# Ethiopian Economics Association (EEA)

# PROCEEDINGS OF THE SEVENTH INTERNATIONAL CONFERENCE ON THE ETHIOPIAN ECONOMY

Edited by
Getnet Alemu

May 2010

## Volume III

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# FOREWORD

The Ethiopian Economic Association (EEA) is happy to issue three volumes of the proceedings of the 7th International Conference (the 18th Annual Conference) on the Ethiopian Economy that was held from June 25 – 27, 2009 at EEA Multi-purpose Building Conference Hall. 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.

Since its establishment, the Ethiopian Economic Association has been actively engaged in economic research, training, and 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 various publications. It has also been able to provide professional opinion and advice on many issues affecting the development of the country.

As a result of these and other efforts of the Association, EEA has successfully established itself as a key player in the economic and social development process of Ethiopia and become 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 7th International Conference on the Ethiopian Economy attracted high turnout of the participants, papers presenters and session organizing institutions. The conference was attended by about 420, 238 and 252 participants during the first, second and third days of the conference, respectively. The conference officially opened by H.E. Ato Neway Gebre-Ab, Director, Ethiopian Development Research Institute and chief economic Advisor to the Prime Minister of FDRE.

All in all, 74 papers were presented in seven plenary and five parallel sessions. Of the total paper presented at the three day conference, 19 papers were presented by session organizers that include World Bank, Future Agriculture, EDRI, IFPRI, RiPPLE, Economics Department of AAU, Young Lives Study and Ethiopian Development Research Institute. The remaining 55 papers were presented by individual researchers.

Out of the total 55 papers presented by individuals on this 7th International Conference, the editorial committee received 37 papers from authors and reviewed them. Comments and suggestions including editorial comments were communicated to authors for improvement. Among the 37 papers, the editorial committee selected 25 papers to be included in this edition. In addition to this, six papers which were presented by session organizers (IFPRI, Future Agriculture, EDRI and AAU) were edited and included in this edition. All these papers are organized into three volumes. Volume I contains Growth & Development, Volume II contains Finance and Social Sector Development and Volume III contains Agriculture and Related Development.

I would like to take this opportunity to express my heartfelt gratitude, on my own behalf and on behalf of the Ethiopian Economics 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 World Bank and Commercial Bank of Ethiopia 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 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 Economics Association for the dedicated services and the leadership they provided to the Association.

Our special thanks go to our partners who have shared our vision and provided us with generous financial support to materialize the activities of EEA. These include; The African Capacity Building Foundation (ACBF), The Norwegian Church Aid, The Royal Netherlands Embassy, The Swedish Embassy through SIDA, The Development Cooperation of Ireland (DCI) and the Ireland Embassy, the British Embassy through DFID, the Friedrich Ebert Stiftung of Germany, and International Development Research Center (IDRC) of Canada.

Finally, I would like to extend my sincere gratitude to H.E, Ato Neway Gebre-Ab, Director, Ethiopian Development Research Institute and chief economic Advisor to the Prime Minister of FDRE, for his an insightful keynote address; and other senior government officials who spared their busy schedule and participated in the conference.

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

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# *Agriculture and Related Developments*

# IMPLICATIONS OF ACCELERATED AGRICULTURAL GROWTH ON POVERTY IN ETHIOPIA: A COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS

Paul Dorosh and James Thurlow[1]

*Abstract*

*Ethiopia's development strategy emphasizes agricultural production as a means of raising national economic growth. Using a dynamic economy-wide model we estimate the impact of alternative sources of growth on household poverty. Results indicate that achieving six percent annual agricultural growth reduces the national poverty headcount by 4.3 percentage points by 2015 and lifts an additional 3.7 million people out of poverty compared to a baseline with more modest growth. However, the composition of agricultural growth matters. Raising cereals yields has larger poverty reducing effects because they constitute a large share of rural incomes and allow farmers to diversify into higher-value crops.*

[1] International Food Policy Research Institute, Washington D.C.

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# 1. Introduction

Ethiopia's economy has experienced rapid growth in recent years. Although growth in agricultural gross domestic product (GDP) from 1998-2007 was less rapid than other parts of the economy, the sector has also performed well, growing faster than the rural population. However, poverty is still severe in Ethiopia and is concentrated in rural areas. To accelerate growth and poverty reduction, Ethiopia's national strategy affords an important role to agriculture, as a source of both growth and development for the broader economy. This is essential given that agriculture is an income source for most of the population. The sector accounts for more than two-fifths of GDP, three quarters of merchandize export earnings, and provide key inputs into the manufacturing sectors, whose agricultural processing sectors contribute further to national GDP. In parallel to Ethiopia's agricultural strategy, the New Partnership for Africa's Development is in the process of implementing the Comprehensive Africa Agriculture Development Program (CAADP), together with African governments. The CAADP initiative supports the identification of an integrated framework of development priorities aimed at restoring agricultural growth, rural development and food security in the African region. The main goal of CAADP is for African countries to achieve six percent agricultural growth per year.

Since there are choices involved within the agricultural sector, both for the sector as a whole and across sub-sectors, many investment and policy interventions will be designed at the sub-sector level. However, strong inter-linkages occur across sub-sectors and between agriculture and the rest of the economy. To understand these linkages and how sectoral growth can contribute to the country's broad development goals, an integrated economy-wide framework is needed in order to synergize the growth projections among different agricultural commodities or subsectors and evaluate their combined effects on national economic growth and poverty reduction. Moreover, agricultural production growth is often constrained by demand in both domestic and export markets, and demand, in turn, depends on income growth both in agriculture and in the broader economy. While agriculture is a dominant economic activity in Ethiopia and a majority of the population lives in rural areas, both rural and urban sectors need to be included in this framework in order to understand the economy-wide impact of agricultural growth.

This paper analyzes agricultural growth options that can support the development of a more comprehensive rural development component under Ethiopia's agricultural strategy that is also in alignment with the principles and objectives collectively defined by African countries as part of the CAADP agenda. In particular, the paper seeks to position Ethiopia's agricultural sector and rural economy within the country's national

strategy. For these purposes, and to assist policymakers and other stakeholders to make informed long-term decisions, a new economy-wide model for Ethiopia has been developed and used to analyze the linkages and trade-offs between economic growth and poverty reduction at both macro- and micro-economic levels. The results from the model simulations are intended to guide debate in prioritizing the contribution of different subsectors in helping Ethiopia achieve its broader development objectives.

## 2. Modeling sources of agricultural growth and poverty reduction

A dynamic computable general equilibrium (DCGE) model of Ethiopia was developed to capture (i) trade-offs and synergies from accelerating growth in different agricultural sub-sectors; (ii) the economic inter-linkages between agriculture and the rest of the economy; and (iii) the effects of alternative sources of growth on household incomes and poverty.[2] Although this paper focuses on agriculture, the DCGE model also contains detailed information on non-agriculture. In total the model identifies 69 sub-sectors, 24 of which are in agriculture (see Table 1). Agricultural crops fall into five broad groups: (i) cereal crops, which are separated into teff, barley, wheat, maize, and sorghum and millet; (ii) pulses and oilseeds, which is separated into pulses, such as beans, and oilseed crops, such as groundnuts; (iii) horticulture, which is separated into fruits, vegetables, and enset; (iv) higher-value export-oriented crops, which are separated into cotton, sugarcane, tobacco, coffee, tea, and cut flowers; and (v) other crops, which includes chat and other staples, such as root crops. The model also identifies four livestock sub-sectors, including cattle, milk, poultry, and other animal products.

To complete the agricultural sector, the DCGE model contains two further sub-sectors capturing forestry and fisheries. Most agricultural commodities are not only exported and/or consumed by households but are also used as inputs into downstream processing activities within manufacturing. The seven agricultural processing activities identified in the model include meat and fish processing, dairy, grain milling; sugar refining, beverages, tobacco, and other foods. The agricultural sub-sectors also use inputs from non-agricultural sectors, such as fertilizer from the fertilizer sub-sector and marketing services from the trade and transport subsectors.

[2] See Appendix 1 for a discussion of the model equations and parameters.

**Table 1: Activities, factors and households in the DCGE model**

| | |
|---|---|
| Activities | Teff; barley; wheat; maize; sorghum; pulses; oilseeds; vegetables; fruits; enset; cotton; sugarcane; tea; chat; tobacco; coffee; flowers; other crops; cattle; milk; poultry; animal products; fisheries; forestry; meat; dairy; vegetable products; grain milling; milling services; sugar refining; tea processing; other food processing; beverages; tobacco processing; textiles; yarn; fibers; lint; clothing; leather products; wood products; paper and publishing; petroleum; fertilizer; chemicals; non-metallic minerals; metals ; metals products; machinery; vehicles and transport equipment; electronic equipment; other manufacturing; coal; natural gas; other mining; electricity; water; construction; wholesale and retail trade; hotels and catering; transport; communications; financial services; business services; real estate; other private services; public administration; education; health. |
| Regions | Humid cereals; humid enset; drought-prone; pastoralist. |
| Factors | Agricultural labor; administrative workers; professional workers; skilled workers (e.g., sales clerks and machinists); unskilled workers in elementary occupations; regional labor and livestock by poor/non-poor household classification (16 factor types); physical capital. |
| Households | Rural households by four agro-ecological zone and poor/non-poor classification (8 representative households); small and large urban centers by poor/non-poor classification (4 households). |

The model also captures regional heterogeneity. Farm production is disaggregated across four rural zones. These include Zone 1a (humid cereals region); Zone 1b (humid enset region), Zone 2 (drought-prone region); and Zone 3 (pastoralist region). These zones reflect different agro-ecological and climatic conditions across the country as well as the dominant crop or farming system. Cropping patterns in the model are therefore unique to each of the four zones.

Representative farmers in each zone respond to changes in production technology and commodity demand and prices by reallocating their land across different crops in order to maximize incomes. These farmers also reallocate their labor and capital between farm and non-farm activities, including livestock and fishing, wage employment, and diversification into non-agricultural sectors, such as transport, trade and construction. Thus, by capturing production information across sub-national regions, the model combines the national or macroeconomic consistency of an economywide model with zonal-level production models, and is thus an ideal tool for capturing the sectoral linkages and income-and price-effects resulting from accelerating growth in different agricultural sectors.

Finally, the model endogenously estimates the impact of growth on household incomes and poverty. There are 12 representative household groups in the model, disaggregated by rural zones, small and large urban centers, and poor/non-poor status. 'Poor' is defined here as including all households falling into the lowest two per capita expenditure quintiles (i.e., the poorest 40 percent of the population).[3] Household income elasticities are based on estimates from the 2004/05 household income and expenditure survey (HICES, 2005) (see Table 2).

**Table 2: Income elasticities in the DCGE model**

| Agricultural commodities | Rural | Urban | Non-agricultural commodities | Rural | Urban |
|---|---|---|---|---|---|
| Maize | 0.70 | 0.50 | Cattle meat | 0.80 | 0.80 |
| Wheat | 1.00 | 0.66 | Poultry | 0.75 | 1.15 |
| Teff | 1.10 | 0.70 | Milk | 0.75 | 0.75 |
| Other cereals | 0.70 | 0.50 | Other meats | 0.50 | 0.50 |
| Root crops | 0.50 | 0.70 | Fish | 0.70 | 0.70 |
| Pulses | 0.75 | 0.60 | Processed foods | 0.80 | 0.90 |
| Oilseeds | 0.80 | 0.50 | Beverages | 0.50 | 0.80 |
| Enset | 0.70 | 0.50 | Textiles | 1.20 | 1.00 |
| Vegetables | 0.50 | 0.75 | Other manufactures | 1.20 | 1.00 |
| Fruits | 0.50 | 0.75 | Construction | 0.90 | 0.50 |
| Sugarcane | 0.75 | 0.60 | Utilities | 1.00 | 0.80 |
| Chat | 0.70 | 0.50 | Trade and transport | 1.00 | 0.80 |
| Coffee | 0.60 | 0.60 | Restaurants | 0.80 | 0.50 |
| Tobacco | 0.70 | 0.50 | Other private services | 1.10 | 1.10 |
| | | | Public services | 1.20 | 0.90 |

Source: Adjusted econometric estimates from the 2005/06 household income and expenditure survey.

Each household questioned in HICES is linked to a representative household in the model. This is the model's micro-simulation component. Changes in representative households' consumption and prices in the DCGE model component are passed down to their corresponding households in the survey, where total consumption expenditures are recalculated. This new level of per capita expenditure for each survey household is compared to the separate poverty lines for rural and urban

[3] Given this definition of poverty, we then use the cutoff level of per capita expenditures that defines the poor and non-poor households (separately for the rural and urban areas) as the poverty lines in the subsequent simulations.

areas, and standard poverty measures are recalculated. Thus, poverty is measured in exactly the same way as standard poverty estimates, and changes in poverty draws on the consumption patterns, income distribution and poverty rates captured in the latest household income and expenditure survey.

## 3. Poverty reduction under Ethiopia's current growth path

We first use the DCGE model to examine the impact of Ethiopia's current growth path on poverty reduction. This 'business-as-usual' scenario draws on production trends for various agricultural and non-agricultural sub-sectors. Ethiopia experienced rapid growth from 1998 to 2007, with national GDP growing at almost eight percent per year. During this period the agricultural sector did not grow as rapidly, with an average growth rate of six percent per year. However, much of this rapid economic growth has occurred in the last few years, and it is uncertain whether, given the global economic recession starting in 2009, such rapid growth can still be achieved over the near-term. Accordingly, the baseline scenario takes a more cautionary position and assumes average annual agricultural growth of 3.8 percent per year during 2009-2015 (see Table 3).[4] Although this is below the recent spike in agricultural GDP growth rates, it still assumes a fairly strong performance by the agricultural sector over the coming decade.[5]

More than half of agriculture's strong growth performance during 1998-2007 was driven by land expansion, with the rest resulting from changes in cropping patterns and improvements in yields. For example, land area under maize cultivation expanded by 2.2 percent per year during this period, while yields improved each year by 1.5 percent. Similar patterns were observed for other cereals, with the only exception being wheat, where land area expanded extremely fast at 5.5 percent per year, compared to yield growth of 2.7 percent. Long-term agricultural growth has thus been driven more by expanded cultivated land than by improvements in cropping technologies. The Baseline scenario is calibrated to production trends from 1998-2007 and so it assumes that land expansion will continue along its long-term path, with about two-thirds of production increases driven by area expansion. This is equivalent to an increase in total harvested land by 2.6 percent per year during 2009-

[4] Simulations are run beginning with the base year of 2005/06. However, accelerated agricultural productivity gains are only modeled from 2008/09 onwards (i.e. all scenarios are the same until 2008/09).

[5] As discussed in section 4, five scenarios were designed for this analysis. Scenarios 1-3 target specific groups of crops or agricultural sub-sectors, including cereals (Simulation 1); export-oriented crops (Simulation 2); and livestock (Simulation 3). The 'all agriculture' scenario (Simulation 4) includes additional growth from the fisheries and forestry sub-sectors. Finally, Simulation 5 accelerates non-agricultural productivity growth, as well.

2015, which is slightly below to the rural population growth rate of 3.0 percent. According to production trends, land area expansion varies across zones. Cultivated land growth is 2.2 percent per year in Zones 1a and 1b (humid regions), 3.2 percent in Zone 2 (drought-prone region), and 3.7 percent in Zone 3 (pastoralist region). As shown in Table 3, the non-agricultural sectors are expected to maintain their strong performance over the coming decade, with manufacturing and services growing more rapidly than agriculture at 8.2 percent per year.

