibility, in order to maximise the time spent in field research. The methods used were key informant interviews, semi-structured focus group discussions and individual case interviews. Interviewees and focus group members were identified through local contacts, based on purposive criteria including age, gender, farming experience, and engagement in livelihood activities such as trade and wage labour.

The overall purpose of the qualitative work was to follow up some questions raised by the survey, and to identify any important policy-relevant issues which had not been captured by the questionnaire. Flexible checklists were developed for the focus groups and interviews, around the following themes:

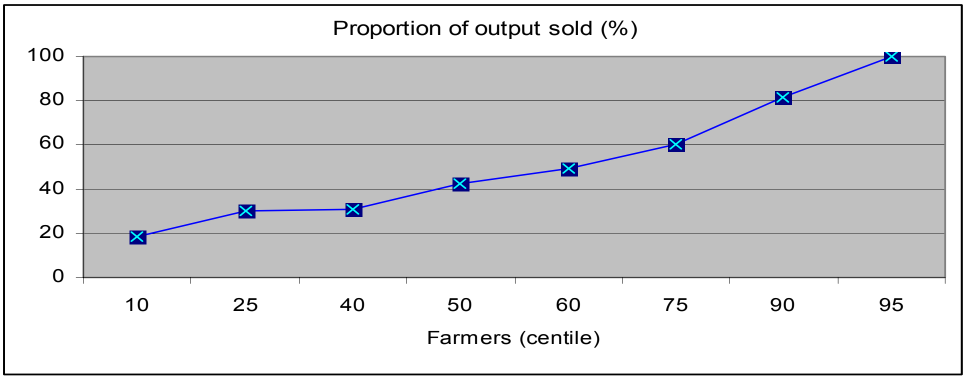
- **Opinions and perceptions** of the advantages and disadvantages of producing for the market *versus* producing for household consumption;
- **Reasons** for different farmers following different strategies (such as selling more or less produce than others), and factors encouraging or discouraging increased market engagement. The discussions tried to explore the direction of causality of some key relationships identified by the quantitative analysis (e.g. the positive association of farm size with degree of commercialisation).
- **Employment and labour market** effects of commercial production by smallholders. This was a scoping theme intended to contribute to a proposal for further research, and collected mainly descriptive information about the types of non-household worker employed for different tasks and seasons; comparative wages and conditions; and the availability of alternative (non-farm) employment.
- **Changes over time**, in both farming and market conditions. Discussions covered changes observed in the recent past, as well as people's hopes and expectations for the future of farming in their area.

4. Findings

4.1 The scale of agricultural commercialisation

The survey data indicate that the average farm household in the four weredas sold a little over 49% of their total crop output (in value terms). A slight majority (about 58%) of surveyed households consumed more than they marketed, while 38% sold more than they consumed and the remaining 4% consumed and marketed an equal proportion of their output. Farmers operating at full commercial level (i.e. those who sold 100% of what they produced) constitute 5% of the sample, while another 7% operated at full subsistence level (i.e. consumed 100% of their production). About 50% of the surveyed farmers marketed less than 42% of what they produced or consumed more than 57% of what they produced. If we consider a farmer who marketed at least 50% of his or her output as commercially-oriented, then 40% of the sample could be so classified. Figure 1 shows the degree of commercialisation by centile of households.

Figure **4**: Proportion of output sold



In general, these data indicate that the level of commercialisation in the study areas is considerably higher than the national average.[9] This is as expected, given the

[9] According to Gebremeskel et al. (1998) only 28 percent of the total national grain production (cereals, pulses and oilseeds) was marketed in 1996. A more recent study by the Ethiopian Economic Association in 2004, however, found that grain farmers who participated in the recent extension programme marketed on average about 33% of their output (5.7 quintals), while non-participants marketed 36% (4.7 quintals). These figures indicate the gross amount sold, without adjusting for any quantities of grain that farmers might have purchased towards the end of the cropping season.

purposive selection of areas known for the production of tef (a highly-marketed commodity), with relatively good access to major markets.

Despite this relatively high degree of market participation, the market size (in terms of the volume of transaction per seller) is thin. Fifty-seven percent of sampled households sold farm produce worth 2,000 Birr (about US$ 222)[10] or less, while the average farmer sold only 933 Birr's worth of produce. Fewer than a quarter (23%) of farmers sold produce (mainly tef, chickpeas and wheat) worth 3,500 Birr or above. As the grain market is characterised by many small sellers, competition among farmers is likely to be fierce. This problem arises mainly due to low per capita production, as confirmed by a single-equation regression model specifying trade as a function of production (see Box 1). The model indicates a significant and positive association between production and trade (both measured in value terms). The regression coefficient of 0.81 shows that for a unit increase in the value of production, earnings from trade rise by 0.81. The high coefficient of determination (r^2=0.63) also shows that about 63% of the variation in trade was explained by the volume of production, keeping other factors constant.

Box **1**: Trade-production relationship among sampled households

$Y_i = -79 \quad + \quad 0.81X_i$	$P = \ (0.93) \ \ (0.00)$
$t = (0.12) \qquad (16.23)^*$	$R^2 = 0.63$

In general, econometric evidence suggests that the higher the level of production the higher will be the probability of farmers engaging in commercially-oriented agriculture. A multivariate econometric model to elaborate this result is discussed later in the paper.

A simple correlation analysis suggests that the more a farmer sold, the lower the *proportion* of output marketed (r=0.12 or r^2=0.1). In other words, as the volume of marketed output increases the volume of output consumed on the farm also increases, but by a higher proportion. This finding, from cross-sectional analysis of households in a given period, is paralleled by observations from the qualitative fieldwork about the pattern of change over time. Farmers in Ada'a Lome observed that both production and marketing of grain crops have risen over the last decade or so, but that the volume marketed has risen less than the volume produced. For tef in

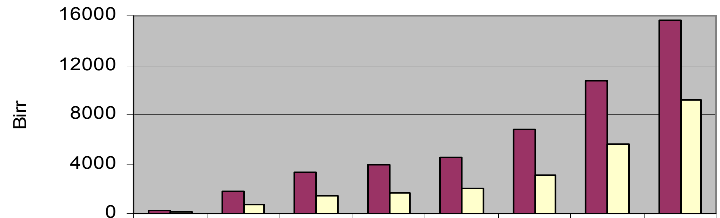
[10]US$1 = approx. 9 Birr.

particular, they considered this increase in home consumption of farm produce to be a sign of rising prosperity:

“Before, we used to mix chickpeas, wheat, or sorghum for *enjera*, but now this has almost stopped – people here eat tef. Because of the increased production and better standard of living, people don’t have to eat these inferior mixtures.”
[Interview with Kebele Chairman]

This type of relationship between marketed and consumed production is not unusual in a farming system dominated by poor smallholders, and signifies the need to investigate the meaning of agricultural commercialisation beyond the simple proportion of agricultural output marketed. In this regard, it is important to include other characteristics of agricultural change associated with commercialisation, and to consider agricultural commercialisation as a process so that changes over time can be incorporated. The potential tensions and synergies between commercialisation and food security for small farmers are particularly important, and will be investigated in more depth during the next phase of this study.

Figure 5: The relationship between crop produced and sold



	10	25	40	50	60	75	90	95
Value of crop produced (Br.)	200	1800	3300	3975	4530	6810	10720	15610
Value of crop sold (Br.)	90	770	1400	1620	2050	3050	5640	9155

Farmers (centile)

4.2 Specialization in tef production

The theoretical literature suggests that agricultural specialization could be considered as a transition from subsistence-oriented to market-oriented production, and hence as a process leading to increased commercialisation. Some authors like Pingali and Rosegrant (1995) even propose the degree to which production is specialized as a signifier of commercialisation (next to the degree of participation in the market and the importance of the profit motive in production). However, there is no conclusive evidence as to whether commercialisation necessarily brings (or is signified by) either increased specialization or diversification (see Leavy and Poulton, 2007).

Crop choice and agro-ecology are among the key factors determining the relationship between specialization and commercialisation. If the crop is a non-food cash or export crop, there could be a high degree of association between the two. This is especially evident in specialization based on agro-ecological advantage, with crops such as coffee or cocoa. On the other hand, among crops like tef which is both a cash and food crop for producers, the relationship is less apparent. In such cases, the relative prices of tef and other competing food or cash crops (which might or might not be produced locally) are important in shaping the relationship between agricultural specialization and the degree of smallholders' market orientation.

In this study, the degree of specialization in tef production was measured in three ways: the proportion of land allocated to tef; the proportion of farm income derived from tef; and the relative amount of purchased inputs (fertilizer) used in tef production. Statistical analysis of these indicators showed a high degree of specialization in tef production. The average farmer cultivated tef on 62% of his or her land (as shown in Table 3), while more than 75% of farmers planted tef on about half of their cultivated area. Over 86% of purchased fertilizer went to tef production, which on average brought in 70% of the gross crop income.

Table **5**: Degree of specialization in tef production among farmers in the study areas

Farmers (percentile)	Land cultivated (ha)	Proportion of tef in		
		cultivated land	fertilizer use	total farm income
10	0.74	32.4	61.2	31.2
25	1.25	48.2	75.1	54.8
40	1.81	57.6	85.1	70.4
50	2.24	62.5	91.6	79.7
60	2.68	68.1	100	88.6
75	3.51	79.2	100	100
90	5.03	93.3	100	100
95	6.01	97.6	100	100
Mean	2.6	61.7	86.4	69.8

The question then arises of the relationship (if any) between this observed high degree of specialization in tef production and commercialisation. A linear covariation between the two was estimated using a coefficient of determination. The coefficient of determination is only 5.4%, meaning that less than 6% of the variation in the degree of market orientation among sampled households is explained by their difference in specialization in tef production, keeping other factors constant. By contrast, there is a high degree of association between farm size and market orientation. The coefficient of determination, r^2=0.76, implies that 76% of the variation in the degree of trade among sampled farmers can be accounted for by the variation in total cultivated land. Another interesting result emerging from the analysis is that the absolute size of land allocated to tef (r^2=0.48) is considerably more important than the proportion of land allocated to tef production in determining the degree of commercialisation. In general, therefore, the empirical evidence suggests that specialization in tef is relatively weakly linked to the degree of market orientation of farmers. This in turn could be associated with the relatively high degree of similarity in tef specialization within the study areas, combined with a high disparity in the size of land cultivated by surveyed farmers.

4.3 Comparative analysis of highly and less commercially-oriented farmers

Many internal and external factors affect the interest and capacity of smallholders to participate in, and benefit from, the exchange economy. The adoption of market-oriented production, for instance, could be influenced by the amount of productive resources at farmers' disposal (especially land, as suggested above), and by their access to markets, information, and financial and technical inputs. A one-way analysis of variance (ANOVA) was conducted to verify the importance of some of these variables in determining the market orientation of farmers in the study areas. For this purpose, sampled farmers were categorized into three groups based on the degree of their participation in output markets to test the existence of statistically significant differences among these groups' vis-à-vis selected variables including the sex and age of household heads, their access to land, use of purchased inputs, income and consumption. The categorization of households is explained in Table 4.