**Table 3: Sector growth results from model scenarios**

| | GDP share, 2009 (%) | Average annual GDP growth rate, 2009-2015 (%) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Baseline (1) | Cereals (2) | Export-crops (3) | Livestock (4) | All agric. (5) | Non-agric. (6) |
| Total GDP | 100.00 | 5.95 | 6.26 | 6.39 | 6.81 | 6.88 | 8.50 |
| Agriculture | 44.90 | 3.81 | 4.57 | 4.87 | 5.81 | 5.98 | 6.08 |
| Cereals | 13.49 | 5.18 | 7.25 | 7.30 | 7.51 | 7.53 | 7.79 |
| Pulses & oilseeds | 3.83 | 3.34 | 3.54 | 3.60 | 3.75 | 3.77 | 3.73 |
| Horticulture | 2.45 | 3.84 | 3.96 | 4.01 | 4.08 | 4.26 | 4.32 |
| Export crops | 4.50 | 4.54 | 4.54 | 7.20 | 7.20 | 7.20 | 7.20 |
| Other crops | 3.66 | 3.79 | 4.07 | 3.94 | 3.96 | 3.97 | 3.78 |
| Livestock | 12.94 | 2.88 | 2.91 | 2.93 | 6.02 | 6.02 | 6.14 |
| Other agriculture | 4.04 | 1.51 | 1.52 | 1.52 | 1.52 | 3.52 | 3.53 |
| Industry | 12.47 | 7.27 | 7.27 | 7.28 | 7.36 | 7.36 | 10.43 |
| Manufacturing | 5.24 | 8.15 | 8.18 | 8.17 | 8.42 | 8.40 | 11.35 |
| Agro-processing | 2.41 | 6.08 | 6.51 | 6.69 | 6.83 | 6.82 | 8.20 |
| Other industry | 1.89 | 6.93 | 6.99 | 7.05 | 7.18 | 7.16 | 8.93 |
| Services | 33.47 | 8.19 | 8.20 | 8.20 | 8.23 | 8.25 | 11.32 |

Source: Results from the DCGE model.

Note: Simulation results are cumulative, such that the *Export-Crop* scenario (2) contains the results from the *Cereals* scenario (1), plus additional productivity gains for export crops. Similarly, the Livestock scenario (3) contains the productivity gains for both cereals and export crops (i.e., from the previous two scenarios).

The 3.8 percent agricultural growth rate in the Baseline scenario is based on more detailed production trends for different agricultural sub-sectors. Table 4 shows the assumptions made about each sub-sector's yield growth. We initially adopt the teff yield of 0.76 tons per hectare that was observed in 2005/06 and then assume that teff yields grow at 2.86 percent per year such that Ethiopia achieves a sustained national average teff yield of 1.01 tons per hectare by 2015). Land area under teff cultivation also grows at 2.33 percent each year under the Baseline scenario, such that overall production expands by 5.26 percent. This is consistent with observed production

patterns for 1998-2007. Moreover, yield and area expansions vary at the zonal-level based on actual production trends. The Baseline thus reflects expected improvements in the performance of the teff sector over the next decade with the rate of growth of investments continuing as before. Similarly, for wheat, we assume that initial yields continue to grow rapidly at 3.40 per year, and that yields rise to 1.67 tons per hectare by 2015. National and regional productions of each of the five cereals crops in the DCGE model are thus calibrated to closely reproduce long-term production trends.

**Table 4: Production targets for baseline and agricultural growth scenarios**

| | Crop yields | | | | | Crop production | | | | | Crop land area | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Levels (mt/ha) | | | Growth rates (%) | | Levels (1000 mt) | | | Growth rates (%) | | Growth rates (%) | |
| | Initial | Baseline | Target | Baseline | Target | Initial | Baseline | Target | Baseline | Target | Baseline | Target |
| | 2005 | 2015 | 2015 | 2005-15 | 2005-15 | 2005 | 2015 | 2015 | 2005-15 | 2005-15 | 2005-15 | 2005-15 |
| Cereals | | | | | | | | | | | | |
| Teff | 0.76 | 1.01 | 1.11 | 2.86 | 3.82 | 2,191 | 3,660 | 4,010 | 5.26 | 6.23 | 2.33 | 2.32 |
| Barley | 1.00 | 1.30 | 1.51 | 2.63 | 4.15 | 1,271 | 2,009 | 2,264 | 4.68 | 5.94 | 2.00 | 1.73 |
| Wheat | 1.20 | 1.67 | 2.18 | 3.40 | 6.18 | 2,230 | 4,105 | 5,567 | 6.29 | 9.58 | 2.80 | 3.20 |
| Maize | 1.72 | 1.99 | 2.32 | 1.46 | 3.03 | 3,647 | 5,424 | 6,095 | 4.05 | 5.27 | 2.55 | 2.17 |
| Sorghum | 1.12 | 1.44 | 1.56 | 2.48 | 3.30 | 2,608 | 4,226 | 4,564 | 4.94 | 5.76 | 2.40 | 2.37 |
| Pulses & oils | | | | | | | | | | | | |
| Pulses | 0.92 | 1.03 | 1.04 | 1.08 | 1.20 | 1,110 | 1,632 | 1,699 | 3.93 | 4.35 | 2.82 | 3.11 |
| Oilseeds | 0.77 | 0.76 | 0.78 | -0.10 | 0.08 | 778 | 1,035 | 1,054 | 2.90 | 3.08 | 3.00 | 3.00 |
| Horticulture | | | | | | | | | | | | |
| Enset | 7.52 | 8.74 | 8.92 | 1.51 | 1.72 | 211 | 321 | 336 | 4.25 | 4.74 | 2.70 | 2.97 |
| Vegetables | 4.17 | 4.54 | 4.60 | 0.86 | 1.00 | 954 | 1,321 | 1,340 | 3.31 | 3.45 | 2.42 | 2.42 |
| Fruits | 13.73 | 15.78 | 15.99 | 1.40 | 1.54 | 436 | 630 | 639 | 3.74 | 3.88 | 2.31 | 2.31 |
| Export crops | | | | | | | | | | | | |
| Sugarcane | 33.69 | 36.79 | 38.67 | 0.88 | 1.39 | 1,617 | 2,614 | 2,747 | 4.92 | 5.44 | 4.00 | 4.00 |
| Tea | 0.96 | 1.04 | 1.08 | 0.76 | 1.16 | 5 | 9 | 10 | 6.81 | 7.23 | 6.00 | 6.00 |
| Cotton | 1.01 | 1.07 | 1.25 | 0.58 | 2.13 | 86 | 135 | 157 | 4.61 | 6.21 | 4.00 | 4.00 |
| Tobacco | 0.67 | 0.64 | 0.74 | -0.34 | 1.02 | 3 | 3 | 3 | -1.33 | 0.01 | -1.00 | -1.00 |
| Coffee | 0.66 | 0.66 | 0.81 | 0.04 | 2.12 | 157 | 244 | 300 | 4.54 | 6.72 | 4.50 | 4.50 |
| Flowers | 1.00 | 1.10 | 1.21 | 1.00 | 1.91 | 10 | 13 | 15 | 3.02 | 3.95 | 2.00 | 2.00 |
| Other crops | | | | | | | | | | | | |
| Chat | 0.77 | 0.79 | 0.79 | 0.19 | 0.19 | 120 | 165 | 165 | 3.24 | 3.24 | 3.05 | 3.05 |
| Other staple | 4.89 | 5.26 | 5.30 | 0.73 | 0.80 | 1,576 | 2,537 | 2,586 | 4.87 | 5.07 | 4.12 | 4.24 |
| All crops | | | | | | | | | | | 2.62 | 2.62 |

Source: Crop targets drawn from consultations with CAADP stocktaking team and representatives from the Ministry of Agriculture; final sector targets are based on results from the DCGE model.

National production trends were used to calibrate the Baseline growth rates for non-cereals crops. Particularly rapid production growth was observed for the horticultural crops, including fruits, vegetables and enset. However, unlike cereals, these high growth rates were driven more by land expansion than by improvements in crop yields. For example, during 1998- 2007, enset yields remained largely unchanged, but cultivated land area grew extremely fast. This is reflected in the Baseline scenario, where the production growth rate is driven mainly by a faster expansion of enset land area. Similar biases towards land expansion over yield improvements were observed for pulses, oilseeds, and other staples, such as root crops.

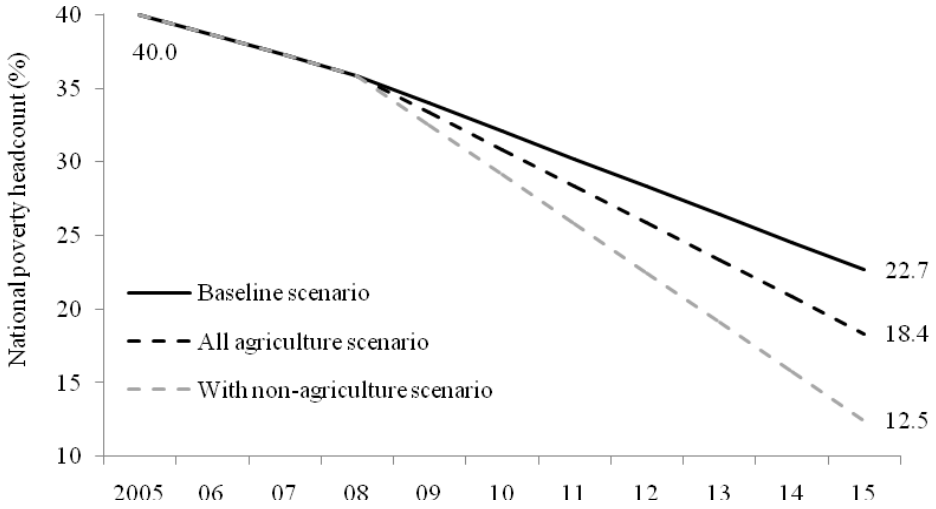
Industrial and export crops performed quite well during 1998-2007, with the exception of tobacco, whose production levels declined slightly. This is reflected in the Baseline scenario. For example, coffee and cotton production rises by 4.54 and 4.61 percent per year respectively during 2009-2015. This is driven by a fairly rapid expansion of land area under export crop cultivation. The Baseline scenario therefore assumes that the export-oriented continue to grow rapidly, albeit slower than the major staple crops. Only tobacco production is expected to decline based on long-term trends.

Livestock is a key agricultural sub-sector generating a significant share of agricultural GDP, and with strong upstream linkages to meat processing in the manufacturing sector. The Baseline scenario assumes that livestock GDP will expand at a rate of 2.9 percent per year (see Table 3). This is below the rapid growth of the crop sectors, but is entirely consistent with livestock GDP growth rates reported in national accounts for 1998-2007. The Baseline scenario does reflect more rapid growth in the milk and poultry sub-sectors. Fisheries and forestry are also agricultural sub-sectors in the model, with the latter generating 4.04 percent of total agricultural GDP in 2005/06. Based on national accounting for the period 1998-2007, the Baseline scenario assumes that fisheries GDP remains virtually unchanged during 2009-2015. For the forestry sub-sector, the Baseline scenario assumes that value-added in this sub-sector will grow at 4.02 percent per year.

Drawing on the above trends, the simulation results indicate that, with four percent growth in the agricultural sector and more rapid growth in the non-agricultural sectors, overall national GDP will grow at an average rate of 5.95 percent during 2009-2015. This is equal to the average GDP growth rate of six percent observed for 1998-2007, thus assuming that Ethiopia's economy will maintain its long-term growth rate over the coming decade. With population growth at three percent per year, this means that per capita GDP also grows rapidly at about three percent. With rising per capita incomes and growth across all sectors, the model estimates that poverty will decline from 40 percent to 23 percent during 2005-2015 (see Figure 1). The faster expansion of the non-agricultural sectors means that national income growth favors urban

households and areas more than rural ones. For example, poverty falls in small urban centers from 34 to 9 percent by 2015, while rural poverty declines from 41 to 25 percent. Given overall rapid poverty reduction, and despite an expanding population, the absolute number of poor people in Ethiopia would decline from 25.8 million people in 2005 to 19.6 million by 2015. While this is a significant reduction in the number of poor people living in Ethiopia, it reveals the persistent burden of poverty in the country and emphasizes the need for reinforcing pro-poor sources of economic growth.

**Figure 1: National poverty results from model scenarios.**




Source: Results from the DCGE model.

**Note:** The 'poverty headcount' is the share of the population living below the poverty line. We assign the poverty line so that 40 percent of the population is classified as 'poor' (i.e., the bottom two expenditure quintiles).

## 4. Accelerating agricultural growth and poverty reduction

In the previous section we described the results of the Baseline scenario, which estimated the impact of Ethiopia's current growth path on poverty reduction. We found that while economic growth over the coming decade is expected to remain robust and will halve the national poverty rate by 2015, it will reduce the number of poor people by less than one-third. Therefore, in this section we examine whether a medium-term six percent agricultural growth target identified by CAADP is achievable, based on reasonable sub-sector growth potentials. We also estimate the

potential contribution of different agricultural sub-sectors in helping Ethiopia substantially reduce poverty throughout the country.

## 4.1 Achieving six percent agricultural GDP growth

Accelerated crop production is modeled by increasing yields in order to achieve yield targets identified for 2015. Taking teff as an example, under the Baseline scenario we assumed that average yields would increase from 0.76 to 1.01 tons per hectare during 2006-2015 (see Table 4). In this section we model more ambitious teff yield improvements, with the annual yield growth rate for teff rising from its current 2.86 percent per year to 3.82 percent per year. This implies that national average teff yields will rise consistently over the next decade to reach 1.11 tons per hectare by 2015. This national target yield was identified together with the CAADP stocktaking team and in consultation with the Ministry of Agriculture and Rural Development (MOARD). The yields of other crops were also increased in a similar manner but to differing degrees based on long-term trends and potential yields. Production growth targets were also identified for the livestock and fisheries subsectors.

Five different scenarios were designed for this analysis. In Scenarios 1-3 we target specific groups of crops or agricultural sub-sectors, including cereals (Simulation 1); export-oriented crops (Simulation 2); and livestock (Simulation 3). For instance, in the 'cereals-led growth' scenario we increase total factor productivity (TFP) for all cereals crops so as to achieve the crop-specific yield target shown in Table 4. In the non-crop scenarios, such as 'livestock-led growth', we also increase total factor productivity (TFP) to achieve targeted GDP growth rates. The results of each simulation are cumulative, so that Simulation 2 includes the effects of Simulation 1, Simulation 3 includes the effects of Simulation 2, and so on. In the 'all agriculture' scenario (Simulation 4), we include additional growth from the fisheries and forestry sub-sectors. This is equivalent a 'CAADP' scenario, since it captures all possible sources of additional agricultural growth. Finally, in the 'non-agriculture' scenario (Simulation 5), we accelerate economic growth in not just the agricultural sector, but in non-agriculture as well. The results of these scenarios are discussed below.

Under the 'All Agriculture' scenario, agricultural growth accelerates to six percent per year for the period 2009-2015 (see Table 3). This is driven by a strong expansion in cereals production. For example, wheat production increases from about four million tons under the Baseline scenario to over six million tons under the 'All Agriculture' scenario (see Table 4). Similarly large expansions of coffee production are also achieved under this accelerated scenario. Thus, even though the additional growth required for other crops is less pronounced, the achievement of the six percent

agricultural growth target remains ambitious. Livestock growth would also have to double from an annual average growth rate of 2.88 percent per year under the Baseline scenario to 6.02 percent under the 'All Agriculture' scenario. However, despite these challenges, the results from the model indicate that if the crop yield and livestock productivity targets can be achieved by 2015 then Ethiopia will be able to achieve and sustain the six percent agricultural growth target set forth by CAADP.