Table 6: Categorization of households by level of commercialisation

	Commercial orientation		
	Low	Medium	High
Proportion of output sold	Less than 30%	30% to 80%	Above 80%
Percent of sellers	67% [11]	100%	100%
Number of households (percent of sample, N=155)	33 (21%)	90 (58%)	32 (21%)

4.3.1 Productive resources

Farmers operating at a higher level of commercialisation (here defined as those who sold more than 80% of their total production) [12] are characterized by cultivating larger land holdings (41% more), renting in more land (33% more) and allocating more land to tef [13]: see Table 5. The highly-commercialised group allocated more than 70% of their land to tef production, while the least commercialised group (i.e. those who sold less than 30% of their farm output) allocated only about half of their land to tef and the other half to the production of other, lower-priced, grains. However, this difference in terms of specialization (in the former case) or diversification (in the latter) is statistically insignificant and signifies the relative unimportance of specialization in tef as a strategy of expanding commercialisation in the study areas.

By contrast, the difference in area cultivated among farmers operating at different levels of commercialisation is statistically significant (at the 5% level): the average farm size of the most commercialised group (3.2 ha) is a third larger than that of the least commercialised. Household size and dependency ratios, on the other hand, do not differ significantly among the categories. The least commercialised households have a household labour:land ratio more than twice that of the highly-commercialised group. Interestingly, this is not reflected in the amount of labour spent on farming activities: the least-commercialised farmers used 12% less labour on a hectare of land than their more market-oriented neighbours (69 person-days compared to 78: see Table 5). A possible explanation is that farmers in the least-commercialised category gave lower priority to farming than to other uses of household labour. Although farming is the major source of income for all the surveyed household heads irrespective of their

[11] The "low commercial orientation" category includes the 7% of sampled households who marketed none of their crop (hence only 67% of this group are sellers). Further analysis should separate out this entirely non-commercial group of farmers.

[12] This classification, categorizing farmers who sold more than 80% of their output as commercially-oriented, is adopted from Lerman (2004) who applied it to the commercialisation of subsistence farms in transition countries.

[13] The average farm size owned and cultivated by farmers in the study areas is far higher than the national average, and is among the highest in the country.

market orientation (see section 4.3.3. and Table 7 below), it is not equally important as an occupation for all groups. All household heads in the highly commercialised category considered farming their main occupation, compared to 94% in the medium group and only 80% in the least commercialised group (although this variation is statistically insignificant). Another hypothesis is that the more commercially-oriented farmers were able to hire more labour. Further analysis is needed of the data collected on labour intensity of farming, as well as on the use of household, hired, and exchange labour by different categories of farmer in different seasonal operations

Table **7**: Household resource ownership at different levels of commercialisation

Proportion of output sold	Commercial orientation						
	Low		Medium		High		
	Less than 30%		30% to 80%		Above 80%		
	mean	sd	mean	Sd	mean	sd	F-value
Total cultivated land (ha)	2.4	1.6	3.1	1.7	3.2	1.6	3.45**
Land rented-in (ha)	0.6	0.7	0.6	0.9	0.8	0.7	1.25
- HHs renting-in land (%)	49		52		72		
Acreage allocated to tef (%)	49.1	34.2	62.5	20.0	70.7	21.6	0.69
Sex of hh head (% of male)	85.0	36.0	85.0	36.0	95.0	24.0	0.18
Age of hh head	48.9	15.4	49.9	13.5	45.3	10.7	0.58
Main occupation of hh head (% farming)	80.5	12.5	94	4.7	100	5.3	0.26
HH size (adult-equivalent)	5.0	1.9	5.3	2.0	5.5	1.8	0.60
Labour-land ratio	2.7	4.1	1.6	1.9	1.2	0.7	4.22***
Dependency ratio (hh size/ labour)	1.6	0.3	1.6	0.4	1.7	0.4	1.46
Labour intensity (person-days/ha)	68.6	47.5	84.7	55.6	77.8	38.3	0.54

****, ** & * indicate significance at 1%, 5% and 10% levels, respectively.*

Demographically, highly-commercialised farmers are slightly younger and more likely to be male. Survey data indicated that household heads in the most commercialised group are, on average, four years younger than those in the least commercialised group, and 95% of them are male (compared to 85% among the least commercialised group). Again, these variations were statistically insignificant

4.3.2 Fertilizer use and productivity

As shown in Table 6, the more commercialised farmers applied more fertilizer (both per farm and per hectare) and spent more on purchased inputs. They spent about

21% of the value of their output (Birr 1,234, equivalent to US$140) on inputs. [14] The intensity of fertilizer use among this group was 102 kilograms per hectare, 19% more than the least commercialised group (16% of whom used no fertilizer). One interesting result emerging from the analysis is that the intensity of fertilizer use on a hectare of land does not vary significantly among the different groups of farmers, but when other variable inputs (hired labour and other non-land inputs) are included the difference in total variable cost per hectare becomes statistically significant.

Land productivity (in Birr per hectare terms) is 22% lower among the least commercialised farmers than among the most commercialised group: however, the difference is statistically insignificant. Among the three groups, farmers operating at a medium level of commercialisation registered the highest land productivity by a small margin. In general, the survey data indicate that the use of fertilizer and other purchased inputs increases as the level of commercialisation increases: however, the impact of this on productivity is inconclusive.

Table 8: Use of purchased inputs and productivity at different levels of commercialisation

Proportion of output sold		Commercial orientation						F-value
		Low		Medium		High		
		Less than 30%		30% to 80%		Above 80%		
		Mean	sd	mean	sd	mean	sd	
Fertilizer use	- kg/farm	216	192	273	199	306	166	4.81***
	- kg/ha	86	69	98	75	102	60	0.55
Variable cost	- Birr/farm	837	719	1314	941	1234	702	3.72**
	- Birr/ha	347	262	465	280	421	263	2.52*
Land productivity	- Birr/ha	1094	1237	1474	1308	1405	2926	0.15
Labour productivity	- Birr/person-day	23	20	27	17	30	53	0.50

***, ** & * indicate significance level at 1%, 5% and 10%, respectively.

4.3.3 Household income, employment and consumption

Table 7 presents data on income, employment and consumption by level of commercialisation: these indicate higher levels of income and consumption among more market-oriented farmers. The average household in the highly commercialised group earned Birr 5,818 (or Birr 1,058 per capita), 39% more than those in the least-

[14] For comparison, the least commercialised group spent on average 837 Birr (about 24% of the value of their farm outputs) on purchasing inputs.

commercialised group (though the difference is not statistically significant). Interestingly, the higher level of income is associated with a higher level of income disparity. In the most commercialised group, only 33% of the households earned more than the group's average income. The corresponding figure for the least-commercialised group is 48%.

These income differences are mirrored in consumption of basic food and other essentials such as clothes, shoes and healthcare. Households in the highly commercialised group were better off by this measure. The average member of this group consumed food items worth Birr 23 per capita (or Birr 124 per household) during the seven days prior to the survey, 19% more than the least-commercialised households. This difference is statistically significant. A multivariate regression model is estimated below (in section 4.4.), to verify whether commercialisation is indeed a factor contributing to this variation in consumption.

Despite these observed differences in income and consumption by degree of commercialisation, the reported income of all the surveyed farmers is insufficient to finance their expenses on basic necessities (food, clothes, shoes, education and healthcare, social obligations, and taxes). Farmers in the least-commercialised category (about 21% of the total sample) can finance on average only 58% of their reported expenditure on basic essentials from farm income: [15] this ratio rises to 74% when income from non-farm sources is included. On the other hand, farmers in the highly-commercialised category generate 68% of their consumption expenditure from farming and another 9% from non-farm or off-farm sources. These data suggest that crop production cannot be the sole livelihood for any farming household even in these highly fertile and relatively land-abundant regions of the country. This remains true whether farmers choose an outward or inward looking production scheme.

Market dependence for food, interestingly, appears highest in the medium commercialisation group. Although this is not statistically significant, the inconclusive finding is a reminder that household food security concerns are quite different for smallholders who produce and market staple foods, compared to producers of non-food crops such as coffee (see Samuel and Ludi). Where the main cash crop is also a locally-consumed food, the usual assumption that commercialised farmers are more reliant on (and more vulnerable to) the market for food does not necessarily hold. Two cases encountered by the qualitative field team illustrate this (see Annex 3 for a

[15] Any expenditure on variable inputs (e.g. fertilizer, seeds, hired labour and other non-land costs) was taken into account as the gross margin was computed by deducting variable costs from gross revenue.

summary of the interviews). The poorer of the two farmers, who was considered less market-oriented, has to purchase about 50% of his household's staple food needs; while his more prosperous neighbour covers all his consumption needs from his own production in addition to marketing eighteen times as much.

Table 9: Income, employment and consumption at different levels of commercialisation

Proportion of output sold	Commercial orientation						F-value
	Low		Medium		High		
	Less than 30%		30% to 80%		Above 80%		
	Mean	sd	mean	Sd	mean	sd	
Income and employment							
Total household income [16] (Birr)	4,192	3,571	4,990	4,791	5,818	8,570	0.58
Per capita income	879	811	963	824	1,058	2,314	0.50
HHs earning above the group average income (%)		48		34		33	
Contribution of income sources (%)							
▪ Crop farming	84	36	86	21	88	28	0.95
▪ Non-farm self-employment	9	37	4	11	7	22	3.09**
▪ Employment (off-farm and non-farm)	2.3	13.3	7.3	17.0	5.0	14.6	0.40
Migration (% hhs with one or more member who migrated for at least one month)		21		15		24	
Consumption							
Estimated expenses for basic goods & services [17]							
▪ Birr/per capita/annum	1,125	732	1,420	878	1,437	725	9.6***
▪ Share of food expenditure (%)	81.5	12.3	78.2	22.6	80.9	17.3	7.6***
▪ Share of clothes and shoes (%)	7.6	11.7	10.3	36.1	7.7	16.9	0.73
▪ Share of education, health, social issues, taxes (%)	10.9	15.4	11.5	21.2	11.4	23.4	2.08
Capacity of income to meet expenditure (%)		74		67		77	

****, ** & * indicate significance level at 1%, 5% and 10%, respectively.*

[16] Income from livestock is not included. Farmers in the study areas follow a mixed farming system where livestock is primarily an integral part of the crop production system, rather than a separate enterprise. However, this should not indicate the absence of direct income from livestock activities. In the qualitative fieldwork, a number of farmers reported seasonal livestock fattening as an income source.

[17] Annual expenditure for food was computed based on detailed information obtained from the surveyed households on their food consumption for 7 days prior to the survey. The value of food consumed during that week was converted to annual consumption. Other expenditures are usually made once or twice a year.

The two interviews further highlight some of the limitations of the quantitative measures employed in this paper, and the need to look at smallholder commercialisation within the context of the household economy (and, indeed, the wider geographic and economic context). The more prosperous Farmer A is marketing more produce and clearly gaining more net benefit from his interactions with traders than is his neighbour Farmer B: key informants from the local Bureau of Agriculture suggested him as an example of a successful market-oriented farmer. Yet the proportion of crop output he sells would probably put him in the medium or even the low commercialisation category (he had sold 27% of his crop output at the time of interview, and planned to sell a little more later in the season). Farmer B, on the other hand, is considered to be struggling and finds that higher tef prices and easy market access are of little benefit to him, since he is equally a seller and a buyer of grain. Yet, according to the standard indices applied in the survey analysis, he is more specialised than Farmer A in tef production (which accounts for 100% of his cultivated land, fertilizer use and crop income), and has a similar level of crop commercialisation (selling 29% of his much smaller output).

4.4. Econometric evidence - Multivariate regression analysis

Using a multivariate regression model, the study attempted to identify the factors that led some farmers to adopt a more market-oriented strategy than others. The model also helped to verify some of the results obtained through the one-way analysis of variance.

4.4.1 Determinants of commercialisation

A logistic model was formulated to estimate the probability of adopting commercially oriented agriculture by creating a dichotomous dependent variable based on the first and third categories above: households following commercially-oriented agriculture (defined as selling more than 80% of output) versus the least commercialised households (defined as selling less than 30% of output). If the j^{th} farmer's level of commercialisation is denoted by z_i and a corresponding probability (i.e., the probability of commercial orientation) by p_i such that the probability of following a commercial agriculture (z_i=1)= p_i and the probability of following non-commercial agriculture (z_i=0)= 1-p_i, the logistic model is specified by:

$\text{Logit}(p_i) = \text{Log}(p_i/1-p_i)=B_0 + B_1X_{1i} + B_2X_{2i} + \ldots\ldots + B_nX_{ni} = h_i$
So that $p_i = e^{ni}/(1- e^{ni})$

where e^{ni} is known as the logistic transformation of p_i.

A number of independent variables were hypothesized to affect farmers' decisions either to follow a commercial or non-commercial strategy. There could be a combined effect of a number of factors related to farmers' production objectives, their resources and constraints. The independent variables considered in the model are as follows:

1. *Wealth related variables*, both income- and asset-based. These include gross farm income, per capita farm income, livestock and land ownership, and the type and size of house (represented by the number of rooms and the roofing material). All these variables were hypothesized to affect the commercial orientation of sampled farmers positively, as they increase the probability of surplus production or raise farmers' risk tolerance.
2. *Price.* The price farmers receive for their products is an important factor in their decision to follow a market oriented strategy. The relative prices of competing products are more important than the price of a single product (e.g. tef). However, for lack of data, only the tef price is included in the model to test for any difference among farmers who received different prices. Instead of the current price, a lagged price was used.
3. *Characteristics of the farm manager* (household head). These include age, sex and basic education (literacy). While age was a continuous variable, sex and literacy were entered into the model as dummy variables. Being young, male and able to read and write were hypothesized to increase the probability of farmers following a more commercial production strategy.
4. *Household size.* This could have either a positive or a negative impact on households' decision to adopt outward-looking or inward-looking strategies. A large family could reduce the volume of marketable surplus because of high on-farm food demand or consumption. Conversely, it could provide a large labour force to work on the farm or in non-farm activities that bring cash to the household. This, in turn, could either reduce farmers' incentive to take part in output markets (because their demand for cash was met by other income), or increase their capacity to do so by improving access to purchased inputs like fertilizers and thus raising production.
5. *Participation in land rental markets.* As farm land becomes increasingly scarce (because of high population growth, low out-migration, increased demand for land for non-farm activities, and the growing problem of land degradation), land rental markets create opportunities for farmers and landless persons to access more land and thus increase their production. Hence, participation in the land rental market and renting in large areas were expected to enhance the commercial orientation of surveyed farmers.

6. *Specialization in tef,* measured in terms of the proportion of land allocated to tef production, is hypothesized to enhance the degree of farmers' participation in output markets.
7. *Use of more purchased inputs.* Farmers spending more on purchased inputs are expected to participate more in output markets. This is could be associated with increased demand for cash to finance their input purchase, or high productivity due to increased use of purchased inputs, or both.
8. *High dependence on the market for food.* The degree of households' dependence on the market for food (measured in terms of the proportion of food purchased) was expected to be positively associated with agricultural commercialisation.
9. *High cash demand for non-food essentials,* measured in terms of the amount of cash spent on clothes and shoes, was hypothesised to be positively associated with the probability of households being more market-oriented.
10. *Migration*, defined as having one or more family member who migrated to other areas, is hypothesized to enhance the degree of farmers' participation in agricultural markets (possibly through the use of remittances for input purchase).
11. *Engagement in rural financial markets and off-farm activities* were hypothesized to encourage farmers (or force them if they borrowed money) to adopt an outward (more commercial) production strategy.

As indicated by a chi-square (significant at 5%), the independent variables as a whole made a difference in predicting the dependent variable. In other words, the estimated model indicated the importance of these explanatory variables in influencing farmers' commercial orientation.

A simultaneity bias test (using a Hausman Specification Test) was also run, to test the existence of a reverse relation between the household commercialisation index (the dependent variable) and the size of farm cultivated (one of the independent variables). In other words, the interest was to determine whether the size of cultivated land is an exogenous or endogenous variable. The test rejected the hypothesis of simultaneity between the household commercialisation index and the size of cultivated land. [18]

Wealth-related factors were found to have a positive and statistically significant effect on commercialisation. The size of land owned and cultivated had a positive and

[18] The test involved two steps. First, the household commercialisation index (HCI) was regressed on all the explanatory variables including farm size, to obtain the residual. Second, farm size was regressed on HCI and the residual from the first regression. The test statistic on the coefficient of the residual gave an insignificant result, implying that the hypothesis of simultaneity between the two variables can be rejected.

significant effect on whether a household followed a commercial orientation or not. Farmers who are relatively well-endowed with agricultural land are more likely to follow commercially-oriented agriculture. Households who rented in land, and those who rented larger areas, have a higher probability of commercialisation. The positive and significant impact of the size of rented land on commercialisation reinforces the previous result, and demonstrates the critical role of farm size in agricultural commercialisation in the study areas.

Table 10: Determinants of commercialisation (logit results)

	Coefficient	F-statistics
Type of roof (dummy, 1=corrugated iron, 0=other)	4.71	2.45**
Number of rooms	2.09	2.11**
Value of total farm output (crops) produced	0.02	2.72***
Per capita (gross) farm income, proxy for wealth	-0.01	2.62
Farm gate price	-0.00	-.10
Livestock - number owned and present on your farm	-0.12	0.94
Sex of household head	5.98	2.04**
Age of household head	0.53	1.32
Basic education, dummy, 1=able to read and write, 0=otherwise	-2.51	1.53
Size of land rented-in	3.99	2.47**
Participation in land markets, 1=participated, 0= did not participate	-1.04	0.63
Land owned and cultivated	2.13	2.15**
Acreage allocated to tef (% of total cultivated land)	0.04	1.50
Household labour force (man-equivalent) §	-0.12	0.13
Household size (adult-equivalent) §	-1.37	1.66*
Total variable cost incurred (fertilizer, pesticides, seeds, hired labour)	-0.01	2.19**
Variable expenses per hectare of land	0.01	1.51
Market dependence for food (%food purchased)	0.02	0.84
Expenditure for clothes and shoes (lagged variable)	0.01	1.64*
Migration dummy, 1=if any hh member migrated, 0=otherwise	2.50	1.53
Participation in credit market	-0.38	0.24
Participation in off-farm activities	-0.98	1.01
Number of observations	60	
LR χ^2 (23)	38.21	
Prob > χ^2	0.0242	
Pseudo R^2	0.4597	
Log likelihood	-22.450564	

§ See Annex 1 for conversion factors

Other wealth-related factors such as the value of total farm outputs and the size and type of housing were also found to have a positive and significant effect on the probability of outward-looking (commercialised) farming. The positive impact of high production could be associated with its effect on the level of household surplus, while the positive impact of housing quality (as a proxy for wealth) could be explained by the greater ability of better-off households to manage the risks of market participation. On the other hand, agricultural intensification (measured in terms of variable costs of purchased inputs [19] per hectare) was found to be statistically irrelevant to the probability of commercialisation.

The gender of the household head emerges as a statistically significant determinant of commercialisation, and female-headed households have a higher probability of being in the least commercialised category of farmers. In focus group discussions, women farmers in Ada'a Lome explained that their key constraint (compared to their male neighbours) was access to labour, particularly adult male labour for ploughing. This means that on the one hand their production costs are higher (as they have to hire more labour), while on the other their yields are lower because their fields are less thoroughly ploughed, or not ploughed and planted at the optimal time. Meanwhile they have to repay the same amount of fertilizer credit as the more productive male farmers (the Bureau of Agriculture supplies a fixed package per hectare). In marketing their output they found no gender barriers ("we stand equal with the men"), but their difficulties were in achieving higher production. Like the male farmers interviewed, the women focus group members said that they would like to market more if they could produce more: "Yes, why not? The price is increasing, the living conditions are improving. If we had labour and oxen why wouldn't we want to sell more?"

Larger households have a low probability of commercially oriented agriculture according to the multivariate regression results (contrary to the earlier finding from bivariate statistical analysis). On the other hand, the probability of farmers being more market-oriented is positively and significantly affected by the level of consumption of industrial goods (clothes and shoes) which was entered into the model as a lagged variable.

[19] This measure of intensification does not include household (non-purchased) labour inputs, although qualitative discussions suggest that this is a very important factor. Further analysis is needed.

4.4.2 Testing the effects of commercialisation

4.4.2.a Effect on consumption

Agricultural markets could affect smallholders' consumption either positively or negatively, directly or indirectly. Markets create opportunities for smallholders to generate cash that can be used for the purchase of agricultural inputs, which in turn could improve production and consumption. Smallholders could also sell a high value food crop such as tef to buy a lower-value staple such as maize. However, if agricultural markets operate at a low competitive level and fail to provide a stable and fair price, the production of cash crops or a high degree of participation in agricultural markets could also harm the welfare of smallholders and encourage them to adopt an inward-looking production strategy.

According to our survey, the level of consumption varies markedly among sampled households. As shown in Table 9, the bottom 20 percent of households consumed food and other basic essentials (clothes, shoes, healthcare and education) worth only Birr 867 per capita per annum, less than half the average consumption of the top 20 percent (Birr 1,999). This variation in consumption is not an isolated phenomenon: there is a correspondingly high degree of variation in the level of commercialisation. Farm households in the bottom 20 per cent, for instance, sold only 29% of their output, while those in the top 20 percent sold 65%. It is therefore important to ascertain the relationship between consumption and the degree of participation in agricultural output markets.

The standard literature describes household consumption as a function of income, asset ownership and family size. Households' capacity to make use of markets could also affect consumption directly or indirectly. A multivariate linear regression model consisting of these variables was formulated to test empirically the role of agricultural markets in consumption. The model estimated household per capita expenditure on food (produced and purchased) and other basic essentials as a function of household income from both farming and non-farming activities; their family size expressed in terms of adult equivalent (consumption unit); and other demographic characteristics such as age, sex, education of the household head and household assets (notably land and livestock). The household commercialisation index was included as an independent variable. It was hypothesized to affect consumption either positively or negatively depending on the competitiveness of the market.