Since agriculture is more than a third of the Ethiopian economy, the acceleration of agricultural growth increases the national GDP growth rate from its current 5.95 percent per year to 6.88 percent per year. Faster agricultural growth also stimulates additional growth in the non-agricultural sectors, by raising final demand for non-agricultural goods and by lowering input prices and fostering upstream processing. For instance, under the 'All Agriculture' scenario, the GDP growth rate of agriculture-processing in the manufacturing sector increases from 6.08 percent under the Baseline scenario to 6.82 percent per year. Achieving the six percent agricultural growth target therefore has economywide growth-linkage effects for non-agriculture.
Finally, we examine the impact of accelerating economic growth outside of agriculture. In the 'Non-agriculture' scenario we increase the productivity growth rates of the nonagricultural subsectors by an additional two percentage points per year during 2009-2015. As shown in Table 3, this causes the national GDP growth rate to increase from 6.88 percent under the 'All Agriculture' scenario to 8.50 percent. Faster nonagricultural growth also stimulates additional demand for agriculture, thus helping raise agriculture's GDP growth above the six percent target. The increase in demand for agricultural products is larger for cereals and livestock, which form a larger share of urban households' and nonagricultural workers' consumption baskets, and whose incomes are rising as a result of faster nonagricultural growth. Thus, accelerating agricultural growth has positive economywide effects, which can be further strengthened by an expanded nonagricultural sector.

## 4.2 Impacts on household incomes and poverty

The acceleration of agricultural growth to around six percent per year under the 'All Agriculture' scenario and its spillover effects into non-agriculture causes poverty to decline by a further 4.3 percentage points. This is shown in Figure 1, where the share of Ethiopia's population under the poverty line falls to 18.36 percent by 2015 under the 'All Agriculture' scenario compared to 22.67 percent under the Baseline scenario. Thus, taking population growth into account, achieving the six percent growth target lifts an additional 3.7 million people above the poverty line by 2015. This is sufficient to almost halve the number of poor people in Ethiopia today (i.e., from 25.8 to 15.9 million).

Faster agricultural growth benefits a majority of households. However, not all households in all agro-ecological zones benefit equally from achieving the higher crop yields and faster sub-sector growth rates targeted under the 'All Agriculture' growth scenario. Table 5 shows how poverty rates change under the various scenarios. Poverty declines amongst both rural and urban households, although the declines are more than twice as large in rural areas. Moreover, there are large declines in rural poverty rates in the two zones where poverty is initially highest: humid enset region (Zone 1b) and drought-prone region (Zone 2). Within urban areas, households in both small and large urban centers benefit from faster agricultural growth. This is because urban households usually spend a significant share of their incomes on food and agricultural products. They thus benefit from faster agricultural growth and lower food prices.

**Table 5: Household poverty results from model scenarios**

| | Initial poverty headcount (%) | | Final year poverty headcount, 2015 (%) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Baseline | Cereals | Export-crops | Live-stock | All agric. | Non-agric. |
| | 2005 | 2008 | (1) | (2) | (3) | (4) | (5) | (6) |
| National | 40.02 | 35.88 | 22.67 | 20.28 | 19.36 | 18.38 | 18.36 | 12.46 |
| Rural regions | 41.33 | 37.28 | 25.49 | 22.80 | 21.80 | 20.82 | 20.77 | 13.72 |
| Humid cereals (1a) | 38.19 | 33.91 | 20.71 | 18.48 | 17.65 | 17.35 | 17.35 | 12.12 |
| Humid enset (1b) | 44.98 | 41.05 | 30.15 | 27.66 | 26.26 | 24.83 | 24.41 | 15.05 |
| Drought-prone (2) | 47.97 | 44.14 | 33.13 | 29.43 | 28.31 | 26.92 | 27.08 | 17.77 |
| Pastoralist (3) | 27.70 | 24.11 | 16.10 | 13.45 | 12.91 | 10.19 | 10.19 | 6.12 |
| Small urban centers | 33.95 | 28.94 | 8.57 | 7.55 | 7.10 | 6.20 | 6.41 | 5.18 |
| Large urban centers | 32.95 | 29.16 | 9.30 | 8.48 | 7.84 | 6.75 | 6.77 | 8.16 |

Source: Results from the DCGE model.

**Note:** The 'poverty headcount' is the share of the population living below the poverty line. We assign the poverty line so that 40 percent of the population is classified as 'poor' (i.e., the bottom two expenditure quintiles).

The impact of agricultural growth on households' incomes and poverty depends on a number of factors. One key factor is the geographic distribution of agricultural production. Higher-value export-oriented crops are grown more intensively in certain zones. Coffee, for example, is concentrated in the humid cereals region (Zone 1a). However, it forms a large share of agricultural GDP in the humid enset (Zone 1b). Similarly, while cereals form a large share of agricultural GDP in the humid cereals region (Zone 1a), it also contributes a large share to the poorer drought-prone region's agricultural GDP (i.e., it is 41.8 percent in Zone 1a and 34.1 percent in Zone 2). Finally, livestock is a key sector in all regions, contributing between one-quarter to one-third to agricultural GDP in Zones 1a, 1b and 2. However, it is especially important in the pastoralist region, where it accounts for most of agricultural GDP, with the remaining agricultural incomes dominated by cereals. These concentrations

of particular crops and sub-sectors will influence how agricultural growth driven by certain sectors affects household incomes in different parts of the country.

The sources of additional incomes also vary across representative households within zones. Not surprisingly, households that already depend more on cereals tend to benefit more from cereals-led growth. However, there are two forces driving changes in production following sub-sector-specific yield improvements. First, increasing cereals yields directly effects farm incomes since it increases the quantity of output that a farm produces using the same quantity of factor inputs. But since supply of the agricultural product increases faster than demand (unless incomes are rising rapidly from other sources), prices typically fall following yield increases. In response to these price changes, farmers may reallocate some of their land to other crops. Thus it is important to note that, while we model cereals-led growth by increasing cereals yields, some of the gains under this scenario are derived from diversification into other higher-value crops facing better demand conditions. The DCGE model captures both direct and indirect effects in its assessment of the effects of improved yields in different sub-sectors.

Real income and poverty impacts are also determined by household consumption demand. For example, households that spend a significant share of their incomes on cereals will benefit from lower prices when cereals production rises. Household consumption patterns are based on the 2004/05 household income and expenditure survey, as captured in the 2005/06 social accounting matrix (Ahmed et al. 2009). The average budget shares for different household groups are shown in Table 6. Even though relatively little agricultural GDP in the Pastoralist region (Zone 3) is derived from cereals production, households in this region spend 16 percent of their disposable income on cereals. Thus, while a national expansion of cereals production may not directly benefit households in the Pastoralist region, it will indirectly benefit them through lower food prices. This is also the case for urban households, who derive relatively little income from agriculture directly, but spend at least a third of their incomes on agricultural goods and processed foods. Together with regional production patterns, these average budget shares and the income elasticities in Table 2 will determine the impact of agricultural growth on poverty.

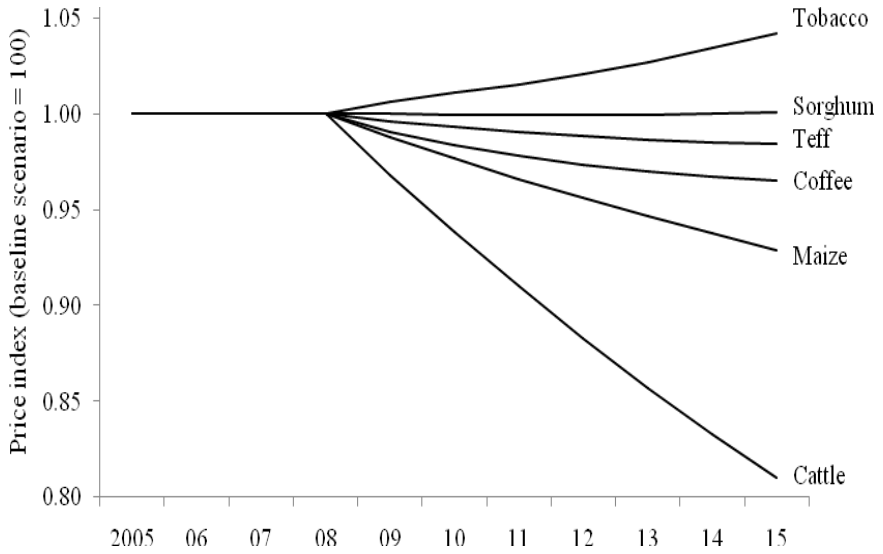
**Table 6: Household average consumption shares**

| | Commodity expenditure share in household consumption (%) | | | | | |
|---|---|---|---|---|---|---|
| | Rural households | | | | Urban households | |
| | Humid cereals (Zone 1a) | Humid enset (Zone 1b) | Drought-prone (Zone 2) | Pastoralist (Zone 3) | Small centers | Large centers |
| All goods and services | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Agriculture | 53.4 | 47.1 | 57.1 | 56.8 | 31.1 | 21.8 |
| Cereals | 23.1 | 13.1 | 21.8 | 15.8 | 10.1 | 6.9 |
| Pulses & oilseeds | 5.0 | 2.7 | 4.5 | 1.4 | 1.8 | 1.3 |
| Horticulture | 2.5 | 7.5 | 3.5 | 0.5 | 1.5 | 1.0 |
| Export crops | 2.8 | 3.7 | 1.9 | 1.3 | 1.5 | 0.8 |
| Other crops | 4.8 | 5.4 | 7.4 | 5.8 | 3.9 | 2.6 |
| Livestock | 9.1 | 6.8 | 11.6 | 28.3 | 9.0 | 8.1 |
| Other agriculture | 6.0 | 7.8 | 6.4 | 3.6 | 3.4 | 1.1 |
| Industry | 24.1 | 30.9 | 24.3 | 29.4 | 41.4 | 48.8 |
| Manufacturing | 23.4 | 30.3 | 23.3 | 28.6 | 39.0 | 43.8 |
| Agro-processing | 11.7 | 14.2 | 11.3 | 15.2 | 16.7 | 15.4 |
| Other industry | 0.7 | 0.6 | 1.0 | 0.8 | 2.4 | 4.9 |
| Services | 22.5 | 21.9 | 18.6 | 13.8 | 27.5 | 29.4 |

Source: Authors' calculations using the 2005/06 social accounting matrix.

Figure 2 shows the importance of taking demand constraints and relative price changes into account. Wheat, for example, faces domestic demand constraints and has weaker linkages to upstream food processing and foreign markets. As such, when wheat production increases substantially under the 'All Agriculture' scenario, its prices decline by seven percent in real terms (or relative to the overall consumer price index). Milk and cattle product prices decline in more sharply (by more than 15 percent), highlighting the crucial importance of improved marketing in these sub-sectors. By contrast, some agricultural subsectors do not experience yield improvements under the 'All Agriculture' scenario, such as pulses and horticulture, and so increased household incomes causes real prices for these crops to rise. Finally, some crops may also have stronger linkages to upstream processing and foreign markets, such as coffee, which means that their prices are quite stable, even in the 'All Agriculture' scenario.

**Figure 2: Changes in real market prices from baseline values under 'All Agriculture' scenario.**




Source: Results from the DCGE model.

Note: These are real prices changes for selected products relative the prices achieved under the baseline scenario (adjusted for changes in the overall consumer price index). They therefore show how additional production places downward pressure on some commodities' prices, but rising incomes and demand allow some commodities' prices to rise when growth is accelerated.

In summary, the model results indicate that it is possible for Ethiopia to reach the CAADP target of six percent agricultural growth. It will, however, require substantial improvements in crop yields and livestock productivity over a relatively short period of time (i.e., seven years). If these crop- and sub-sector-level targets can be achieved then the resulting broader-based agricultural growth is likely to benefit households in both rural and urban areas. However, the higher growth potential of certain export crops and better market conditions in certain parts of the country may cause uneven income growth and poverty reduction. The livestock sub-sectors also contribute to agricultural growth and poverty reduction throughout the country. Finally, accelerating nonagricultural growth can reduce some of the demand constrains on agricultural growth

## 4.3 Comparing sub-sector growth in terms of growth and poverty reduction

The previous section highlighted the potential contributions of different crops and subsectors in increasing agricultural growth and poverty reduction. However, the different sizes of these sub-sectors made it difficult to compare the effectiveness of sector growth in reducing poverty. Understanding how growth-poverty linkages vary at the sub-sector and household level is important for designing pro-poor growth strategies in different parts of the country. In this section we calculate poverty-growth elasticities that allow us to compare the 'pro-poorness' of growth in alternative sub-sectors. These elasticities are endogenous outcomes from the DCGE model's results. Growth affects individual households differently due to heterogeneity across household groups. The above analysis has shown how, with differences in household and farm characteristics, changes in income and consumption across households can differ considerably from average changes at the national level. Thus, to capture growth-poverty linkages, changes in the distribution of incomes, which are primarily determined by a country's initial conditions, need to be understood. In the previous section we saw how households in certain regions have better opportunities to produce export-oriented crops, and are thus better positioned to benefit from export-crop-led agricultural growth. However, export-crop-producing households are typically less poor than other rural households. Thus, agricultural growth driven by export crops may have less of an impact on poverty, especially amongst the poorest households. By contrast, cereals tend to be a more important source of agricultural incomes for poorer households. Thus, growth in cereals may be more effective at reducing poverty than similar growth in export crops.

The 'poverty-growth elasticity' measures the responsiveness of the poverty rate to changes in per capita agricultural GDP growth. More specifically, the elasticity measures the percentage change in the poverty rate caused by one percent increase in agricultural GDP per capita. Table 7 shows the calculated poverty-growth elasticities under the different growth scenarios. The results indicate that agricultural growth driven by cereals is particularly effective at reducing poverty in the drought-prone region (Zones 2 and 3), where households are generally poorer and depend more heavily on incomes from cereals production. Poverty in the Pastoralist region (Zone 3) is also greatly affected by cereals-led growth due to these crops importance in poorer households' consumption baskets (see Table 6). For a similar reason, cereals-led growth is also effective at reducing poverty in smaller urban centers, where households are poorer than in larger centers and thus spend a larger share of their incomes on purchasing cereals and milled grains.

**Table 7: Poverty-growth elasticities from model scenarios**

| | Percentage change in poverty headcount rate from a one percent increase in national agricultural GDP led by the following sectors | | |
|---|---|---|---|
| | **Cereals-led** | **Export-crops-led** | **Livestock-led** |
| National | -1.17 | -1.08 | -0.36 |
| Rural regions | -1.27 | -1.13 | -0.35 |
| Humid cereals (1a) | -1.16 | -1.03 | -0.12 |
| Humid enset (1b) | -1.06 | -1.44 | -0.46 |
| Drought-prone (2) | -1.48 | -1.06 | -0.42 |
| Pastoralist (3) | -1.94 | -0.93 | -1.50 |
| Small urban centers | -0.62 | -0.65 | -0.42 |
| Large urban centers | -0.50 | -0.92 | -0.50 |

Source: Results from the DCGE model.
Note: The 'poverty headcount' is the share of the population living below the poverty line.

We assign the poverty line so that 40 percent of the population is classified as 'poor' (i.e., the bottom two expenditure quintiles).

In contrast, expanding export crops is most effective at reducing poverty in the humid enset region (Zone 1b) and amongst households in larger urban centers, who are better endowed with capital and other assets needed to produce export crops. Finally, livestock production is especially effective at reducing poverty in urban areas and amongst rural households in the pastoralist region (Zone 3). Urban consumers spend a larger share of their incomes on meat and dairy and so benefit more when production in this sector expands. Overall, however, it is cereals that is most effective at reducing national poverty, since a larger share of poor household depend on cereals for their incomes, and since more poor consumers (in rural and urban areas) spend a greater share of their income on cereals and milled grains.

The previous section concluded that to increase agricultural growth and reach the six percent growth target, it will be necessary to encourage growth in a number of agricultural subsectors. The poverty-growth elasticities suggest that cereals should be afforded a high priority in any strategy aimed at substantially reducing poverty. Moreover, cereals already form a large part of the agricultural sector and have high enough growth potential to substantially raise agricultural and national GDP. Cereals are therefore a priority sector for increasing investments.

# 5. Conclusion

A new economy wide modeling framework was developed and used to examine the contribution of accelerating growth in alterative agricultural crops and sub-sectors and to assess how Ethiopia can achieve the CAADP target of six percent agricultural growth. The impact of agricultural growth at the macro- and microeconomic levels, as well as on poverty, was estimated. The three major conclusions of this paper are summarized below.