Table 11: Consumption of basic essentials and agricultural commercialisation

Sampled Households (Percentile)	Expenditure on food, clothes, healthcare and education (Birr/ capita/ annum)	Household commercialisation index (% of output sold by value)
10	686.4	22.9
20	866.7	29.1
25	944.2	30.3
50	1,262.6	42.4
60	1,414.5	46.6
75	1,789.1	60.0
80	1,998.6	64.6
90	2,340.1	80.5
N = 137		

The model, using the Ordinary Least Square (OLS) method, provides robust estimates (see Table 10). The level of consumption is significantly affected by the size of farm land cultivated by households. This is not unexpected in a farming system where land is becoming increasingly scarce. Coefficients from the regression model show that, as farm size increases by a hectare, per capita consumption goes up by Birr 136, keeping other factors constant. Consumption is also affected positively by the level of market-orientation.

The OLS estimates also indicate negative effects of large family size and female headship on per capita consumption. Both of these results were statistically significant.

Despite these interesting results, the low R^2 value of 32 percent indicates that only one third of the total variation in consumption is explained by the set of independent variables considered in the model. This might seem a rather low value but in cross-sectional data low R^2 values are common, possibly because of the diversity of the units in the sample. Therefore, one should not be surprised or worried about finding a low R^2 in cross-sectional regressions. What is relevant is that the model is correctly specified, that the regressors have the correct (i.e. theoretically expected) signs, and that (hopefully) the regression coefficients are statistically significant (Gujarati 2003:260).

Table **12**: Determinants of consumption (regression results)

	OLS with robust s.e		**Descriptive statistics**	
	Coeff.	**t-statistics**	**mean**	**sd**
Dependent variable:				
Per capita consumption of basic goods & services (Birr)			1,483	874
Independent variables:				
Per capita gross farm income (Birr) §	0.11	0.95	769	689
Per capita income from own non-farm activities (Birr)	-0.15	0.41	55	224
Per capita income from employment (Birr)	-0.12	0.34	85	239
Household size (adult equivalent)	-202.3	4.5***	5.3	2.1
Sex of hh head (dummy)	-606.7	2.38**	0.88	0.32
Age of hh head	5.28	0.80	48.2	13.4
Basic education of hh head (dummy)	234.9	1.21	0.61	0.49
Size of cultivated land §	135.7	2.22*	2.37	1.60
Livestock size	-20.1	0.86	3.03	3.2
Index of hh commercialisation	9.84	2.72***	46.5	22.9
R^2	32			

****, ** and * indicate significance at 1%, 5% and 10%, respectively.*

§ A test to detect multicollinearity between per capita gross farm income and the size of cultivated land does not show the existence of a high degree of multicollinearity that could bias the estimates. The partial correlation between the two variables is less than 15%.

4.4.2.b Impact on productivity

Evidence from a range of Asian and African countries demonstrates the central role of increased agricultural productivity in promoting pro-poor growth, especially in the early stages of development and when productivity growth results in lower food prices (Byerlee et al., 2005). Competitive agricultural markets are expected to affect productivity positively. Productivity increase usually follows the market, responding to opportunity and demand; but this also depends on other factors affecting one or both of these factors. Moreover, experiences from elsewhere do not show a consistent pattern.

The study therefore tried to identify the factors that contributed to the observed wide difference in agricultural productivity among surveyed farmers [20] and to establish

[20] Survey data indicate that the bottom 10% of the surveyed farmers earned only 544 Birr (net) from a hectare of land, while the top 10% earned Birr 5,581 from the same land size. Similarly, the bottom 25% earned Birr 1,098, while the upper 25% earned Birr 3,695.

whether a higher degree of commercialisation (defined as a higher degree of market participation) is among the determinants of agricultural productivity in the study areas.

Table 13: Land productivity and agricultural commercialisation among surveyed farmers

Sampled households (percentile)	Gross margin (Birr/ha)	Household commercialisation index (%)
10	553.5	22.9
20	904.8	29.1
25	1097.8	30.3
50	2118.2	42.4
60	2603.0	46.6
75	3695.0	60.0
80	3980.5	64.6
90	5581.2	80.5
N = 137		

A linear multivariate regression was run, regressing land productivity as the dependent variable on a range of explanatory variables including the use of different production factors and inputs, the degree of farm specialization in tef production, household income (from both farm and non-farm activities), age and sex of household head, and the household commercialisation index. Land productivity was measured by dividing gross margin (total value of outputs minus variable costs) by the total area of land cultivated. [21]

The results indicated no association between agricultural commercialisation and land productivity (although the estimate had a positive sign), confirming the ANOVA result reported earlier. This weak association could be attributed to the multifaceted relationship between farm size, productivity and the proportion of output marketed. Commercialisation was significantly and positively affected by farm size, but farm size was significantly and inversely related to land productivity.[22] On the other hand, the more commercialised farmers are more land abundant (relative to labour) than the

[21] Total factor productivity (TFP), which is measured as the ratio of value of output over the value of all inputs, was preferred, but it was found difficult to construct since it is often problematic to value key inputs where factor markets are not well-functioning.

[22] In their study on the effects of cash crop production on food crop productivity in Zimbabwe in 1995/96, Govereh and Jayne (1999) obtained a similar result.

least commercialised group. These opposite-direction interactions among the three variables could overshadow the potential link between agricultural commercialisation and productivity.

4.5 Labour intensity, productivity and employment

Access to labour emerged from the qualitative fieldwork as a critical factor in farmers' ability to increase their production and to benefit from favourable market conditions. The potential of market-oriented smallholder farms to generate decently paid employment (both for household members and others) is also one of the key policy issues raised by Future Agricultures' study of the various commercialisation pathways. It is taken as a premise that labour markets, both agricultural and non-agricultural, are a vital mechanism for the transmission of growth benefits to the majority of poor people. Ultimately it is labour productivity (the returns per person, rather than per hectare) which will determine the poverty-reduction effect of agricultural intensification and commercialisation.

The survey analysis presented above has touched on some aspects of labour access and intensity of labour use as a factor of production in crop farming. Both labour intensity (in terms of person-days per hectare – see Table 5) and labour productivity (in Birr per person-day – see Table 6) appear to be higher for more commercialised farmers in the study areas. However, the differences are not statistically significant among the commercialisation categories as defined here, and further analysis of these relationships is needed. The finding (in section 4.3.2.) that total variable input costs are significantly related to commercialisation level, while fertiliser use is not, suggests that expenditure on hired labour may be an important factor: again, more analysis is needed to disaggregate labour costs from other inputs and to test the relationship.

Household-level data were also collected on farm labour inputs by seasonal activity and by plot and crop. Labour inputs were quantified in person-days, and categorised as family or landlord labour; hired labour; or *debo* (work party) [23] and other forms of exchange arrangement. These data have not yet been analysed but will be employed

[23] In *debo*, the land owner provides food and drink in return for the labour of a group of friends or neighbours. Other local forms of labour exchange include *jigi*, a reciprocal arrangement in which a group of farmers work each other's fields in rotation. In focus group discussions, women farmers noted that they were usually able to access ploughing labour through *debo* during the land preparation season, but not at sowing time when labour was scarce and cash payments were needed. Able-bodied men (like Farmer B in Annex 3) can exchange their own labour for oxen use at ploughing time.

in the next phase of research, to explore further the relationships between commercialisation, productivity and employment.

Tef production, like coffee, has seasonal labour bottlenecks which are met partly by temporary migrants from other farming areas. During the qualitative fieldwork, scoping discussions were held with local wage-labourers and with experienced farmers who employ farming labour (both local and migrant). On this occasion it was not possible to interview migrant workers themselves, as they had already left the area with the end of the harvesting season. Employers explained that groups of farm workers (all men) come to Ada'a each year from relatively poor and food-insecure areas such as Wollo, Gojjam and Selale. Some come only for the labour-intensive harvest, while others stay for the whole cropping season. In addition to cash wages (usually agreed on a piece-work basis) they receive board and lodging with the employing household. While some farmers preferred to hire local workers, others maintained that the migrants work harder and faster because they have no distractions or social obligations in the area, and because they travel and work in organised groups under experienced leaders. Local youths, who take waged work either to supplement or replace farming on their own account, complained that the migrants undercut their pay rates.

Wage rates for farm labour were, nonetheless, reported to have risen steeply in the last few years, driven (in local people's opinion) both by commodity price rises and by labour scarcity due to competition from non-farm employment. [24] Increased production of tef and other crops, in response to favourable prices and the availability of technical inputs, is likely to have played a part in these wage rises. Current daily rates for different types of work in the area range between 7 and 20 Birr (see Annex 2).

Estimates of the overall scale of temporary labour migration within Ethiopia, particularly between different farming areas, are lacking. In the one kebele where these discussions were held, the seasonal inflow of labour was significant (50 to 60 migrant farm-workers had been hosted in the preceding cropping season, by a total resident population of around 500 households). This supply of mobile, experienced farming labour contributes both to the production of tef and other marketed crops in high-potential areas and to the incomes and food security of the migrants' areas of origin. While some migrant workers are landless (or rent out their land because they lack the means to farm it), others are able to combine farming in their home areas with seasonal labour migration because of the varied cropping seasons in different agro-ecological zones of the country. Such temporary labour migration has so far

[24] Ada'a Lome is well-served by infrastructure and location, being on the main trunk-road east of Addis Ababa and within daily commuting distance (2 hours' walk) of the city's industrial outskirts.

been neglected in rural development, poverty-reduction and commercialisation policies: further research and consultation are needed to raise the profile of this issue.

5. Conclusions

5.1 Summary of survey findings

The degree of agricultural commercialisation

- The level of commercialisation in the study areas is far higher than the national average. The average farmer sold about half (49.7%) of what he or she produced (in value terms), compared to a national average in 2004 of about 33% (EEA 2006).
- The degree of commercialisation, however, differs widely across sampled households, which implies a correspondingly wide variation in the potential and constraints for further commercialisation. Therefore, any agricultural commercialisation strategy should be customized for different groups of farmers.

Commercialisation and trade

- A simple correlation analysis suggests that the more a farmer sold the less will be the proportion of marketed output ($r=0.12$ or $r^2=0.1$). In other words, as the volume of marketed output is increased the volume of output consumed on the farm is increased even by a higher proportion, so that degree of commercialisation (as measured in terms of the proportion of output sold) is decreased.
- Despite the relatively high degree of market orientation in the study areas, the size of market (per seller) is very thin.
- The volume of trade is constrained by low per capita production. Over 63% of the variation in trade among sampled households is explained by variation in production, keeping other factors constant.

Who are the commercialised farmers?

- Survey data indicated that commercial farmers were younger (by 4 years, on average) than less-commercialised farmers. Over 60% of the least commercialised group were aged 40 or over, while the corresponding figure among more market-oriented households was 44%.
- Male household heads are more likely to be commercialised than female household heads. Evidence from the regression model also verified a statistically significant effect of gender on the probability of households following a market-oriented strategy.
- The probability of higher commercialisation decreased as the size of family increased.

- Better off households had a higher probability of being more commercialised.