First, six percent agricultural growth is ambitious but achievable. The CGE model results indicated that if Ethiopia can meet its targets for crop yields and livestock productivity, then it should be possible to reach and sustain the six percent agricultural growth target during 2006-2015. Even though these yield targets are below the maximum potential yields identified by agricultural field trials, they are still ambitious given the short timeframe of the CAADP initiative (i.e., seven years). However, by focusing additional growth in agriculture, agricultural growth at six percent per year would increase overall GDP growth by one percentage point per year. This higher growth rate would reduce national poverty to 18.36 percent by 2015, which is lower than the 22.67 percent poverty rate that would have been achieved without additional agricultural growth. This means that the higher growth under the accelerated agricultural growth scenario would lift an additional 3.7 million people above the poverty line by 2015.

Secondly, not everyone will benefit equally under the CAADP growth scenario. Most households are expected to benefit from faster agricultural growth. However, some agro-ecological zones that grow higher-value cereals and export-oriented crops and which are better situated to larger urban markets (e.g., the rain sufficient highlands) stand to gain more than other parts of the country. Furthermore, poverty amongst households in some zones will remain high, despite faster agricultural growth. Finally, both rural and urban households benefit from faster agricultural growth, although rural households benefit more. This is because, agricultural incomes are most important for rural households, but food commodities are an important part of the consumption baskets of both urban and rural households.

Thirdly, the composition of agricultural growth matters. Comparing the effectiveness of growth driven by different sub-sectors in reducing poverty and encouraging broader-based growth, additional growth driven by cereals have larger impacts on poverty reduction, especially in rural areas. This is because these crops are already large and so can contribute substantially to achieving broad-based agricultural growth. Yield improvements in these crops not only benefit households directly, by

increasing incomes from agricultural production, but also by allowing farmers to diversify their land allocation towards other higher-value crops. Cereals are also effective at raising rural real incomes and reducing poverty, especially amongst the poorest households. Thus, high priority should be afforded to improving cereals yields and opening market opportunities for upstream processing to reduce demand constraints.

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**Appendix 1: Description of the Ethiopian DCGE model**

The model captures differences in employment patterns across activities by identifying 69 sectors, 34 of which are in farming and agro-processing (see Table 1).[6] The model further separates agricultural activities across four sub-national regions based on agro-ecological conditions and dominant farming system. Representative producers in each sector and region combine intermediate inputs with factors of production so as to maximize profits. The model separates factors into land, labor, livestock and capital. Nested production functions allow producers to imperfectly substitute between factors based on their relative prices. The model distinguishes between agricultural, unskilled and skilled labor and assumes that these groups are fully-employed earning flexible wages. Land and labor can migrate between sectors but not across regions in response to changing factor demands. By contrast, new capital is allocated across sectors and regions according to profit-rate differentials and then, once invested, becomes immobile earning sector-specific returns.

International trade is captured in the model by allowing production and consumption to shift imperfectly between domestic and foreign markets, depending on the relative prices of imports, exports and domestic goods (inclusive of indirect taxes). This reflects differences in domestic and foreign products and allows for two-way trade. Ethiopia is a small economy and so its trade flows do not influence world prices. The real exchange rate (i.e., price index of tradable-to-non-tradable goods) adjusts to maintain a constant current account balance.

The model distributes factor incomes to households' based on their factor endowments drawn from the 2004/05 household income and expenditure survey (HICES, 2005). Representative households are disaggregated by rural and urban areas, small and large urban centers, and by poor and non-poor categories. Households save part of their income (based on fixed savings rates) and consume commodities under a linear expenditure system of demand, which permits non-unitary income elasticities. This specification allows us to measure shifts in the distribution of incomes, and to track how changes in household demand affect production and prices. Households also pay taxes to the government based on fixed direct and indirect tax rates. Tax revenues finance exogenous recurrent spending, resulting in an endogenous fiscal deficit. Finally, a separate micro-simulation module based links each respondent in the household survey (HICES) to their corresponding representative household group in the model. Changes in commodity prices and households' consumption spending are passed down from the DCGE model to the

[6] The model is a variant of the basic neo-classical CGE model developed by Dervis, de Melo and Robinson (1982); and Lofren, Harris and Robinson (2001), and closely follows that of Thurlow (2005).

micro-simulation module, where per capita consumption and standard poverty measures are recalculated.

The model's variables and parameters are calibrated to empirical data from a social accounting matrix that captures the initial structure of Ethiopia's economy in 2005/06 (Ahmed et al. 2009). Parameters are then adjusted over time to reflect demographic and economic trends and the model is re-solved annually for the period 2005-2015. Between periods the model is updated to reflect exogenous rates of land and labor expansion and technical change. The rate of capital accumulation is determined endogenously, with previous period investment converted into new capital stocks, which are then added to previous capital stocks after applying depreciation.

**Table A1: Model indices, variables and parameters**

| | | | |
|---|---|---|---|
| ***Indices*** | | | |
| $c$ | Commodities and activities | $h$ | Representative households |
| $f$ | Factors (land, labor and capital) | $t$ | Time periods |
| *Exogenous parameters (Greek characters)* | | | |
| $\alpha^a$ | Production function shift parameter | $\theta^v$ | Value-added share of gross output |
| $\alpha^q$ | Import function shift parameter | $\pi$ | Foreign savings growth rate |
| $\alpha^t$ | Export function shift parameter | $\rho^a$ | Production function substitution elasticity |
| $\beta$ | Household marginal budget share | $\rho^q$ | Import function substitution elasticity |
| $\gamma$ | Non-monetary consumption quantity | $\rho^t$ | Export function substitution elasticity |
| $\delta^a$ | Production function share parameter | $\sigma$ | Rate of technical change |
| $\delta^q$ | Import function share parameter | $\tau$ | Foreign consumption growth rate |
| $\delta^t$ | Export function share parameter | $\upsilon$ | Capital depreciation rate |
| $\varepsilon$ | Land and labor supply growth rate | $\varphi$ | Population growth rate |
| $\theta^i$ | Intermediate share of gross output | $\omega$ | Factor income distribution shares |
| *Exogenous parameters (Latin characters)* | | | |
| $ca$ | Intermediate input coefficients | $pwm$ | World import price |
| $cab$ | Current account balance | $qfs$ | Total factor supply |
| $cd$ | Domestic transaction cost coefficients | $qgov$ | Base government consumption quantity |
| $ce$ | Export transaction cost coefficients | $qinv$ | Base investment demand quantity |
| $ci$ | Capital price index weights | $rf$ | Factor foreign remittance rate |
| $cm$ | Import transaction cost coefficients | $sh$ | Marginal propensity to save |

**Table A1 continued: Model indices, variables and parameters**

| | | | |
|---|---|---|---|
| $cpi$ | Consumer price index | $tf$ | Factor direct tax rate |
| $cw$ | Consumer price index weights | $th$ | Personal direct tax rate |
| $ga$ | Government consumption adjustment factor | $tm$ | Import tariff rate |
| $gh$ | Per capita transfer from government | $tq$ | Sales tax rate |
| $pop$ | Household population | $wh$ | Net transfer from rest of world |
| $pwe$ | World export price | | |
| *Endogenous variables* | | | |
| $AR$ | Average capital rental rate | $QG$ | Government consumption quantity |
| $FS$ | Fiscal surplus (deficit) | $QH$ | Household consumption quantity |
| $IA$ | Investment demand adjustment factor | $QI$ | Investment demand quantity |
| $PA$ | Activity output price | $QK$ | New capital stock quantity |
| $PD$ | Domestic supply price with margin | $QM$ | Import quantity |
| $PE$ | Export price | $QN$ | Aggregate intermediate input quantity |
| $PM$ | Import price | $QQ$ | Composite supply quantity |
| $PN$ | Aggregate intermediate input price | $QT$ | Transaction cost demand quantity |
| $PQ$ | Composite supply price | $QV$ | Composite value-added quantity |
| $PS$ | Domestic supply price without margin | $WD$ | Sector distortion in factor return |
| $PV$ | Composite value-added price | $WF$ | Economywide factor return |
| $QA$ | Activity output quantity | $YF$ | Total factor income |
| $QD$ | Domestic supply quantity | $YG$ | Total government revenues |
| $QE$ | Export quantity | $YH$ | Total household income |
| $QF$ | Factor demand quantity | $X$ | Exchange rate |

**Table A2: Model equations**

| | |
|---|---|
| *Prices* | |
| $PM_{cr} = pwm_c \cdot (1 + tm_c) \cdot X + \sum_{c'} PQ_{c'r} \cdot cm_{c'c}$ | 1 |
| $PE_{ct} = pwe_c \cdot X_c - \sum_{c'} PQ_{c't} \cdot ce_{c'c}$ | 2 |
| $PD_{ct} = PS_{ct} + \sum_{c'} PQ_{c't} \cdot cd_{c'c}$ | 3 |
| $PQ_{ct} \cdot (1 - tq_c) \cdot QQ_{ct} = PD_{ct} \cdot QD_{ct} + PM_{ct} \cdot QM_{ct}$ | 4 |
| $PX_{ct} \cdot QX_{ct} = PS_{ct} \cdot QD_{ct} + PE_{ct} \cdot QE_{ct}$ | 5 |
| $PN_{ct} = \sum_{c'} PQ_{c't} \cdot ca_{c'c}$ | 6 |
| $PA_{ct} \cdot QA_{ct} = PV_{ct} \cdot QV_{ct} + PN_{ct} \cdot QN_{ct}$ | 7 |
| $cpi = \sum_c cw_c \cdot PQ_{ct}$ | 8 |
| *Production and trade* | |
| $QV_{ct} = \alpha_{ct}^{v} \cdot \sum_f \left(\delta_{fc}^{v} \cdot QF_{fct}^{-\rho_c^v}\right)^{-1/\rho_c^v}$ | 9 |
| $WF_{ft} \cdot WD_{fct} = PV_{ct} \cdot QV_{ct} \cdot \sum_{f'} \left(\delta_{f'c}^{v} \cdot QF_{f'ct}^{-\rho_c^v}\right)^{-1} \cdot \delta_{fc}^{v} \cdot QF_{fct}^{-\rho_c^v - 1}$ | 10 |
| $QN_{ct} = \theta_c^i \cdot QA_{ct}$ | 11 |
| $QV_{ct} = \theta_c^v \cdot QA_{ct}$ | 12 |
| $QA_{ct} = \alpha_c^z \cdot \left(\delta_c^z \cdot QE_{ct}^{\rho_c^z} + (1 - \delta_c^z) \cdot QD_{ct}^{\rho_c^z}\right)^{1/\rho_c^z}$ | 13 |
| $\frac{QE_{ct}}{QD_{ct}} = \left(\frac{PE_{ct}}{PS_{ct}} \cdot \frac{(1 - \delta_c^z)}{\delta_c^z}\right)^{1/(\rho_c^z - 1)}$ | 14 |
| $QQ_{ct} = \alpha_c^q \cdot \left(\delta_c^q \cdot QM_{ct}^{-\rho_c^q} + (1 - \delta_c^q) \cdot QD_{ct}^{-\rho_c^q}\right)^{-1/\rho_c^z}$ | 16 |
| $\frac{QM_{ct}}{QD_{ct}} = \left(\frac{PD_{ct}}{PM_{ct}} \cdot \frac{(1 - \delta_c^q)}{\delta_c^q}\right)^{1/(1+\rho_c^z)}$ | 17 |
| $QT_{ct} = \sum_{c'} (cd_{cc'} \cdot QD_{c't} + cm_{cc'} \cdot QM_{c't} + ce_{cc'} \cdot QE_{ct})$ | 18 |

**Table A2 continued: Model equations**

| | |
|---|---|
| *Incomes and expenditures* | |
| $YF_{fr} = \sum_c WF_{fr} \cdot WD_{fcr} \cdot QF_{fcr}$ | 19 |
| $YH_{hr} = \sum_f \omega_{hf} \cdot (1 - tf_f) \cdot (1 - rf_f) \cdot YF_{fr} + gh_h \cdot pop_{hr} \cdot cpi + wh_h \cdot X$ | 20 |
| $PQ_{cr} \cdot QH_{chr} = PQ_{cr} \cdot \gamma_{ch} + \beta_{ch} \cdot \left( (1 - sh_h) \cdot (1 - th_h) \cdot YH_{hr} - \sum_{c'} PQ_{cr} \cdot \gamma_{c'h} \right)$ | 21 |
| $QI_{cr} = IA_c \cdot qinv_c$ | 22 |
| $QG_{cr} = ga_c \cdot qgov_c$ | 23 |
| $YG_r = \sum_h th_h \cdot YH_{hr} + \sum_f tf_f \cdot YF_{fr} + \sum_c (tm_c \cdot pwm_c \cdot QM_{cr} \cdot X + tq_c \cdot PQ_{cr} \cdot QQ_{cr})$ | 24 |
| *Equilibrium conditions* | |
| $qfs_{fr} = \sum_c QF_{fcr}$ | 25 |
| $QQ_{cr} = \sum_{c'} ca_{cc'} \cdot QN_{c'r} + \sum_h QH_{chr} + QG_{cr} + QI_{cr} + QT_{cr}$ | 26 |
| $\sum_c pwm_c \cdot QM_{cr} + \sum_f (1 - tf_f) \cdot rf_f \cdot YF_{fr} \cdot X_r^{-1} = \sum_c pwe_c \cdot QE_{cr} + \sum_h wh_h + cl$ | 27 |
| $YG_r = \sum_c PQ_{cr} \cdot QG_{cr} + \sum_h gh_h \cdot pop_{hr} \cdot cpi + FS_r$ | 28 |
| $\sum_h sh_h \cdot (1 - th_h) \cdot YH_{hr} + FS_r + cab_r \cdot X_r = \sum_c PQ_{cr} \cdot QI_{cr}$ | 29 |
| *Capital accumulation and allocation* | |
| $AR_{fr} = \frac{YF_{fr}}{qfs_{fr}}$ | 30 |
| $QK_{fcr} \cdot \left( \sum_{c'} PQ_{c'r} \cdot ci_{c'} \right) = \left( \frac{QF_{fcr}}{qfs_{fr}} \cdot \frac{WF_{fr} \cdot WD_{fcr}}{AH_{fr}} \right) \cdot \left( \sum_{c'} PQ_{c'r} \cdot QI_{c'r} \right)$ | 31 |
| $QF_{fcr+1} = QF_{fcr} \cdot (1 - v) + QK_{fcr}$ | 32 |
| *Land and labor supply, technical change, population growth, and other dynamic updates* | |
| $qfs_{fr+1} = qfs_{fr} \cdot (1 + \varepsilon_f)$ | 33 |
| $\alpha_{cr+1}^q = \alpha_{cr}^q \cdot (1 + c_c)$ | 34 |
| $pop_{hr+1} = pop_{hr} \cdot (1 + \varphi_h)$ | 35 |
| $ga_{r+1} = ga_r \cdot (1 + \tau)$ | 36 |
| $cab_{r+1} = cab_r \cdot (1 + \pi)$ | 37 |

# SEED, FERTILIZER, AND AGRICULTURAL EXTENSION IN ETHIOPIA

David J. Spielman[1], Dawit Kelemework[2] and Dawit Alemu[3]

*Abstract*

*Over the past four decades, decision-makers in Ethiopia have pursued a range of policies and investments to boost staple crop production and productivity as a means of reducing poverty. These policies and investments have specifically aimed at increasing the availability of improved seed, fertilizer, and extension services for smallholders. While there is some evidence to suggest that this process has improved both output and yields, decision-makers still recognize that further improvements are urgently needed. This paper synthesizes lessons from Ethiopia's past, identifies challenges facing the country's continuing efforts on this front, and recommends policy solutions for the future.*

**Keywords:** Agricultural development, agricultural extension, fertilizer, seed markets, cultivar improvement, sub-Saharan Africa, Ethiopia

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## 1. Introduction

Over the past two decades, decision-makers in Ethiopia have pursued a range of policies and investments to boost agricultural production and productivity, particularly with respect to the food staple crops that are critical to reducing poverty in the country. A central aim of this process has been to increase the availability of improved seed, chemical fertilizers, and extension services for small-scale, resource-poor farmers, particularly those cultivating food staple crops. While there is some evidence to suggest that the process has led to improvements in both output and yields during this period, decision-makers still recognize that there is extensive room for improvement. And given the persistent food security issues facing Ethiopia year on year, there is a sense of urgency underlying the need for improvement.

This paper begins with a brief overview of efforts to promote improved seed, chemical fertilizers, extension services, and other modern agricultural inputs and services in Ethiopia. Following a brief review of sequential programs aiming to promote agricultural development and intensification, we focus this discussion of history to three policy "episodes" that have occurred over the past two decades.

We then examine the systems and markets for seed, fertilizer, and extension. We do so by exploring both the theoretical and practical roles of the public and private sectors as they relate to seed, fertilizer and extension systems and markets. We conclude by offering several policy solutions that aim to encourage investment, improve incentives, and strengthen institutions necessary to improve smallholder access to improved seed, chemical fertilizers, and extension services in Ethiopia.

## 2. Ethiopia's input systems and markets in historical perspective

Ethiopia presents one of the most important global challenges in agricultural development. It is among the poorest countries in the world, and its agricultural sector accounts for about 44 percent of national GDP, 85 percent of employment, and 90 percent of the poor. Rural poverty is further compounded by extreme land shortages in the highlands (where per capita land area has fallen from 0.5 ha in the 1960s to only 0.2 ha by 2008), low productivity of food production (with cereal yields averaging around 1.5 ton/ha), recurrent droughts and variable rainfall, and, as a consequence, high variability in agricultural production (World Bank, 2005). As a result, Ethiopia experiences widespread structural food deficits that lead to chronic dependence on food aid.

Accordingly, the Government of Ethiopia (GoE) has consistently emphasized agricultural productivity growth and food security in its long-term development strategies. Key components of these strategies date back to the mid-1960s with the introduction of policies and programs specifically aimed at increasing access to modern inputs and extension services for the country's largely smallholder-based agricultural sector (Table 1).

The first such programs were organized as Comprehensive Integrated Package Projects (CIPPs) and promoted by the Imperial regime during the period 1968-1973. On the ground implementation focused on the promotion of modern inputs, credit, and extension, and the formation of cooperative societies, and were highlighted by area development programs—the Chilalo Agricultural Development Unit (CADU, 1967), the Wolaita Agricultural Unit (WADU, 1970), and the Ada District Development Project (ADDP, 1972). While these programs helped to develop Ethiopia's expertise in agricultural intensification, their scale was too small to boost output or productivity. Thus, by the end of the Imperial era, Ethiopia's extension services reached only about 16 percent of the farming population, while input and credit provision catered largely to the feudal class rather than the smallholder population engaged in food production (Rahmato, 2004).

The first Minimum Package Program (1971-1979) attempted to expand access to modern inputs such as improved seed and fertilizer, while simultaneously reducing the level and cost of services provided to smallholders. A minimum package area comprised about 10,000 farm households residing along a main all-weather road for 50-75 km and away from the road for 5-10 km on both sides.

Although the program was designed during the Imperial era, its implementation continued into the military *Derg* regime that followed (1974–1991). During this latter regime, economic reforms undertaken by the *Derg* led to significant changes in Ethiopia's rural landscape. The feudal system was summarily dismantled; agricultural production was organized around peasant cooperatives, state-owned farms, and collectives; and the formal research and extension systems were expanded throughout the entire country. But by the end of the *Derg* regime, the extension services had been reduced to instruments of political control over the peasantry, while input and credit provision was largely focused on covering the inefficiencies of large state farms and peasant collectives (Wubneh, 2007).

Since the end of the *Derg* in 1991, the GoE has introduced new policies to intensify cereal production, accelerate agricultural growth, and achieve food security under a national economic strategy known as Agriculture Development Led Industrialization (ADLI) (FDRE, 2006a, 2002, 1993). During the 1990s, ADLI set in motion a series of

reforms that sought to generate a more supportive macroeconomic framework, liberalize markets for agricultural products, and promote the intensification of food staple production through the use of modern inputs, especially seed and fertilizer packages (FDRE, 2006a, 2002). The intensification campaign focused on cereals in the moisture-reliable highlands where 60 percent of the rural population lives and where the strategy had the best chance of success.

**Table 1: Polices regimes and development programs in agricultural input systems and markets, 1957-1995**

| Period | Intervention/Event | Focus/Objectives | Remarks |
|---|---|---|---|
| **1957-1967** | First and Second Five Year Development Plans | Develop large-scale commercial farms and coffee exports | Subsistence farming was neglected |
| **1968-1973** | Third Five Year Development Plan (Comprehensive Integrated Package Projects) | Transport infrastructure development; dissemination of high-input technologies, credit, and extension; formation of cooperative societies. | Implementation revolved around three comprehensive extension programs that focused on high-potential areas only. |
| **1971-1979** | Minimum Package Program I (MPP-I) | Expand geographic coverage of the comprehensive extension programs; provide fertilizer, credit and extension to “minimum package areas.” | Fertilizer procurement managed by Agricultural and Industrial Development Bank (AIDB), distribution managed by Ministry of Agriculture (MoA). |
| **1978** | Agricultural Marketing Corporation (AMC) | Improve management of agricultural input importation, storage, and transport by handing over control of these tasks to the AMC. | MoA maintains roe of distributing fertilizer to farmers, disbursing credit, and estimating fertilizer demand through approx 18,000 peasant associations. |

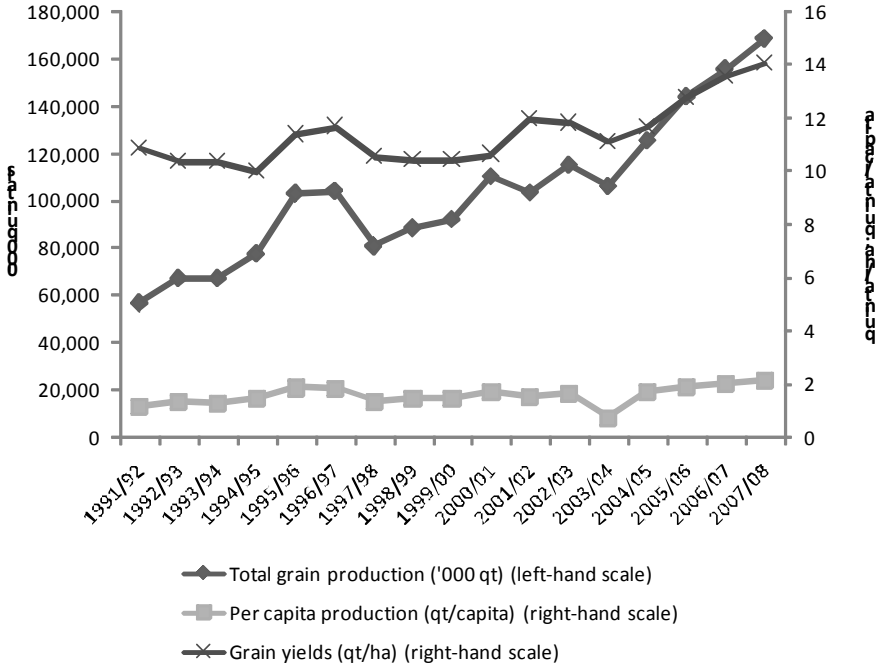
**Table 1 continued…**

| Period | Intervention/Event | Focus/Objectives | Remarks |
|---|---|---|---|
| 1980-1985 | Minimum Package Program II (MPP-II) | Expand input supply and extension service coverage three-fold. | Actual provision of inputs and extension was limited due to: lacking financial support for MPP-II; increasing inefficiency in MoA and AMC; fertilizer overstocking due to inaccurate demand estimates; and poor institutional coordination of input deliveries. |
| 1984 | Agricultural Input Supply Corporation (AISCO) | Improve the importation and distribution of fertilizer and marketing of other agricultural inputs | As a successor to AMC, AISCO was limited by lengthy bureaucratic process needed to secure foreign exchange, high freight costs, lack of proper port facilities, high inland transport costs, inaccurate demand estimates, and organizational inefficiency. |
| 1986-1995 | Peasant Agricultural Development Program (PADEP) | Provide inputs, credit, and extension services to smallholders organized into approximately 2,900 farmer service cooperatives (SC) using a Training and Visit (T&V) extension approach. | As a successor to MPP-II, PADEP aimed to cover 8 development zones across the country, but only received financing sufficient for 3 zones, all located in high potential areas. |

Source: Stepanek (1999), Demeke (1995), Gebremedhin et al (2006), Abate (2008), and authors.

By and large, the GoE's macroeconomic reforms have been successful, resulting in more than a decade of sustained economic growth. Similarly, the GoE's cereal intensification efforts have experienced similar successes, although growth has been more episodic than continuous, with fairly stagnant per capita production of grain (Figure 1)

**Figure 1: Total and per capita grain production and grain yields, 1991–92 to 2007–08**




Note: The term "grain" refers to all cereals, legumes, and pulses cultivated in Ethiopia.
Source: CSA (various years).

The first episode of success ran from about 1994–95 to 2000–01, and hinges on the achievements of the National Agricultural Extension Intervention Program (NAEIP). The NAEIP was a scale-up of the Participatory Demonstration and Training Extension System (PADETES), an integrated program of extension, seed, fertilizer and credit that was piloted by Sasakawa Global 2000 (SG2000), an international nongovernmental organization. The NAEIP reached about 40 percent of the roughly 10 million farm households in Ethiopia over a 10-year period. The extensive data from millions of demonstrations carried out through PADETES (3.6 million in 1999 alone) indicated that the adoption of seed-fertilizer technologies could more than double cereal yields (Table 2) and would be profitable to farmers in moisture-reliable areas (Howard et al., 2003).

This episode was succeeded by a period of volatility (2001–02 to 2002–03) that demonstrated just how susceptible Ethiopia's agricultural economy is to weather and price shocks. First, maize prices collapsed in 2001, partly as a consequence of a glut

that resulted from intensification of maize production in the 1990s. A drought soon followed, contributing to further reductions in cereal production (DSA, 2006).

**Table 2: Yields in on-farm field trials vs. farmers' yields, 1993–2008 (metric tons/hectare)**

| Crop | SG2000 (1993–1999) | | NAEIP (1995–1999) | | Current farm yields (2000–08) |
|---|---|---|---|---|---|
| | Improved | Traditional | Improved | Traditional | |
| Maize | 4.60 | 1.57 | 4.73 | 1.57 | 1.98 |
| Wheat | 2.31 | 0.95 | 2.93 | 1.17 | 1.47 |
| Sorghum | 2.08 | 0.92 | 2.79 | 1.12 | 1.4 |
| Teff | 1.62 | 0.64 | 1.43 | 0.85 | 0.93 |
| Barley | – | – | 2.15 | 1.00 | 1.19 |

[a] NAEIP is the National Agricultural Extension Intervention Program. SG2000 is the Sasakawa Global 2000 program.
Source: World Bank, 2006b.

The next episode might be described as a period of rapid agricultural growth. Following a recovery from the drought, agricultural GDP growth averaged 12 percent per annum between 2003–04 and 2007–08. But this growth period was paradoxically accompanied by a surge in food price inflation which escalated from 2 percent in 2003–04 to 78 percent in 2007–08 (Ulimwengu et al., 2009; Mishra, 2008) and raises a number of questions including some pertaining to the quality of agricultural production statistics (IFPRI, 2009; Minot, 2009; Taffesse, 2008).

These episodes raise the question of to what extent the policies governing Ethiopia's input markets and extension services have helped or hindered Ethiopia's agricultural intensification efforts over the past 15 years (Table 3). While the use of improved seed and chemical fertilizer have increased across these episodes—by about 50 and 30 percent respectively, between 1995 and 2008—the gains have been inconsistent and volatile. Part of this may be attributable to the shifting roles of the public and private sectors, and the occasional policy changes that have influenced their respective roles in different ways. Ethiopia's experiences over the past 15 years, and the issues raised by these experiences, are summarized below for each of the major components of the country's agricultural input system and market—seed, fertilizer, and extension.

**Table 3: Polices regimes and development programs in agricultural input systems and markets, 1995-present**

| Period | Intervention/Event | Focus/Objectives | Remarks |
|---|---|---|---|
| 1991-1995 | Partial liberalization of the fertilizer market | Open the importation, wholesaling, and retailing of fertilizers to private companies | Undertaken by the Transitional Government of Ethiopia (TGE). Fertilizer prices remained pan-territorial and subsidized. |
| 1993–1999 | Participatory Demonstration and Training Extension System (PADETES) | Promote improved seed-fertilizer-credit packages (primarily for maize and wheat) through a "training and visit" approach piloted by Sasakawa Global 2000. | PADETES demonstrated on a pilot basis that yields could be doubled with the application of modern inputs in Ethiopia. |
| 1995–present | National Agricultural Extension Intervention Program (NAEIP) | Scale up the PADETES approach to the national level as a means of boosting cereal yields and output | Efforts to scale up the PADETES approach were less successful than the piloting demonstrated by Sasakawa Global 2000. |
| 1997-98 | Fertilizer price liberalization | Eliminate subsidies and deregulate the price of fertilizer at the wholesale and retail levels. | Liberal prices have not resulted in competitive market due to the government's continued control over marketing and credit. |
| 2000-07 | Shifting industry structure | Private companies withdraw from the fertilizer market in 2000, succeeded by "holding" companies; cooperative unions enter the market in 2005, followed by the withdrawal of "holding" companies" in 2007. | The Agricultural Input Supply Enterprise (AISE) and cooperative unions emerge as the only actors engaged in fertilizer importation, and are also the largest players in the wholesale and retail markets, in conjunction with the regional input supply and extension systems. |

Source: Stepanek (1999), Demeke (1995), Gebremedhin et al (2006), Abate (2008), and authors.

## 3. Seed systems and markets

From a conceptual perspective, seed systems and markets are subject to at least three unique constraints—three market failures—that complicate early stages of seed market development. These constraints are contestable property rights relating to the

improvement of cultivated varieties (cultivars); absent institutions in the market for improved cultivars; and information asymmetries in the exchange of seed between buyers and sellers (Gisselquist and Van Der Meer, 2001; Hassan et al. 2001; Morris 1998; Tripp and Louwaars, 1997).

The first constraint emerges from the public goods nature of research embodied in improved cultivars, and the inherent market failure that accompanies cultivar improvement. Consider a scenario where a farmer saves and replants seed of an improved cultivar across seasons and, in doing so, avoids paying the private innovator who improved the cultivar for his or her investment in research and development (R&D). In this scenario, the social returns from enhanced yields or increased output exceed the returns to the private innovator. This suggests that the public sector must play a continuous role in cultivar improvement, i.e., by investing in agricultural R&D.

The second constraint is associated with mechanisms designed to increase the private innovator's capacity to recoup his or her investment in R&D and overcome the market failure described above. Biological mechanisms such as hybridization (common in maize and increasingly in rice, millet, and sorghum) imply that farmers must purchase seed each season to reap the yield benefits of hybrids—the vigor conferred by *heterosis.* Institutional mechanisms such as intellectual property rights (plant variety protection certificates, patents, and trade secrecy laws) similarly allow the innovator to recoup investment costs through litigation when a farmer plants improved cultivars without paying some fee to the innovator for use of the seed. The inability to leverage the biological properties of hybrids, enforce IPRs, or prevent farmers from saving seed can discourage private investment in cultivar improvements that have potentially significant social impacts, thus signaling another difficulty in correcting this market failure.

A third constraint emerges where the characteristics of improved seeds are known only by the innovator, implying that farmers are unable to make accurate ex ante assessments of quality, giving unscrupulous sellers an advantage over their customers. Remedies to this include strong regulation of the seed certification process, or truth in labeling laws. Importantly, the absence of such regulations—or worse yet, the wholesale deregulation of the seed sector as part of a wider market liberalization program—can inhibit smallholder adoption of improved cultivars (Tripp and Louwaars, 1997).