Land and labour

- The more commercialised farmers cultivated larger land holdings (41% more), rented in more land (33% more) and were more specialized in tef production (tef occupied 70% of the cultivated area). These variations are statistically significant.
- Farmers in the most commercialised group are more land abundant relative to labour than the least commercialised. The household labour:land ratio of the latter group is more than double that of the former.
- Farm size, and the size of land rented in, have strong positive associations with the degree of commercialisation. Estimates from the econometric regression model indicated that farmers who are relatively well-endowed with agricultural land are more likely to be practising market-oriented agriculture. The direction of causality is not clear, however. Discussions during the qualitative work suggest that this may be something of a chicken-and-egg question: people with more land can market more, but equally those who profit from selling their produce are more able to accumulate land through the active rental market.

Farm expenditure, productivity and income

- Farmers operating at a higher commercial level spent a significantly larger amount of cash on farming inputs. However, there is no statistically verifiable evidence that this had a corresponding impact on or association with agricultural commercialisation.
- Land productivity was 28% lower among the least-commercialised farmers than the most commercialised. However, this difference is statistically insignificant. The household commercialisation index had a weak association with land productivity.
- Farmers operating at the higher commercial level earned on average Birr 6074 per household (or Birr 1256 per capita). This exceeds the average income of the least commercialised households by 45%, though the difference is not statistically significant.
- Income disparity is high among the more commercialised households, where only 33% of the households earned at least the group average income. The corresponding figure for the least commercialised group is 48%.

Consumption

- Households in the highly commercialised group were better off in terms of consumption of food and other essentials (clothes, shoes and healthcare). The average household in this group consumed 19% more food (i.e. food worth Birr 22 per capita) during the seven days prior to the survey. This difference is statistically significant and indicates that farmers operating at a higher level of commercialisation are better off.

- Results from the multivariate econometric model also indicated that the household commercialisation index is among the factors that positively affect consumption among the surveyed households.
- The positive and significant association between the amount of money spent by a household on clothes and shoes and the degree of crop commercialisation confirms the potential role of demand-led agricultural development in the growth of light industries.

Livelihoods

- Income and consumption data indicate that crop agriculture cannot be the sole livelihood for any of the surveyed households. This remains true whether farmers sold a higher or lower proportion of their output: however, crop income met a lower percentage of consumption needs among the less-commercialised farmers.
- Similarly, there is some variation in the degree of dependence on agriculture. All household heads operating at the highest level of commercialisation gave farming as their main occupation, compared to only four in five (80%) of the least commercialised group.

5.2 Policy issues

At the farm household level, the major constraints to commercialisation in the study areas appear to be production constraints. The strong positive association between farm size and the degree of crop commercialisation suggests that consolidation of land holdings into larger units may be necessary for significant increases in commercialisation to take place. Both the survey data and the qualitative discussions show that there is an active land rental market in the study areas, enabling some farmers to expand their cultivated area while others reduce their farming operations and perhaps diversify into other income sources. The nature and quality of those alternative income sources, and the conditions of exit for farmers (and farmers' children) leaving the land, will be crucial in determining the economic and welfare effects of land accumulation by the more successful commercially-oriented farmers.

The development of sustainable and reasonably-paid alternative employment in the non-farm economy is therefore an essential complement to agricultural intensification. The survey finding that even commercialised households, even in these prosperous farming areas, cannot meet their consumption needs from crop income reinforces the need for economic diversification alongside agricultural growth.

At the same time, employment within agriculture should not be neglected. It is not only large-scale agribusiness that generates jobs. Commercialising smallholders also provide employment to non-household members, even though it is usually casual, seasonal, and invisible to official employment statistics. Measures which increase labour productivity should also transmit increased earnings to agricultural workers, including migrants. Temporary labour migration in general, and seasonal rural-rural migration in particular, has so far been absent from policy debates on rural development and poverty reduction: yet it contributes both to production in the high-potential areas and to food security in the poorer agricultural sending areas. More attention is needed to these linkages.

5.3 Continuing research

In general, the findings discussed above indicate the positive role and effects of agricultural commercialisation for smallholders in the study areas, where access to roads and markets is above the national average and where conditions favour a degree of specialisation in tef, a crop commanding high market demand and prices. These effects will not necessarily hold true in other areas and other farming systems, where conditions and opportunities may be very different. Continuing research into agricultural commercialisation(s) should keep in mind the diversity of the smallholder sector, as well as the other complementary pathways to commercialisation sketched out in the introduction.
This paper has investigated the extent, determinants and effects of commercialisation at the household level, as measured by a simple index of the proportion of crop output marketed. It has also highlighted some known limitations of such indices. Further research needs to incorporate a more multi-dimensional definition of commercialisation, and to consider factors such as specialization and diversification at a wider level than the household alone.

Market access, conditions and institutions are, of course, critically important in determining who benefits from commercialisation and to what extent. While some preliminary research was carried out into the operation of newly revitalised farmer co-operatives in the selected areas and commodities, this topic has not been covered in the present paper. Co-operatives may play an important role in improving smallholders' bargaining capacity and access to market information, as well as providing a degree of temporal arbitrage (by buying farmers' produce at harvest when they need cash and selling at a higher price later in the season, with a percentage of the profit reverting to the producer). These evolving institutions, and other aspects of smallholders' terms of engagement with input and output markets, are a key part of the overall policy research agenda on commercialisation.

The food security implications of increasing market orientation among different smallholder sub-sectors require further investigation and analysis. A comparison of household strategies in the contrasting cases of the tef (food crop) and coffee (non-food crop) study areas could help to illuminate the issues.

Lastly, not enough is known about the employment effects of smallholder commercialisation, including the role of seasonal labour migration in both sending and receiving areas. Further research is proposed on this theme.

References

Befekadu Degefe and Berhanu Nega (eds) (2000). Annual Report on the Ethiopian Economy. Vol I. 1999/2000. The Ethiopian Economic Association. Addis Ababa, Ethiopia.

Byerlee, Derek, Xinshen Diao and Chris Jackson (2005). Agriculture, Rural Development and Pro-poor growth. Country Experiences in the post-reform era. Agriculture and Rural Development Discussion Paper 21. The World Bank.

CSA (2006a). Agricultural Sample Survey 2005/2006: Report on Area and Production of Crops. Vol. I, Statistical Bulletin 361. Central Statistical Agency, Addis Ababa, Ethiopia.

CSA (2006b). Agricultural Sample Survey 2005/2006, Vol. II, Statistical Bulletin 361. Central Statistical Agency Addis Ababa, Ethiopia.

EEA (2002). Second Annual Report on the Ethiopian Economy. The Ethiopian Economic Association. Addis Ababa, Ethiopia.

EEA (2004): Report on the Ethiopian Economy. Vol. III, 2003/04, Addis Abeba, Ethiopia.

EEA (2005). Report on the Ethiopian Economy. Vol. IV, 2004/05, Addis Abeba, Ethiopia.

EEA (2006). Evaluation of the Ethiopian Agricultural Extension with Particular Emphasis on the Participatory Demonstration and Training Extension System (PADETES), Addis Abeba, Ethiopia.

Eleni Gabre-Madhin and Tadesse Mezgebou (2006). Prices and Volatility in the Ethiopian Grain Market. Paper submitted for ESSP Policy Conference 2006. Ethiopia Strategy Support Program. International Food Policy Research Institute and Ethiopian Development Research Institute. Addis Ababa, Ethiopia.

FDRE (2006). Plan for Accelerated and Sustained Development to End Poverty (PASDEP). Federal Democratic Republic of Ethiopia, Ministry of Finance and Economic Development, Addis Ababa.

Gebremeskel Dessalegn, T.S. Jayne and J.D. Shaffer (1998). Market Structure, Conduct and Performance: Constraints on Performance of Ethiopian Grain Markets. Working Paper 8, Grain Market Research Project, Ministry of Economic Development and Cooperation, January 1998, Addis Abeba.

Govereh, J. and T.S. Jayne (1999). The Effects of Cash Crop Production on Food Crop Productivity in Zimbabwe: Synergies or Trade-offs? Policy Synthesis Number 40. Michigan State University http://aec.msu.edu/fs2/polsyn/No40.htm

Gujarati, Damodar N. (2003). Basic Econometrics. Fourth Edition. The McGraw-Hill Companies, Inc.

Hailu Tefera and Seifu Ketema (2000). Production and Importance of Tef in Ethiopian Agriculture. In: Hailu Tefera, Getachew Belay and Mark Sorrells (eds) (2000). Narrowing the Rift: Tef Research and Development. Proceedings of the International Workshop on Tef Genetics and Improvement, Debrezeit, Ethiopia. 16-19 October 2000. Ethiopian Agricultural Research Organization, Addis Ababa, Ethiopia.

Hailu Tefera, Getachew Belay and Mark Sorrells (eds) (2000). Narrowing the Rift: Tef Research and Development. Proceedings of the International Workshop on Tef Genetics and Improvement, Debrezeit, Ethiopia. 16-19 October 2000. Ethiopian Agricultural Research Organization, Addis Ababa, Ethiopia.

Kenea Yadeta, Gezahegn Ayele and Workneh Negatu (2000). Farming Systems Research on Tef: Smallholders' Production Practices. In: Hailu Tefera, Getachew Belay and Mark Sorrells (eds) (2000). Narrowing the Rift: Tef Research and Development. Proceedings of the International Workshop on Tef Genetics and Improvement, Debrezeit, Ethiopia. 16-19 October 2000. Ethiopian Agricultural Research Organization, Addis Ababa, Ethiopia.

Ketema, Seifu (1989). Production trends, germplasm resources, breeding and varietals improvement of small millets, with special emphasis on tef in Ethiopia. Pp 167-172. In: Seetharam A., Riley K.W. and Harinarayna G (Eds.) Small Millets in Global Agriculture. IDRC, Oxford & IBH Co., India.

Leavy, J. and C. Poulton (2007). Commercialisations in Agriculture: a Typology. Paper presented at the Fifth International Conference on the Ethiopian Economy, EEA, June 2007, Addis Ababa. www.future-agricultures.org

Lerman, Zvi (2004). Policies and institutions for commercialization of subsistence farm s in transition countries. Department of Agricultural Economics and Management, Faculty of Agriculture, The Hebrew University, Rehovot 76100, Israel.

Samuel Gebreselassie and E. Ludi (2007), Agricultural Commercialisation in Coffee-growing Areas of Ethiopia. Paper presented at the Fifth International Conference on the Ethiopian Economy, EEA, June 2007, Addis Ababa. www.future-agricultures.org

Storck, H., Bezabih E., Berhanu, A., Andrzej, B. and Shimelis W/ Hawariat (1991). Farming Systems and Farm Management Practices of Smallholders in the Hararghe Highlands. Farming Systems and Resource Economics in the Tropics. Vol. 11. Wissenschaftsverlag Vauk Kiel, Germany.

von Braun, Joachim (1994). Production, Employment, and Income Effects of Commercialization of Agriculture. In: Joachim von Braun and Eileen Kennedy (eds) (1994). Agricultural Commercialization, Economic Development and Nutrition. The Johns Hopkins University Press, London.

von Braun, Joachim and Eileen Kennedy (eds) (1994). Agricultural Commercialization, Economic Development and Nutrition. The Johns Hopkins University Press, London.

von Braun, Joachim, Howarth Bouis and Eileen Kennedy (1994). Conceptual Framework. In: Joachim von Braun and Eileen Kennedy (eds) (1994). Agricultural Commercialization, Economic Development and Nutrition. The Johns Hopkins University Press, London.

Annex 1: Conversion factors

1. Adult equivalents (household size)

To compute household size in Adult-Equivalent (AE) based on consumption needs the following standard conversion factors were used. A male adult is assumed to require 3,000 kcal/day.

Age group (years)	*Male*	*Female*
< 10	0.6	0.6
10 – 13	0.9	0.8
14 – 16	1	0.75
17 – 50	1	0.75
> 50	1	0.75

Source: Institut pan-Africain pour le Developpement (1981) as quoted in Storck et al. (1991).

2. Man equivalents (labour-force)

To compute household labour force in Man-Equivalent (ME) the following standard conversion factors were used.

Age group (years)	*Male*	*Female*
< 10	0.0	0.0
10 – 13	0.2	0.2
14 – 16	0.5	0.4
17 – 50	1	0.8
>50	0.7	0.5

Source: These conversion factors were developed comparing between Here (1986), Johnson (1982), Ruthenberg (1983) and Nair (1985) as quoted in Storck et al. (1991).

Annex 2: Wage rates for farm and non-farm work (Ada'a Lome, 2006/07)

Type of work	Payment terms	Daily wage or equivalent (Birr)*	Comment
Farm employment			
Ploughing	Migrants: 50-100 Birr / month, plus board & lodging, for 6 month season Mar- Aug (ploughing, sowing, weeding)	-	Ploughing done by men only.
	Daily rate for full plough team (2 men, 2 oxen + plough) = 20-30 Birr plus food at planting time (Jul)	10-15	Ploughing for land preparation (Mar-May) costs 15 Birr/day for full team, but usually done through *debo.*
	Daily wage (worker only)	8-10 (preparation) 15 (planting time)	
Weeding	Daily wage (plus food)	15	Same for men and women. 3 years ago rate was 5-6 Birr
Harvesting	Piece work (by kert): ▪ Tef 60-100 Birr/kert, takes 5-7 days ▪ Wheat 80 Birr/ kert, takes 7-10 days ▪ Chickpeas 80 Birr/ kert, takes 4-5 days	 9-20 8-11 16-20	 Tef harvested only by men Other crops - men & women paid same Chickpeas injure the hands
	Plus board and lodging (for migrants) or daily meal (for local workers)		
Non-farm employment			
Quarrying (carrying gravel/ stone)	Daily wage, weekly contract (8-hour day, 6 days a week)	8-10 (men) 7 (women)	Insecure (employers select strongest at weekly spot-market; workers earn nothing if machinery breaks down). Seasonal (most work stops in rainy season) 1 hour's walk away
Portering (carrying grain) in local market	Piece-work (0.75 to 1 Birr per 50kg sack)	10-15 (max.)	Market day only Seasonal (in harvest / dry season – peaks Dec/Jan)
Concrete factory	Daily wage (8-hour day, 6 days a week)	9	2 hours' walk away
Construction (plastering local mud-wall houses)	Daily wage	7-8	Seasonal (Jul/ Aug, in rainy season) Low demand, employment difficult to get
Thatching (local houses)	Piece work (50-60 Birr per house, takes 3-5 days).	12-17	Skilled work – few people can do it.

** Daily wage rates include the cash component only; additional in-kind payments are difficult to value.*
Source: qualitative fieldwork, various group and individual interviews

Annex 3: Two farmers in Ada'a Lome (summary of case interviews)

	*Farmer A **	*Farmer B **
Household size	*6*	*6*
Land	*Owns 20 kert (5 ha)* *Farms 15 kert, gives 5 to son* *Contracts in 2 kert for 2nd son (cash rental, 500 Birr/ kert)*	*Owns 8 kert (2 ha)* *Farms 2 kert, gives 2 to son* *Contracts out 4 kert (cash rental, 5-600 Birr/ kert)*
Labour	*Hiring in* *Employs 2 people for ploughing, 5-7 people for harvesting, live-in herd boy; prefers local to migrant labour*	*Hiring out* *Exchanges own labour for plough use (3 days to 2)* *Two sons and their wives doing daily waged work in concrete factory outside farming season*
Oxen	*Owns 3 pairs*	*None (ox died 7 years ago)*
Crops grown	*Tef; wheat; beans; chickpeas; barley*	*Tef (mixed) only*
Total crop production this year (volume)	*67 Q*	*3.5 Q*
Percent of crop production sold (by volume)	*27% (18Q)*	*29% (1Q)*
Percent of tef production sold	*53% (8/15 Q)*	*29% (1/3.5 Q)*
Tef as % of marketed output (by volume)	*63%*	*100%*
Market reliance for staple food	*None (self-sufficient – expects to have grain still in store to sell off just before next year's harvest)*	*About 50% (retains 5 sacks of own tef harvest for consumption; plans to buy a further 5 sacks with money from land rental)*
Perceived constraints to marketing more	*Labour (workers are becoming scarce due to competition from non-farm employment).* *Land (main constraint according to son)* *Water*	*Oxen* *Land quality (soil not good enough to grow higher-value white tef).*
Attitude to markets	*"Now we don't have quotas, we do as we like …. The government allows us to sell our crops as we like, and the price of tef, wheat etc. is high… We're selling tef at 500 Birr/ Q, a price we never saw before… It's the farmers who can construct modern houses now. We're really in a good condition."* *"A person who has the heart to work can really become prosperous here in 4 or 5 years…. A person who wants to work [and doesn't have land] can get land on contract."*	*"The increase in the price of grain makes no difference because it goes on buying fertilizer – and then I have to buy grain [for consumption]!"* *"I sold 2 sacks [of tef] to pay my land tax."* *"If I had more production I'd sell more, why not? The ox is my only problem."*

* These two farmers were purposively selected through key informants as examples of a prosperous, market-oriented farmer (A) and a less well-off farmer (B) living in the same community – i.e. facing broadly the same environmental and market conditions. Both household heads are male and in their late sixties.

COMMERCIALISATION OF FARMING IN ETHIOPIA: WHICH PATHWAYS?[1]

Kay Sharp[2], Eva Ludi[3] and Samuel Gebreselassie[4]

Abstract

The paper considers the various and potential meanings of commercialisation (or market-oriented agriculture) for Ethiopia. Much attention has been paid recently to high-tech, large-scale, export-oriented enterprises such as floriculture: but international evidence and Ethiopian realities demonstrate that this is only one of many complementary pathways to commercialisation. Most of Ethiopia's small farm households are already engaged with markets to varying degrees: improving the terms of that engagement is likely to have a greater and more widespread impact on poverty than a few large ventures, and should be given equal policy attention.

Policy debates on commercialisation of agriculture are not new in Ethiopia: various approaches and strategies have been dominant in different periods of history. While improving productivity, increasing foreign currency earnings through export and developing a strong agro-industrial sector were the focus of policy attention in the 1950s and 1960s, accelerating growth and poverty reduction have been much more the focus of recent attempts to increase the commercial orientation of farm households.

We suggest that four types of commercial farms can currently be discerned in Ethiopia:

- *Farming households in marginal or remote areas who have had relatively little interaction with markets until now, but who have the potential and interest to benefit from greater commercialisation or more advantageous interactions;*
- *Farming households living in more productive and market-linked areas, and/ or growing highly commercialised crops (such as coffee and tef), who have a long experience of production for the market;*

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[2] Research Fellows, Rural Policy and Governance Group, Overseas Development Institute, London (k.sharp@odi.org.uk; e.ludi@odi.org.uk).

[3] Research Fellow, Agriculture and Rural Development Division, Ethiopian Economic Policy Research Institute (EEPRI), Addis Ababa (sgebreselassie@eeaecon.org)

[4]

- *Small investor-farmers, mostly educated and town-based, some of them agricultural professionals, who have begun to establish farming businesses in the last few years in response to the freeing up of land regulations; and*
- *Large capital-intensive business ventures.*

Different policy support is likely to be needed for different agro-ecological and socio-economic environments and for different groups of farming households, but all can benefit from (and contribute to) enhanced market oriented agricultural growth. Whichever pathways are followed, the destination should be increased income and improved quality of life for rural Ethiopians.

1. Introduction

Agricultural commercialisation has been in the policy spotlight in Ethiopia for the last two years, since it was given a central place in the country's second Poverty Reduction Strategy Paper (MoFED 2006; see also Amdissa 2006). The overall development strategy as set out in the 'Plan for Accelerated and Sustained Development to End Poverty' (PASDEP) for the next five years is built on eight pillars. The second pillar foresees a massive push to accelerate growth aiming at improving people's livelihoods and significantly reducing poverty. The two main thrusts to achieve this are (a) the commercialisation of agriculture, and (b) accelerating the development of the private sector, both within and outside agriculture. A major transformation of the agricultural sector is envisaged and farmers, both small and large, should be linked more strongly to markets by producing marketable farm products, both for export and domestic markets. The Government is well aware that such an agricultural transformation can only be pro-poor if initiatives to enhance market integration are accompanied by substantial measures to support more subsistence-oriented farm households (such as social protection and the development of non-farm income sources).

Although mentioned in the PASDEP, the meaning(s) of commercialisation, and the question of what type of commercialisation should be pursued, has been relatively little discussed by policy makers and development experts. The issue of small versus large farms, or how small a farm could be for sustainable commercialisation, is one that needs policy debate in Ethiopia. Also, whether commercialisation focuses largely on non-food or food crops, and on export or domestic markets, has different implications for the economy.

Recent high-profile agri-business investments (notably in large-scale export floriculture) have led some observers to worry that the new emphasis on commercialisation will mean the neglect of the country's approximately 11.5 million smallholders (MoFED, 2006), or the creation of a dualistic agricultural sector. Yet, on paper at least, the government remains committed to "market-oriented" agriculture for smallholders alongside the promotion of large-scale export-oriented ventures where opportunities exist.

Future Agricultures Consortium (FAC) is a partnership between research-based organisations in Africa and the UK, with work currently focusing on Ethiopia, Kenya and Malawi. The Consortium aims to encourage critical debate and policy dialogue on the future of agriculture in Africa. Through stakeholder-led policy dialogues on scenarios for agriculture, informed by field research, the Consortium aims to elaborate the practical and policy challenges of establishing and sustaining pro-poor agricultural growth in Africa. Current work focuses on three core themes:

- ***Policy processes:*** what political, organisational and budgetary processes promote or hinder pathways to pro-poor, agriculture-led growth? What role should different actors, including Ministries of Agriculture, have in this?
- ***Growth and social protection:*** what are the trade-offs and complementarities between growth and social protection objectives?
- ***Agricultural commercialisations:*** what types of commercialisation of agriculture both promote growth and reduce poverty? What institutional and market arrangements are required?

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Future Agricultures' thematic work on agricultural commercialisation(s) provides a conceptual and international context for the Ethiopian debate. Among the relevant issues Leavy and Poulton (2007) raise in view of current policy discourse around agricultural commercialisation, which are specifically relevant for Ethiopia, are the following.