In short, seed is a tricky good to manage due to inherent market failures that are difficult to overcome. We examine these issues in the context of Ethiopia's seed

system and market, focusing on the (a) adoption of improved seed, (b) the demand and supply for improved seed, and (c) the seed industry structure.

## 3.1 Improved seed adoption

Official estimates from the Central Statistics Agency (CSA) show that while the total quantity of improved seed supplied nationally has been increasing since 1996–97, farmer use of improved seed covered an average of only 4.7 percent of cropped area in 2007–08 (Figure 2). Various surveys similarly report low adoption rates, for example, just 3 percent according to the nationally-representative Ethiopia Rural Smallholder Survey (ERSS) conducted in 2005.[4]

To be sure, most farmers still rely primarily on farmer-to-farmer exchanges or saved seed (Belay, 2004). However, surveys such as these are often unable to provide real insights into the improved seed adoption due to problems in their design. The question that should be asked is what type of variety is a farmer cultivating, and when did he or she purchase the seed. For improved open-pollinated varieties such as wheat and teff, farmers do not necessarily need to purchase seed each season as they would hybrid maize; Rather, they might purchase seed every 4-5 years to replace their stocks of saved seed with seed that has a higher level of purity, and thus better performance when cultivated (Doss et al., 2003).[5]

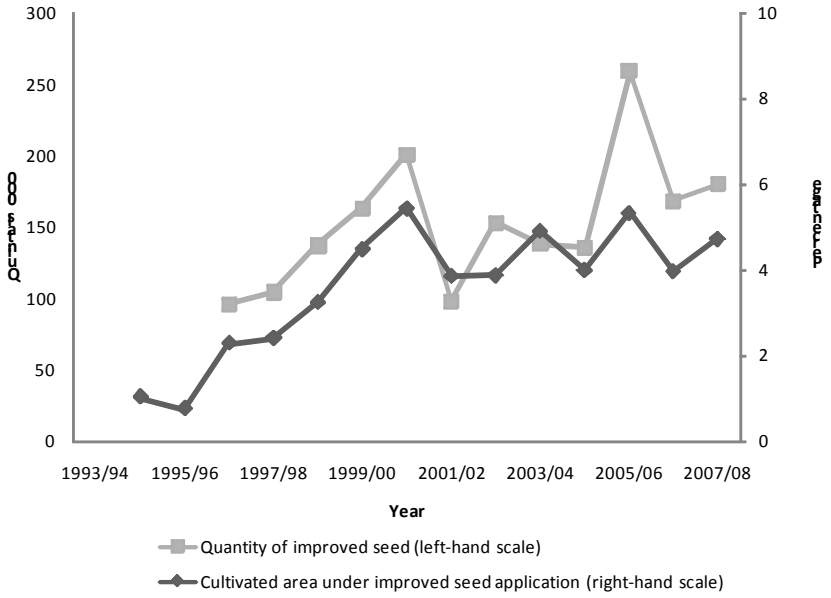
To be sure, a large portion of wheat cultivated in Ethiopia is improved wheat. Lantican et al. (2005) reported that in 2002, 71 percent of all wheat area in the country was sown with improved varieties. Kotu et al. (2000), Beyene (1998) and Zegeye (2001) report improved wheat adoption in selected *woredas* ranging from 42 to 80 percent during various years in the 1990s. Yet as an indication of just how common long-term seed recycling is among Ethiopian smallholders, Lantican et al. (2005) find that only 43 percent of the area under improved wheat varieties was sown with varieties released since 1995.

[4] The Ethiopia Rural Smallholder Survey (ERSS) was conducted by the International Food Policy Research Institute (IFPRI), Ethiopian Development Research Institute (EDRI), and the Central Statistics Agency (CSA). Data were collected mid-2005 from 7,186 households randomly drawn from 293 enumeration areas (EAs, roughly mapping to a *kebele)* based on a stratified two-stage cluster sample design. The sample is considered representative at the national level as well as at the regional level for four regions: Amhara, Oromia, Tigray, and the Southern Nations, Nationalities, and Peoples (SNNP) regional state. The ERSS survey was based on the CSA's Annual Agricultural Sample Survey (AASS) which used a sampling frame of 25 agricultural households selected from each EA, and covered all of rural Ethiopia except Gambella Region, and the non-sedentary population of three zones of Afar Region and six zones of Somali Region.

[5] Interestingly, a study by Bishaw (2004) indicates that the purity and germination rates for farmer saved wheat seed, seed purchased in local markets, and seed purchased or traded from neighbors is comparable to seed supplied by the government (R. Tripp, pers. comm., December 18, 2009).

With respect to maize, CSA reports that area under improved varieties and hybrids has grown from 5 percent in 1998 to 20 percent in 2008. Lantican et al. (2005) report that as of 2001, the majority of the improved maize was accounted for by hybrids. Degu et al. (2000) and Zegeye (2001a, b, c) report improve maize adoption in selected *woredas* ranging from 6 to 47 percent during various years in the 1990s. With respect to teff, barley and sorghum, the other main cereal crops cultivated in Ethiopia, adoption rates are relatively lower than both wheat and maize (Figure 3).

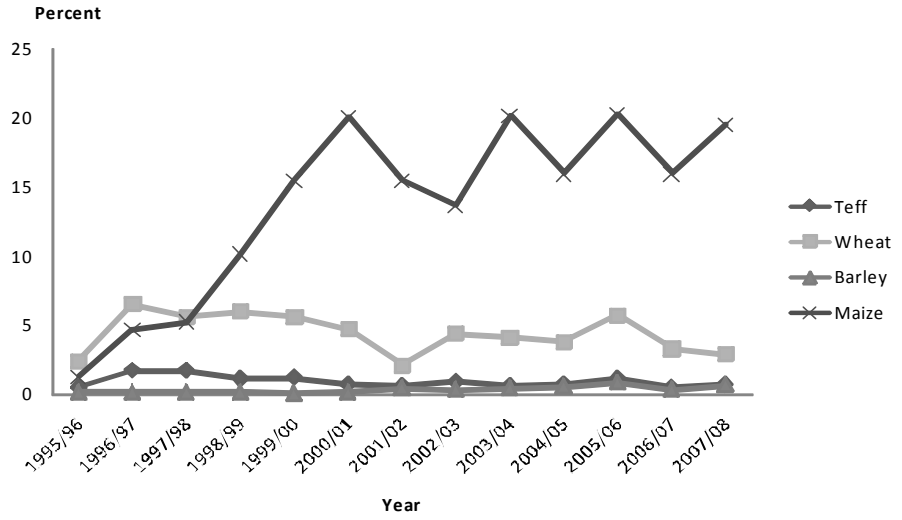
**Figure 2: Area under improved seed application and quantity of improved seed distributed, for cereals only, 1993–94 to 2007–08**




Source: CSA, various years.

In short, the conventionally-cited figures—3 percent adoption of improved varieties and 4-5 percent of cropped area under improved varieties—obscure the extensive uptake of improved wheat and, to a lesser extent improved maize, in Ethiopia. Moreover, these figures obscure the high rates of seed recycling and low rates of seed replacement, suggesting challenges for the promotion and adoption of new cultivars among smallholders.

**Figure 3: Area under improved seed application, main cereal crops, 1995–96 to 2007–08**




Source: CSA, various years.

## 3.2 Seed demand and supply

Estimates of market demand for improved seed in Ethiopia are based entirely on official projections that are developed at the local *(kebele)* level and then transmitted through official channels to zonal and regional levels, after which they are aggregated nationally to produce estimates of the type and quantity (but not preferences for specific varieties or traits) of seed that needs to be supplied in the coming season (Alemu et al., 2007).

The responsibility of responding to these demand estimates lies primarily with the state-owned Ethiopian Seed Enterprise (ESE). On the supply side, production and distribution of improved seed has been stagnant since about 2000. At about this same time, the supply of improved seed channeled through the regional extension and input supply system began to fall short of official estimates of demand (e.g., a 72 percent shortfall in 2008 for the five major cereals). Limited production capacity at ESE for certified seed, combined with insufficient provision of breeder and pre-basic seed from the research system, contribute much to these shortfalls. Assuming that demand estimates are not wholly inaccurate, demand has consistently fallen short of supply, as shown in Table 4.

**Table 4: Seed supply shortfalls in Ethiopia, 2005–08**

| Crop | Supply as a percent of official demand | | | |
|---|---|---|---|---|
| | 2005 | 2006 | 2007 | 2008 |
| Wheat | 20 | 38 | 23 | 24 |
| Maize | 53 | 28 | 60 | 48 |
| Teff | 5 | 12 | 22 | 19 |
| Barley | 16 | 18 | 10 | 7 |
| Sorghum | Na | 7 | 16 | 48 |

Source: MoARD, various years.

And yet, shortcomings in seed quality and timeliness of delivery have been longstanding issues in Ethiopia. Poor cleaning, broken seeds, low germination rates, and the presence of mixed seeds have been reported in ESE-supplied seed (DSA, 2006). In addition, reports are common of seed being distributed after the optimal planting time, or of varieties being distributed that are not appropriate to changes in farmers' expectations of seasonal weather conditions at the local level (e.g. Sahlu and Kahsay, 2002; DSA, 2006; EEA/EEPRI, 2006).

## 3.3 Seed industry structure

Low adoption rates and shortfalls in the supply of improved cultivars can be partly attributed to bottlenecks emerging from the structure of the seed industry and the regulatory agencies that oversee it. We discuss the structure of the seed industry here in the context of hybrid maize because experience from other industrialized and developing countries has shown hybrid maize to be one of the most lucrative seed businesses available to private innovators and investors primarily due to the ability of innovators to recoup their investments in breeding due to the biological properties associated with hybridization that make saving seed by farmers to be a relatively undesirable practice.

The seed industry in Ethiopia involves a range of both public and private sectors (Bishaw, Sahlu and Simane, 2008). The national research system—headed by the Ethiopian Institute of Agricultural Research (EIAR) and comprised of a range of federal research centers, regional research centers, and agricultural universities and faculties—is charged with developing improved varieties and breeder and pre-basic seed needed by other players in the industry. Regulatory functions such as varietal release reviews and seed certification are performed by various departments of the MoARD.

Basic and certified seed production is carried out by the ESE, which relies on its own farms alongside private companies, private subcontractors, state farms, and cooperatives, to bulk up seed that is supplied to the regional extension and input supply systems. More recently, state-owned regional seed enterprises have also emerged in Oromia and SNNPR (in 2008) and in Amhara (in 2009).

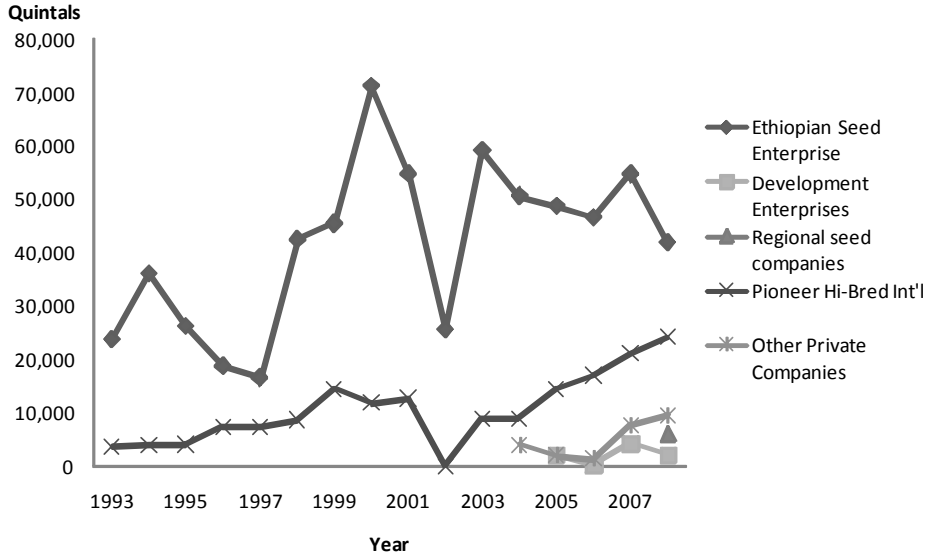
Improved certified seed is supplied to Ethiopian smallholders primarily through regional, state-run extension and input supply systems that operate with a degree of guidance from the federal Ministry of Agriculture and Rural Development (MoARD). This regional system is made up of regional bureaus of agriculture and rural development (BoARDs), their *woreda* (district) offices, and extension agents (termed "development agents" in Ethiopia) working at the *kebele* (peasant association) level. These organizations collaborate closely with farmers' cooperatives and regional credit and savings institutions in both supplying inputs and disbursing credit.

Following market reforms in the 1990s, seed production and distribution were opened to the private sector. In 2004, eight firms were active in seed production, with most of them involved specifically in hybrid maize seed, though primarily as ESE subcontractors (Langyintuo et al., 2008; Alemu et al., 2007). By 2008, the number of firms had increased to 11, although most were again operating primarily as ESE subcontractors. In some cases, these subcontractors also multiply seed for cooperatives, cooperative unions and regional seed companies, although very few actually sell seed directly to farmers (with the exception of Pioneer Hi-Bred International and a few others).

Despite the lucrative potential of the hybrid maize seed market—a potential that private seed companies have realized in other sub-Saharan African countries—approximately 60 percent of maize seed was still controlled by the public sector (primarily the ESE and state-owned development enterprises), with an additional 10 percent serving as sub-contractors to the public sector, and 30 percent (Pioneer and a few small private companies) operating independently from the public sector's seed production system.

An even smaller level of private sector activity is seen in the distribution and retail side of the seed market. The public sector, including the regional extension and input supply systems, accounts for 80 percent of total sales of improved seeds, mostly paid for with credit disbursed against public guarantees (World Bank, 2006c). Even Pioneer relies on the public sector to distribute about half of its seed; initially, through the regional input and extension systems and, more recently, through cooperative unions. Most other seed firms simply produce as subcontractors to ESE, which then distributes seed through the regional extension and input supply systems, cooperative unions, and through its own branch offices, satellite stores, and sales points.

**Figure 4: Hybrid maize seed distribution by type of supplier, 1993–2008**




Source: MoARD, various years.

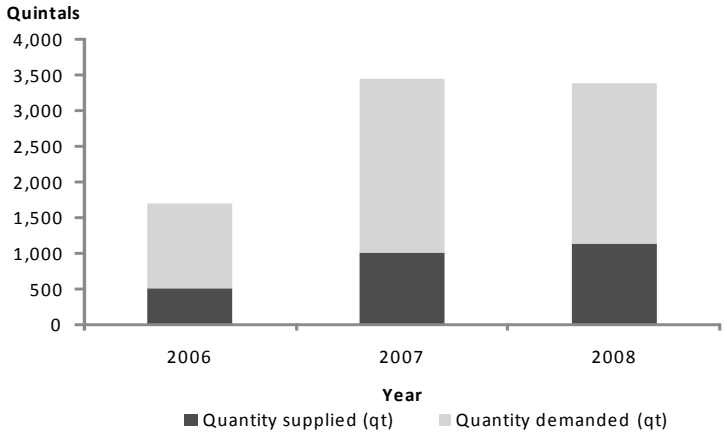
Why is the seed business so difficult to break into in Ethiopia? We examine here the key barriers to entry.

First and foremost, the market failures that characterize seed markets (described earlier) constrain the potential for profitability. Hybrid maize stands out as the exception to this rule because the gains conferred by hybridization can be secured by the farmer year on year only by purchasing new hybrid seed, while saving hybrid maize seed can result in yield losses by as much as 50 percent, depending on the hybrid type.