- There is a tendency to simplification and separation of producers into different types of farms (small versus large farms) growing different types of crops (food versus cash crops) with a distinction made between "subsistence" and "commercial" or "export-oriented" agriculture. In reality, typical farms in Ethiopia, although they tend to be small, combine production both for own consumption and for the market. Even in areas highly favourable for growing export crops such as coffee, farm households usually have a diversified farm, including food crops for consumption and for sale on local markets and cash crops such as coffee, which is destined – depending on the quality – either for the domestic or for the export market.
- Whilst the degree of market participation in the output market lies at the heart of

most definitions of agricultural commercialisation, other dimensions are also of relevance. These include the degree of participation in input markets, the degree of relying on hired labour, and the profit motive.

- Although farm size can have an important influence whether or not a household adopts a commercialised farming strategy, size alone is not the decisive factor. It is, however, a strong limiting factor in the absence of efficient food markets – in this case, households with small holdings have to be assisted to achieve higher staple yield before they will begin to devote land to production of higher value market products. Once households can be reasonably sure that they can meet their food needs in a normal year over a longer period of time, investments in producing for the market starts making sense. Attention will thus have to be paid to increase the productivity of food staples alongside support provided to the expansion of commercial agriculture.
- Large farm bias may develop in practice, even when policy appears to be pro-smallholder on paper. Explanations for this are that large farms can prosper when the basic enabling environment (macroeconomic stability, banking sector, trunk infrastructure, political support for private enterprises, research and development) is in place, as they can secure critical services for themselves. Smallholders, by contrast, need a much more pro-active service and support system (e.g. pre-and post harvest services related to extension, finance, inputs, knowledge and capacity). If these support services are not available – and this is an implementation, not a policy issue - then there is little prospect for the development of a viable commercially-oriented smallholder sector.
- Lastly – a point that has been at least partly taken into account in PASDEP[5] – geography matters for any agricultural policy. Ethiopia is a vast country with a highly differentiated geography and diverse bio-physical and socio-economic endowments. From an agricultural development perspective, absolute and comparative advantages of different communities are fundamentally important frames for designing development strategies. The original differentiation, mainly based on moisture availability, has recently been expanded by including access to markets and infrastructure and population density resulting in 25 sub-categories based on combinations of four criteria: (i) moisture / rainfall (moisture reliable /

[5] PASDEP (MoFED, 2006) defines four main four main zones: (i) areas with significant potential for commercialisation and diversification (i.e. areas with significant access to markets and infrastructure, high agro-ecological potential); (ii) drought-prone regions (emphasis on food security, reducing volatility of production, diversification away from food crops, increasing off-farm income, voluntary resettlement); (iii) regions with adequate rainfall (emphasis on improving infrastructure and basic input and market systems to facilitate increases in agricultural production), and (iv) pastoral areas (emphasis on providing appropriate infrastructure and social services and tailoring research and extension programmes more towards the needs of dryland agriculture and livestock).

drought prone / pastoralist) (ii) altitude (highland / lowland), (iii) access (high / low), and (iv) population density (high / medium / low) (Chamberlin et al., 2006).

This paper sets out to provide a brief narrative context to Future Agricultures' empirical and consultative work on commercialisation in Ethiopia. For specific analyses of two important but very different crops, tef and coffee, see Samuel Gebreselassie and Sharp (2007) and Samuel Gebreselassie and Ludi (2007), respectively. The issue of commercialisation has also been addressed in the series of regional consultations organised to develop and test an inclusive model of policy dialogue, and to generate indicative policy ideas and trends on the future of agriculture in Ethiopia.[6]

2. Historical background

Debates on commercialisation are not new in Ethiopia. Especially since 1957, when various development strategies and economic policies and development plans were introduced in the formal economic planning process, there have been a number of attempts to improve the performance of the agricultural sector and to lower the dependency of the Ethiopian economy on smallholder agriculture. The first Five-Year Plan (1957-61) sought to develop infrastructure and human resources, and aimed to accelerate agricultural development by promoting commercial agricultural enterprises. The second Five-Year Plan (1962-67) signalled the start of a twenty-year programme to change Ethiopia's predominantly agricultural economy to an agro-industrial one. Based on the World Bank's agricultural modernization strategy, large-scale commercial farms were recommended. Increasing agricultural export was also one of the major objectives of the agricultural sector at that time (Dessalegn, 2005; EEA, 2005).

A study by Dessalegn (2005) found that during the Imperial Regime, Ethiopia's agricultural policies became increasingly outward oriented. In the late 1960s, large-scale mechanised farms began to emerge in the southern and eastern part of the country, producing mainly export crops and contributing to the already complicated

[6] Six regional consultations were held in 2006 and 2007, culminating in a national workshop in June 2007 (see http://www.future-agricultures.org/ethiopia_national_consultation.html). The consultations were thematically structured around the scenarios proposed in Devereux et al. (2005), and each included a break-out group and plenary discussion on commercialisation.

structure of land tenure regimes.[7] Investors were supported by government policy which emphasised agricultural mechanisation to improve productivity, by offering tax and financial incentives to investors. The government itself was also involved in such mechanised enterprises and was the largest commercial operator at the end of the 1960s.

Many of the major donor agencies were, at least initially, quite enthusiastic about the prospects of commercial enterprises, both as a source of foreign earnings and as a catalyst for the modernisation of agriculture. There were a number of recommendations towards expanding commercial agriculture and greater investments in agro-industries. A favourable policy environment and a strong international demand for specific products provided positive incentives for investments into export-oriented agriculture. In the early 1970s, mechanised large farms were increasingly criticised. The World Bank, which had been a strong advocate of commercial agriculture in the 1960s, became concerned about the inefficiencies of many of the enterprises and saw instead considerable potential in smallholder agriculture by the end of the decade. Insisting that land reform was essential for a rapid increase in agricultural productivity, the World Bank recommended that policy makers provide strong support to the smallholder sector (Dessalegn, 2005).

Not only investors were engaged in export-oriented agriculture, but also owner-operators who had access to sufficient land. The spread of commercial agriculture in favourable areas (e.g. the Awash Valley, Rift Valley, Humera) in the 1960s opened up opportunities for farmers to engage in export-oriented production. In some areas, farmers were organised into cooperatives to access credit from the Agricultural and Industrial Bank. Commercially oriented farms were also important as they offered seasonal employment. Additionally, contract farming and outgrowing schemes emerged rapidly in some areas such as the Awash Valley (Dessalegn, 2005).

The revolution in 1974 led to significant institutional and policy reforms, including the nationalisation of all land and subsequent distributions among farmers, who lost whatever ownership rights they had, but were granted use rights. Large commercial farms were brought under state control, and most were transformed into state farms. Also small agricultural investors were affected by the land reform as they too lost their land. Furthermore, renting land as well as employing labourers was prohibited, which

[7] Alongside small-scale owner-cultivators, there were landholders who had often obtained their estates through political means. Such landholders were members of the nobility and local gentry. The church and the state itself were also large landowners who had their land worked by sharecroppers.

meant an end to the emerging outgrower schemes and contract farming arrangements.

The stylized summary in the table below highlights some elements of commercialisation policy that have dominated, and recurred, in different historical periods.

	Strategic concerns	Policy foci
1950s	Improving **productivity** Reduce economic dependency on agriculture	**Infrastructure & human resources** Accelerating agricultural development by promoting commercial enterprises
1960s	Transform predominantly agricultural to **agro-industrial** economy Increase **foreign earnings**	**Large-scale** commercial farms Investments in agro-industries Agricultural **mechanisation** Increasing export-orientation
1970s	Concerns about inefficiency of many large, mechanised farms, renewed **focus on smallholder** potential	Proposals for land reform for increased agricultural productivity
1980s (Derg)	Socialist agricultural development Central planning Collectivisation	State farms Suppression of land, labour & commodity markets Land distribution & fragmentation Control of **input & output markets**
1990s (Transitional Period)	ADLI (Agricultural Development-Led Industrialisation)	Liberalisation of output markets Gradual liberalisation of input, labour, land rental markets Privatisation / distribution of state farms Land policy debate

Recent policy on commercialisation

With the change of government in 1991, large parts of the agricultural sector were liberalised, most notably price controls over outputs were abolished, and state control over input and financial markets was gradually reduced. The system of state ownership of land, however, was retained, and only long-term usufruct rights were transferred to farmers. Restrictions on renting and inheriting land were abolished, but it is still illegal to mortgage or sell land. Some of the previous state farms were dismantled and distributed to farmers, while others were kept under state control with a view to selling them to private investors under the privatisation programme. The new government maintained a strong focus on smallholder farming and poverty reduction, and supporting agricultural intensification (e.g. stepping up the agricultural extension systems, providing fertilisers and improved seeds for major grain crops). Where options for agricultural intensification reached their limits, social protection programmes were scaled up, mainly supported through donor funding, including cash and food transfers to vulnerable and resource-poor farm households in rainfall insecure areas.

This agricultural-based poverty reduction strategy was the guiding principle in the first PRS and also shaped the second PRS, the Plan for Accelerated and Sustained Development to End Poverty (PASDEP). Alongside a strong growth focus, PASDEP, covering the period from 2005/06 to 2009/10, aims to "*capture the private initiative of farmers and support the shifts to diversification and commercialisation of agriculture*" (MoFED, 2006).

The Agricultural Development Led Industrialization (ADLI) policy framework, pursued since 1994, still guides current policy. ADLI reflects the importance of the agricultural sector for overall economic development, viewing agricultural development as the key driver for industrialisation by providing a market base. ADLI combines various components supporting agricultural growth, including technology, finance, rural infrastructure, internal and external markets and the private sector focusing on (1) improvements in food security, (2) the commercialisation of agriculture, (3) the extension of credit to small farmers and (4) industrialisation.

Although ADLI is widely regarded as generally going in the right direction, a number of problems and constraints have been raised regarding its different components and its implementation. The most important is that ADLI appears linear, beginning with agricultural development, which will contribute to industrialisation further down the line. However, Ethiopia could move on agro-industrial development now, concurrent with agricultural development and commercialisation alongside more subsistence-oriented agriculture, providing basically a safety-net for the poor (Guinand, forthcoming).

The Rural Development Strategy (FDRE, 2001) defines in more detail how agricultural-centred rural development should work for Ethiopia and emphasises that rural development needs to be labour- rather than capital-intensive. It also addresses issues of (i) diversification and specialisation of crop and livestock production according to agro-ecological zones and market access, (ii) agricultural marketing (i.e. labelling, creating grades and standards, providing market information, establishing and strengthening cooperatives, and strengthening the private sector's role in marketing), (iii) improving the rural financial system, (iv) encouraging the private sector - both national and foreign - in agricultural development, (v) investing in necessary rural infrastructure, and (vi) strengthening links between rural and urban areas, and the farm and non-farm sectors. Overall, the rural development strategy intends to contribute to the transformation of the productive rural sector from a primarily subsistence-oriented to a more market oriented sector, contributing to overall economic growth and poverty reduction.