Second, the seed business depends on the availability of a good supply of high quality pre-basic and basic seed for the production of certified seed that can then be distributed to farmers. The main sources for pre-basic and basic seed in Ethiopia are the federal and regional research centers and universities (with basic seed also being produced by ESE), and bottlenecks at these institutions create significant shortfalls in the availability of these key inputs (Figure 5). In some instances, these shortfalls have been exacerbated by research centers that are engaged not only in producing pre-basic and basic seed, but also in producing certified seed for farmers in areas surrounding the centers. Although the MoARD has taken action to rectify these problematic allocations of scarce seed system resources—for instance, by involving ESE, private firms, and regional seed enterprises in the business of basic seed

production—the pressure on the entire seed industry is not easily resolved (MoARD, 2008; A. Beshir, pers. comm., September 30, 2009).

**Figure 5: Basic seed demand and supply for maize hybrid multiplication, 2006–2008**

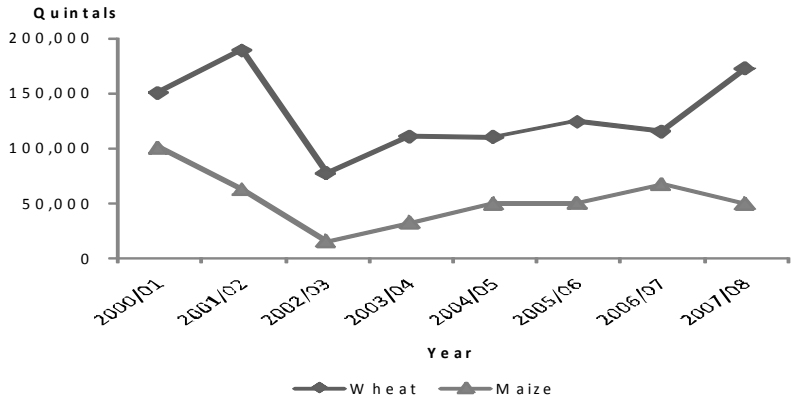



Source: MoARD, various years.

Third, the seed business is risky because seed production is closely correlated to the same weather risks faced by farmers. Hence, seed production in Ethiopia drops during drought periods just as crop production does. Having said this, seed production on irrigated land can mitigate this risk to some extent, and much of ESE's maize seed production operations and subcontracted production currently take place on irrigated land in the Awash River basin. However, the shortage of irrigated land in Ethiopia makes reliable seed production a real challenge for both the public and private sectors (MoARD, 2008).

Fourth, the seed business is often dependent on smallholders themselves as contract growers for ESE's seed multiplication activities, at least for open-pollinated crops such as for lentils, chickpeas, haricot bean, and linseed (but not hybrids due to the technical complexity of hybrid seed production). In 2004/05, ESE produced nearly 8,000 tons of seed through approximately 6,700 contract growers (Beshir, 2005). ESE pays a 15 percent premium over grain prices for quality seed grown by smallholders. However, changing grain prices—particularly low prices at harvesting time and higher prices in planting time—tempt farmers to default on their seed supply contracts to ESE and hold the seed over for sale as grain to local traders and farmers at planting time. This frustrates ESE's attempt to bulk up seed for certain crops.

**Figure 6: Raw seed production, Ethiopian Seed Enterprise, 2000–2008**

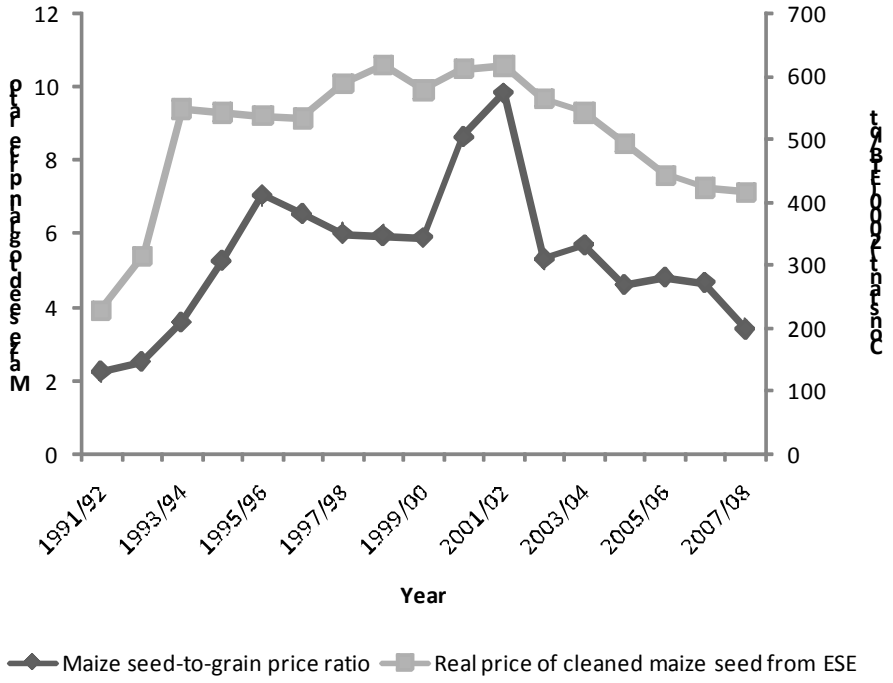



Source: ESE, various years.

Fifth is the issue of price. ESE, the largest seed supplier in Ethiopia, prices its seed at a 5 percent profit margin. But for the industry to be viable, seed prices have to be high enough for private seed firms to recoup their investments in seed production without making seed unaffordable for both farmers who regularly use improved seed and for new adopters. Thus, the optimal seed price is based on the demand derived for the grain that is produced from that seed. A useful benchmark is the seed-to-grain price ratio which, in an emerging maize seed market such as Ethiopia's, might approach 5:1, eventually increasing to 10:1 as the market matures (Morris, 1998). Moreover, seed-to-grain price ratios have fluctuated tremendously: upwards with the collapse of maize prices in 2001–02, down with the drought in 2002–03, and down again to a ratio of 3.42:1 in 2007–08 (Figure 7). The volatility in these ratios suggests similarly volatile returns to investing in the maize seed business in Ethiopia, exacerbated by falling real prices for maize seed in the country.

Related to this is the issue of retail pricing to farmers. In each region, cooperative unions are currently charged with distribution of seed sourced from ESE and other seed providers. Regional bureaus of agriculture and rural development set the price at cost plus transportation and a set profit margin, with some inter-regional variations in pricing policies. For example, Oromia region's Bureau of Agriculture and Rural Development set a profit margin in 2008–09 at 2.5 percent for the cooperative union and 2.5 percent for the primary cooperative. This puts the retail price of hybrid maize seed in Oromia at approximately ETB 1,100 per quintal, which by comparison, is just 43 percent of Pioneer's hybrid maize seed, which was sold at ETB 1,920 per quintal.

**Figure 7: Hybrid maize seed-to-grain price ratios and real seed prices, 1991–92 to 2007–08**




Source: ESE, various years; MoARD, various years.

Yet even Pioneer is marketing their products at relatively low prices by regional standards. This raises the issue of whether Pioneer or another competitor can develop and market a profitable product in Ethiopia. Anecdotal evidence from several sources indicate that the implicit rationing of hybrid maize seed has given rise to a black market in which repackaged (and potentially adulterated) seed sell for two to four times the retail price. This suggests that the market can bear a higher price, whether for hybrids suitable for the highlands such as the ever-popular BH 660 produced by ESE and its subcontractors, or the hybrids suitable for mid-altitudes produced from Pioneer.

Efforts to use smallholders as private agents themselves in the multiplication of seed have met with limited success.[6] Though the technical requirements of maize hybrid multiplication (for example, the need for relatively large field size and means of

[6] For a review of Ethiopia's informal seed system and the role of farmer-based seed multiplication programs, see Thijssen et al. (2008).

controlling cross pollination) might limit its applicability to small farmers in Ethiopia, there is potential for smallholders to play a larger role in multiplying open-pollinated crops (e.g. improved wheat varieties). Both the GoE and non-governmental organizations have invested in various projects aimed at strengthening farmers' skills in seed multiplication, with the goal of increasing the supply of seed for improved varieties both within communities and to the formal seed system. The outcomes to date have been mixed, partly due to poor incentives offered to farmers, insufficient capacity on both sides, and the constant threat of food insecurity that causes farmers to use their seed stocks for food.

Finally, there is the issue of competitiveness. The public sector remains the main seed supplier in Ethiopia partly because it enjoys an implicit subsidy on both the production end (where high administrative costs do not figure into calculations of ESE's financial viability) and on the marketing end (where regional, state-run extension and input supply systems handle distribution and retailing). To compete effectively with the public sector, private companies would have to build their own distribution and marketing networks, develop unique product lines that rival ESE products such as BH 660, establish their brand identities and reputations, provide agronomic services to support their customers, and price their products competitively. At present, only Pioneer markets its own product lines through a network of 15 dealers and through direct sales to state farms, commercial farms, cooperative unions, nongovernmental organizations, and from warehouse purchases (M. Admassu, pers comm., June 16, 2009).

Necessarily, as the maize seed industry in Ethiopia matures and companies begin releasing their own cultivars (rather than multiplying cultivars already released by EIAR), they would also have to contend with significant indirect costs. These costs include the costs associated with navigating the regulatory system, accessing financing from the formal banking sector, and meeting the banks' high collateral requirements. Thus, it is not surprising that Pioneer sells much of its output through official channels (formerly, through the regional extension and input supply systems and more recently, through the cooperative unions). Nor is it surprising that other, smaller private seed companies prefer to operate as ESE subcontractors and/or suppliers to cooperative unions rather than competitors.

In summary, the most lucrative of seed businesses—hybrid maize—has seen very little investment activity in Ethiopia, with far less investment flowing to seed businesses for other crops where the challenges are even greater. Since the introduction of the National Seed Industry Policy in 1992, the GoE has pursued several policies favorable to private sector development such as the basic introduction of a legal framework for seed system operations (Proclamation

206/2000), the inclusion of commercial seed production as a sector under the Investment Code, and the enactment of legislation on breeders' rights and plant variety protection in 2006 (Proclamation 481/2006) (see Bishaw, Sahlu and Simane, 2008).

However, there is little likelihood that these policies will have the desired impact.[7] Opening commercial seed production to investors, for example, is a policy improvement that goes only so far in the absence of regulations allowing investors to access credit without non-agricultural collateral. Further, plant breeders' rights are only as effective as the sector they are meant to protect and only as strong as the judicial system's capacity to enforce these rights. Moreover, there is limited empirical evidence from other developing countries to suggest that breeders' rights actually stimulate private sector investment (see, e.g., Gerpacio, 2003; Pray, Ramaswami, and Kelley, 2001; Alston and Venner, 2000; Pray, 1992; and Butler and Marion, 1985). Finally, it is important to recognize that varietal improvement of many crops in Ethiopia, particularly open-pollinated crops such as wheat, will continue to depend on public breeding and seed production efforts, making the need for organizational reforms in the research system and seed sector as urgent as reforms in the policies governing the seed market itself.

## 4. Fertilizer markets

Chemical fertilizer, a more obvious private good than seed, also possesses several features that complicate early stages of market development (Morris et al., 2007; Crawford et al., 2003). On the demand side, the cost of creating fertilizer markets is high where final consumers are widely dispersed geographically, or where their small landholdings and limited cash resources mean that they purchase only small quantities of fertilizer that are more costly for retailers to sell (Harrigan, 2008; Jayne et al., 2003). Furthermore, in rainfed areas, fertilizer consumption is highly seasonal (a two to three month market window), and year-to-year fluctuations in rainfall patterns contribute to high inter-year variability in demand for fertilizer, with corresponding risks to dealers of high carryover stocks from year to year. On the supply side, the considerable economies of size in international procurement and shipping imply that fertilizer importers require a high degree of liquidity to procure for the supply chain.

These characteristics suggest that while fertilizer may be a tradable private good, development of fertilizer markets may require some degree of public intervention in

[7] For example, the administrative procedures necessary to implement the 2006 legislation on breeders' rights and plan variety protection have yet to be implemented.

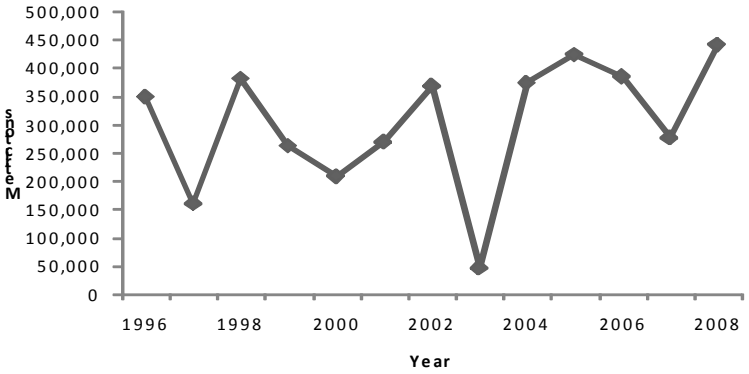
financing and market infrastructure development until markets mature. We examine these issues in the context of Ethiopia's fertilizer market, focusing on the (a) uptake of fertilizer, (b) fertilizer prices and profitability, and (c) the fertilizer industry structure.

## 4.1 Fertilizer uptake

The uptake and use of chemical fertilizer in Ethiopia (primarily DAP and urea) can be assessed in several ways—in terms of total fertilizer imported, percentage of farmers using fertilizer and improved seed-fertilizer packages, percentage of cultivated land under fertilizer application, and household-level estimates of fertilizer application per hectare . We examine these indicators below.

When measured in terms of quantity imported, fertilizer use in Ethiopia has increased from 250,000 tons in 1995 to 400,000 tons of product in 2008 (Figure 8). This growth of total fertilizer consumption was more rapid than the average for Sub-Saharan Africa over the same period (Crawford et al., 2006; Jayne et al., 2003).

**Figure 8: Fertilizer imports, 1996–2008**



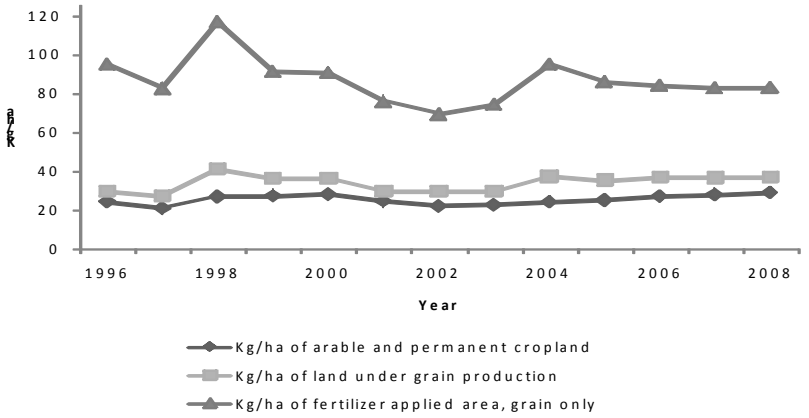

Source: MoARD, various years.

Data on fertilizer use suggest that a significant portion of smallholders use fertilizer: 39 percent according to CSA, and 32 percent according the 2005 ERSS survey. Teff, wheat and maize cultivation account for the majority of fertilizer use.

However, data on application rates tell a slightly different, and often confusing, story about the intensity of fertilizer use in Ethiopia (Figure 9). Fertilizer use intensity, when measured in terms of *kg/ha of arable and permanent cropland,* is currently estimated at 17 kg/ha of nutrients (about 29 kg/ha of commercial product), which is similar to

application rates elsewhere in the region but considerably below comparable smallholder highland farms in neighboring Kenya (applied to 70 percent of maize fields at an average dose for all fields of 45 kg/ha) (Ariga et al., 2008). When measured in terms of *kg/ha of land under grain production,* the figure increases to 21 kg/ha of nutrients (about 37 kg/ha of commercial product). And when measured in terms of *kg/ha of land under grain cultivation where fertilizer is applied* (which accounts for 89 percent of all land cultivated in Ethiopia), the figure increases to 48 kg/ha of nutrients (about 83 kg/ha of commercial product), which begins to approach application rates in Asia.