The overall development strategy for the five years to 2010, as set out in the PASDEP, builds on these earlier strategies. As noted in the introduction, the second of its eight pillars is accelerated growth aiming at improving people's livelihoods and significantly reducing poverty. This is to be achieved firstly through commercialisation of agriculture, and secondly through accelerated private sector development.

The strategy depends heavily on transforming the agricultural sector via major efforts to support the intensification of marketable farm products - both for domestic and export markets, and by both small and large farmers. Elements of the strategy include a shift to higher-valued crops, promoting niche high-value export crops, focusing on selected high-potential areas, facilitating the commercialisation of agriculture, supporting the development of large-scale commercial agriculture where it is feasible, and better integrating farmers with markets (both local and global). The strategy is clear about who should drive these efforts - the private sector, which includes the millions of small farmers. However, given current weaknesses of the market, the state sees a clear role at the beginning of this transformation period, by providing public investments and services needed to help jump-start the process.

The Government is well aware that such an agricultural transformation can only take place in parallel with measures to support more subsistence-oriented farm households who lack the resources for substantial investments in alternative enterprises. In these cases, the main goal will remain higher yields of basic food grains. This will be pursued through a combination of intensified extension support at the *kebele* (sub-district) level, establishment of a network of demonstration centres, increased low-level veterinary services, support for small-scale irrigation and better use of ground water, complemented by Productive Safety Net schemes and off-farm income generating initiatives supported under the Food Security Programme. The PASDEP notes that agricultural development – whether by investors or family farms - can only be achieved by sustainably managing the natural resource base and protecting the environment.

Institutions and incentive systems must also be improved in order to transform the agricultural sector and the economy as a whole, according to a study for the Ministry of Finance and Economic Development (Weeks et al., 2004). For example, agricultural marketing remains constrained and inefficient. It is not backed by a strong transport sector, there are too few intermediaries and traders lack adequate capital and storage facilities; there are few links to agro-processing, and input markets have remained stifling rather than enabling. Diversification into alternative crops and expanding production of higher value goods, often for export, are seen as crucially important. Weeks et al. also observe that Ethiopia, thanks to its favourable agro-ecological conditions and rich pool of genetic diversity, has a large opportunity for diversification which is so far mainly untapped. Currently, successful expansion of horticulture and floriculture and well as dairy and poultry enterprises can be observed in the vicinities of major towns such as Addis Abeba, but there are other products which show considerable potential such as bamboo, spices, and non-timber forest products.

Which pathways?

Perceptions of "commercialisation"

There are various definitions and measurements of commercialisation in the analytical literature: but what does it mean to farmers and agricultural practitioners? The series of regional consultations held by Future Agricultures in Ethiopia encountered some common (mis)perceptions or fears about the nature and effects of commercialisation. Participants in the regional discussions variously understood commercialisation to mean:

- **Large-scale** farming – raising fears of expropriation of land and displacement of small farmers, and even a return to feudalism;
- **Capitalist** farming – that is, extractive, owned by people from outside the farming community or even by foreigners;
- Focusing on **non-food "cash crops"**, which may exacerbate food insecurity by making poor farmers more vulnerable to markets, particularly to volatile or adverse terms of trade between food and cash-crop prices;
- **Export-oriented** – contributing little to the needs of Ethiopians;
- **Mechanised** and "modern" – displacing labour and relying on environmentally un-sustainable imported technologies; or

- **Capital-intense**, rather than labour-intense - again, squeezing out the poor both as workers and investors, and reducing the number of people able to make a living from agriculture.

As Leavy and Poulton (2007:3) point out, all these perceptions amount to a fear that commercialisation will promote the interests of the rich and powerful, at the expense of small farmers. None of these fears is entirely unfounded, and clearly they are partly shaped by experience of the various historical periods of commercialisation outlined above. Equally, none of them is necessarily a feature of more commercialised or market-oriented agriculture. Policy-makers need to guard against the risks that commercialisation may indeed disadvantage small farmers, and to promote participatory and inclusive policy-making processes in which such fears can be aired and understood.

A further perception recurring in the regional discussions of commercialisation is that farmers first need to change their attitude to markets and become more business-minded. We would take issue with this. Our experience suggests that farmers, even poor farmers in "subsistence-oriented" areas, are as entrepreneurial as any other group of people when they find opportunities (although, as with any population group, some will naturally be more business-minded and successful than others). Business acumen, like any skill, comes with practice and experience. While there is certainly a role for skills transfer and basic education in strengthening farmers' market position, the policy priority is therefore to change farmers' opportunity environment rather than their mentality.

Types of commercial (market-oriented) farmer

From preliminary research and consultations, we suggest that there are four different categories of farmer in Ethiopia who could benefit from, and contribute to, market-oriented agricultural growth. Different policy support may be needed for each group, representing four potential "pathways" for commercialisation.

1. Smallholder family farms

- (Type A) Farmers in remote, drought-prone or low-potential areas, generally regarded as "subsistence-oriented" but in fact interacting with markets as both buyers and sellers. The policy challenge posed by these farmers is to improve their terms of engagement with markets, as well as raising productivity and diversifying livelihoods. Where opportunities exist, farmers in these areas can be as entrepreneurial as anywhere else.

- (Type B) "Traditionally" market-oriented small farmers producing crops partly or wholly for sale, alongside crops for their own consumption. Such farmers tend to be in locations with favourable growing and marketing conditions, and to focus on specific high-value commodities (such as coffee and tef: see Samuel and Ludi (2007), Samuel and Sharp (2007)).
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2. Small investor-farmers

- Individuals or small groups of partners, often educated and urban-based; sometimes agricultural professionals with a background in government or development agencies or former state farms; often investing in farming as a secondary activity. These farmers are referred to in World Bank terminology as "emerging commercial farmers", suggesting an expected trajectory from less-profitable smallholder farming towards larger-scale agri-business. However, we suggest that these investors are in fact a separate group. In Ethiopia they have only started to re-emerge in the last few years, when access to land for such investments has been made possible.

3. Large-scale "agri-business"

- Generally capital-intensive enterprises (though they can also generate employment); private or state-owned. Examples are export-oriented horticulture and floriculture.

3. Conclusion

Attempts to integrate farmers into the market have a long tradition in Ethiopia. Different strategies to increase the commercial orientation of farm households have been pursued, although with different motivations at different times. Whereas in the 1950s and 1960s productivity increases, agro-industrial development, and foreign export earnings were in the foreground of the debate, recent attempts towards a commercially oriented agricultural sector are more strongly oriented towards accelerated growth and poverty reduction.

We have proposed a typology of commercial farmers in Ethiopia ranging from smallholder family farms selling part of their production on the market to large-scale, generally capital-intensive farm enterprises. This typology is not meant to imply a temporal succession, but our preliminary findings rather show that these four types of farms can exist simultaneously, also based on their different advantages and disadvantages in relation to production and marketing (e.g. while smallholders are assumed to perform better in labour intensive crops where quality assurance and traceability are not yet that important, large-scale commercial enterprises are better able to engage in risky or capital-intensive enterprises). There is also the potential that these groups complement each other. All four groups can benefit from policies aiming at higher market integration or commercialisation, although the policy focus needs to be different for the different groups.

Policy interventions aiming at pro-actively supporting smallholder family farms to improve their engagement with markets are expected to have the greatest impact on poverty reduction. Great care, however, needs to be taken to avoid unintended large-farm bias during implementation. Measures to avoid this are proposed by Leavy and Poulton (2007) to be:

- Paying attention to food crops
- Pro-actively encouraging asset accumulation (e.g. in animal traction)
- Making markets work for poor farmers in poor (remote) areas.

Leavy and Poulton further conclude, based on international experience, that to support smallholder commercialisation, just focusing on creating an enabling environment is rarely enough, but that there needs to be a much more active provision of relevant pre- and post-harvesting services. This is certainly also the case in Ethiopia. Given the highly diverse landscape in terms of agro-ecology, infrastructure availability, market access, population density and farm types, policy orientation and implementation must take into account these differences.

While debating possible ways forward in agricultural commercialisation and devising the most promising policy options, we should not lose sight of the destination of proposed pathways to commercialisation: poverty reduction, improved income and quality of life for the millions of Ethiopia’s farmers. There is nothing to be gained by policies aiming at increased commercialisation if commercialisation itself does not contribute to these ultimate goals.

References

Amdissa Teshome (2006), 'Agriculture, Growth and Poverty Reduction in Ethiopia: Policy Processes Around the New PRSP (PASDEP)'. Paper presented at the Future Agricultures Consortium workshop, IDS, March 2006 http://www.future-agricultures.org/pdf%20files/Ag_policy_Ethiopia.pdf

Chamberlin, J., J. Pender, B. Yu (2006), 'Development Domains for Ethiopia: Capturing the Geographical Context of Smallholder Development Options'. DSGD Discussion Paper No. 43. Washington DC, IFPRI.

Dessalegn Rahmato (2005), 'From Heterogeneity to Homogeneity: Agrarian Class Structure in Ethiopia since the 1950s'. Addis Abeba, Forum for Social Studies.

Devereux, S., Amdissa Teshome and R. Sabates-Wheeler (2005), 'Too much inequality or too little? Inequality and Stagnation in Ethiopian Agriculture'. IDS Bulletin Vol.36 No.2, pp.121-6.

EEA (2005), 'Report on the Ethiopian Economy'. Volume IV 2004/05, Addis Abeba.

FDRE (2001), 'Rural Development Policies, Strategies and Instruments'. Federal Democratic Republic of Ethiopia, Addis Abeba.

Guinand, Y. (forthcoming), 'Policy Issues and Outlook'. In Hurni, H. et al. (forthcoming) Soil Erosion and Conservation in Ethiopia. Bern, CDE.

Leavy, J. and C. Poulton (2007), 'Commercialisations in Agriculture'. Paper presented at the Fifth International Conference on the Ethiopian Economy, EEA, June 2007, Addis Ababa.

MoFED (2006), 'A plan for Accelerated and Sustained Development to End Poverty (PASDEP) (2005/06-2009/10)'. Volume I: Main Text. Addis Ababa. Ministry of Finance and Economic Development, Addis Abeba.

Poulton, C., G. Tyler, A. Dorward, P. Hazell, J. Kydd and M. Stockbridge (2006), 'All-Africa Review of Experiences with Commercial Agriculture'. Summary Report. Draft.

Samuel Gebreselassie and E. Ludi (2007), 'Agricultural Commercialisation in Coffee-growing Areas of Ethiopia'. Paper presented at the Fifth International Conference on the Ethiopian Economy, EEA, June 2007, Addis Ababa. www.future-agricultures.org

Samuel Gebreselassie and K. Sharp (2007), 'Commercialisation of Smallholder Agriculture in Major Tef-growing Areas of Ethiopia'. Paper presented at the Fifth International Conference on the Ethiopian Economy, EEA, June 2007, Addis Ababa. www.future-agricultures.org

Weeks, J. Alemayehu Geda, Daniel Zerfu, Dawi Weldeyesus and Jonse Degfa (2004), 'Source of Growth in Ethiopia'. Centre for Development Policy and Research, SOAS and Economic Policy and Planning Department, MoFED, Addis Abeba.

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