**Figure 9: Fertilizer use intensity, 1996–2008**




Sources: MoARD, various years; CSA, various years.

There is also some evidence suggesting that these high fertilizer use intensity figures may be overstating the case. A study conducted by EEA/EEPRI (2006) notes that up to a third of farmers covered by PADETES have dis-adopted the seed-fertilizer technology packages over time, likely due to the high cost of inputs, insufficient credit and credit rationing, a lack of varieties with traits appropriate to farmers' needs, and other factors.

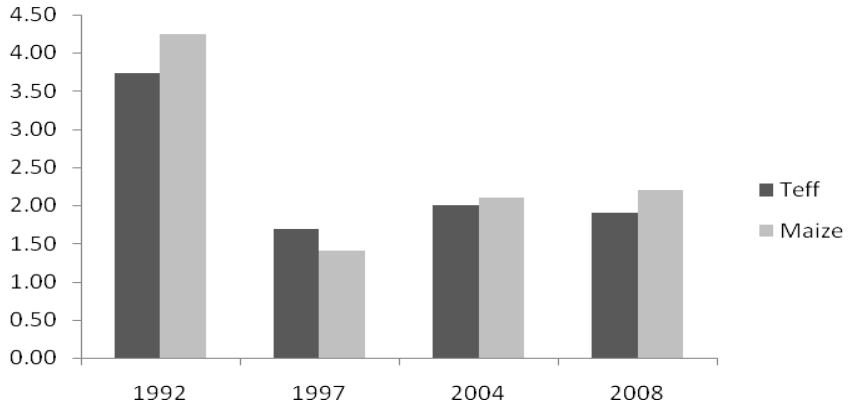
## 4.2 Fertilizer prices and profitability

We explore here the issue of fertilizer demand and supply in terms of the returns to fertilizer use, a subject of extensive discussion in Ethiopia. Estimates of the value cost ratio (VCR) [8] for four years between 1992 and 2008 are shown in Figure 10.

[8] Value cost ratio is calculated as $VCR = (\Delta y \cdot p)/C_f$ where $\Delta y$ denotes incremental yield gains resulting from fertilizer use, $p$ denotes output price per kg, and $C_f$ denotes the cost of fertilizer per recommended rate.

Assuming that fertilizer use is profitable where the VCR is greater than two, then the return to fertilizer use has been generally positive in recent years with a VCR around the threshold of 2. And this holds true even when disaggregated by regional markets, except Arsi/Bale for Teff and Welega/Keffa for maize (Table 5).

**Figure 10: Fertilizer value cost ratios, 1992–2008**




Sources: For 1992 and 1997, Demeke (1997); for 2004 and 2008, authors' calculations.

These figures suggest that fertilizer prices in Ethiopia are competitive. While the margin between domestic and international prices is higher in Ethiopia than in Asian and Latin American countries, it is still comparable to the margin in other sub-Saharan African countries, including South Africa. And while the price build-up from port to farm gate is estimated at 26 percent (Rashid, pers. comm., 2009), comparisons with other African countries indicate that marketing margins in Ethiopia are somewhat lower.[9]

In addition, fertilizer prices represent only one dimension of market performance. As with seed, the ability to provide the right type of input of good quality to farmers in a timely manner is equally important. The distribution system in Ethiopia is inflexible, providing only two types of fertilizer (DAP and urea), both in 50 kg bags. Moreover, numerous farmers in recent years (as many as half in some regions) have consistently reported late delivery of fertilizer.

A study of Ethiopian smallholders by Bonger et al. (2004) found that half of farmers surveyed for the study reported that fertilizer arrived after planting, while 32 percent

[9] The price build-up for fertilizer estimated here is specifically for fertilizer imported through Djibouti, transported to Adama, distributed to cooperative unions, distributed onward to primary cooperatives, and eventually sold to farmers.

reported underweight bags, 25 percent complained of poor quality, and almost 40 percent reported that their planting was delayed by fertilizer problems. Studies by DSA (2006) and EEA/EEPRI (2006) found that while fertilizer quality problems had been reduced in recent years, delays in delivery were still common, with 25 percent or more of farmers complaining of late delivery. Also, unlike neighboring countries, Ethiopia does not offer fertilizer in smaller packages that could be used by smallholders, or in different formulations needed for different types of agroclimates, soils, and crops.

In addition, input distribution tied to credit limits the space available for the emergence of private sector retailers. Thus, those farmers with sufficient resources for cash purchase of fertilizer, often on more favorable terms than on credit, are unable to do so since there are very few private traders. Similarly, the guaranteed loan program with below-market interest rates creates an uneven playing field in the rural finance sector by undermining efforts to set up alternative institutions such as microfinance institutions, branches of commercial banks, or independent financial cooperatives.

Loan recovery, using extension agents and a degree of coercion by local administrative officials, was generally successful until the collapse of maize prices in 2001 and the subsequent drought. In Oromia Region, for example, credit recoveries had averaged above 80 percent up to 2001, but this figure dropped to 60 percent in 2002, forcing a major rescheduling of loans. This has resulted in high fiscal costs and fiscal risks associated with the loan guarantee program. The write-off to loan guarantees amounted to Ethiopian birr (ETB) 84 million in 2001, but by 2005 liabilities had again accumulated to ETB 183 million (DSA, 2006). Also in 2005, Oromia region was obliged to pay approximately ETB 84 million to the Commercial Bank of Ethiopia to honor its guarantees for the previous three-year time period. The guarantee thus becomes a subsidy that is not accounted for in government budgeting.

**Table 5: Fertilizer value cost ratios, 1992–2008**[a]

| *Crop,* zone | 1992 | | | | 1997 | | | | 2004 | | | | 2008 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $C_f$ ETB/ dose | $\Delta y$ Kg/ ha | P ETB/ kg | VCR | $C_f$ ETB/ dose | $\Delta y$ Kg/ ha | P ETB/ kg | VCR | $C_f$ ETB/ dose | $\Delta y$ Kg/ ha | P ETB/ kg | VCR | $C_f$ ETB/ dose | $\Delta y$ Kg/ ha | P ETB/ kg | VCR |
| ***Teff*** | | | | | | | | | | | | | | | | |
| Shewa | 212 | 641 | 1.22 | **3.69** | 516 | 641 | 1.35 | **1.67** | 601 | 641 | 1.80 | **1.92** | 1465 | 641 | 4.36 | **1.91** |
| Gojam | 197 | 592 | 1.22 | **3.66** | 480 | 592 | 1.35 | **1.66** | 587 | 592 | 2.10 | **2.12** | 1387 | 592 | 4.67 | **1.99** |
| Arsi/Bale | 160 | 473 | 1.22 | **3.6** | 391 | 473 | 1.35 | **1.63** | 459 | 473 | 1.80 | **1.85** | 1224 | 473 | 4.36 | **1.69** |
| Across the Country | 192 | 590 | 1.22 | **3.74** | 468 | 590 | 1.35 | **1.69** | 565 | 590 | 1.93 | **2.02** | 1374 | 590 | 4.44 | **1.91** |
| ***Maize*** | | | | | | | | | | | | | | | | |
| Shewa | 194 | 1,325 | 0.65 | **4.44** | 472 | 1,325 | 0.53 | **1.48** | 548 | 1325 | 0.95 | **2.30** | 1346 | 1325 | 2.32 | **2.28** |
| Gojam | 296 | 1,932 | 0.65 | **4.24** | 720 | 1,932 | 0.53 | **1.41** | 874 | 1932 | 1.22 | **2.69** | 2084 | 1932 | 2.61 | **2.42** |
| Welega/ Kefa | 314 | 1,855 | 0.65 | **3.84** | 765 | 1,855 | 0.53 | **1.28** | 974 | 1855 | 0.95 | **1.81** | 2347 | 1855 | 2.32 | **1.83** |
| Gamu Gofa/ Sidamo | 191 | 1,212 | 0.65 | **4.13** | 463 | 1,212 | 0.53 | **1.38** | 543 | 1212 | 0.77 | **1.73** | na | 1212 | 2.30 | **na** |
| Across the Country | 216 | 1,410 | 0.65 | **4.24** | 526 | 1,410 | 0.53 | **1.41** | 633 | 1410 | 0.95 | **2.12** | 1556 | 1410 | 2.41 | **2.18** |

[a] Value cost ratio is calculated as $VCR = (\Delta y \cdot p)/p_f$ where $\Delta y$ denotes incremental yield gains resulting from fertilizer use, $p$ denotes output price per kg, and $C_f$ denotes the cost per recommended dose of fertilizer for a hectare of land. Fertilizer recommendation (dose) and response rate were taken from fertilizer trials conducted from 1989 and 1991 by the Ministry of Agriculture and National Fertilizer and Inputs Unit (NFIU). For 1992 and 1997, Demeke (1997); for 2004 and 2008, authors' calculations.

Beyond fiscal costs, there are also considerable but non-quantifiable implicit costs in the system, many of which are borne by the government through its regional extension and input supply systems. These include the costs resulting from the "central planning" system of demand estimation similar to that described earlier for seed. The indirect costs also include the storage costs and quality deterioration incurred because closing stocks have comprised 50 percent or more of total consumption in most years except in 2004 and 2005. Finally, the implicit costs include those resulting from damage done to extension-farmer relationships when harsh measures have been employed to ensure loan repayment.

## 4.3 Fertilizer market structure

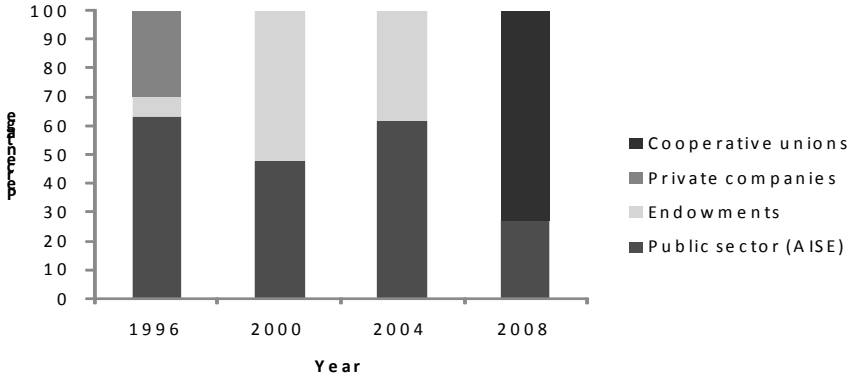
Fertilizer use intensity, demand, and supply discussed above are closely tied to the changing structure of Ethiopia's fertilizer market. The GoE liberalized the fertilizer sector soon after the end of the *Derg* regime. The first reforms occurred in the early 1990s with the privatization and abolishment of the monopoly on fertilizer importation and distribution held by the state-owned Agricultural Inputs Supply Corporation (AISCO, then renamed the Agricultural Inputs Supply Enterprise (AISE)). Policy changes that fully liberalized fertilizer pricing and the removal of subsidies followed in1997–98. The private sector's initial response to market liberalization was rapid. By 1996, several private firms were importing fertilizer, and 67 private wholesalers and 2,300 retailers had taken over a significant share of the domestic market.

Unfortunately, there is little empirical data or analysis against which to assess the private sector's performance during this initial round of reforms. This is due to the fact that the independent private sector rapidly exited the fertilizer market within a few years of its entry. In the case of imports, the share of private firms operating in the market went from 33 percent in 1995 to 0 in 1999. These firms were first replaced by "private" holding companies with strong ties to government (Jayne et al., 2003). Since 2007, fertilizer imports have been controlled by AISE and cooperative unions (Figure 11)

The market share trends are similar in the case of wholesalers. While the AISE had a market share of less than 50 percent during the mid and late 1990s, it had regained the majority share by 2001 when private sector wholesalers, except for the holding companies, had disappeared from the scene. And in the retail market, the decline was even more dramatic. While private retailers held a majority share of the market in the early 1990s, the public sector and cooperative unions have become almost the sole distributors of fertilizer since 2000 (DSA, 2006). As of 2004, the public sector accounted for over 70 percent of distribution, with private dealers accounting for only 7 percent of sales nationwide (EEA/EEPRI, 2006). Public sector supply channels

have also changed; whereas extension agents initially managed distribution, the responsibility was shifted to *woreda* input supply offices and cooperatives in more recent years.

**Figure 11: Fertilizer import shares by type of importer, 1996–2008[a]**




[a] The term "Endowments" denotes the holding companies described in the paper and by Jayne et al. (2003). AISE denotes Agricultural Inputs Supply Enterprise.
Source: MoARD, various years.

The decline in private sector participation in fertilizer markets reflects several factors, including difficulties in the import process itself. Importing fertilizer requires that the importer obtain a license that is allocated by the GoE through a tendering process, and requires that fertilizer be imported in lots of 25,000 tons. The importer almost always requires financing given that a single shipment of fertilizer alone requires over $US 5-10 million over several months. A private sector buyer is currently required to deposit 100 percent of the value of the fertilizer to be imported at the time a line of credit is opened. What remains to be understood clearly is whether these same requirements apply to the AISE, holding companies, or cooperative unions. In so far as these actors in the fertilizer market enjoy privileged collateral requirements, this would suggest an uneven playing field and a clear determinant of the private sector's total exit from the fertilizer market.

## 5. Agricultural extension services

In effect, agricultural extension services are what tie improved seed, chemical fertilizers, and credit together for the Ethiopian smallholder. Extension services were first introduced in 1953 by the Imperial Ethiopian College of Agricultural and Mechanical Arts (also known as Alemaya University and recently renamed Haramaya

University) in the style of a U.S. land grant university. Extension services were later provided to a larger number of farmers in the 1960s under the Comprehensive Integrated Package Projects, described earlier. In the 1980s, the extension system jumped on the bandwagon and transformed itself into a Training and Visit (T&V)-style system that was favored by the international donor community at the time (Abate, 2008).

The PADETES program described earlier worked with this T&V approach to specifically promote improved seed and chemical fertilizer, and succeeded in convincing the GoE to expand its coverage under the NAEIP in 1995. The PADETES/NAEIP programs are credited with expanding the reach of Ethiopia's extension services to some 9 million farmers by 2007–08 (Adugna, 2008).

Over the last five years, the federal and regional extension programs have increased the number of public extension staff almost three-fold—from approximately 15,000 development agents during the PADETES/NAEIP period to almost 47,500 in 2008 (Table 6). This rapid expansion has been accompanied by the establishment of Farmer Training Centers (FTCs), each of which is meant to house three DAs with a range of technical skills, and provide a broad range of demand-responsive extension and short-term training services.

Agricultural extension services in Ethiopia have traditionally been financed and provided almost entirely by the public sector. Thus, these programs represent a significant public investment, amounting to over $50 million dollars annually, or almost 2 percent of agricultural GDP in recent years—a figure that exceeds expenditure in most other developing countries and regions (see Roseboom, 2004).
But real progress on the ground has been mixed with respect to DA deployment and FTC start-ups (Table 6). DA recruitment and training has largely succeeded in meeting its numeric targets, while FTCs have lagged behind. Meanwhile, the expected impact of DAs and FTCs remains unclear due in part to the near absence of any rigorous impact evaluation.

Having said this, four previous studies that evaluate the contribution of agricultural extension in Ethiopia are worth noting. First is the EEA/EEPRI (2006) evaluation of PADETES, which is referred to throughout this paper. Second is Bonger et al. (2004), also referred to herein. Third is a recent impact evaluation of Ethiopia's Productive Safety Net Program (PSNP) by Gilligan, Hoddinott, and Taffesse (2008), which reports a positive impact on a range of food security and poverty indicators from income earned from public works activities undertaken by food-insecure households through the PSNP *when combined with* the "Other Food Security Program" (OFSP) that provides access to improved seed, extension services, and natural resource

management schemes. Fourth is a study based on panel data from the Ethiopian Rural Household Survey by Dercon et al. (2009) that reports a significant effect of extension workers visits on poverty headcounts and consumption growth between 1994 and 2004.

Nonetheless, the entire body of evidence on agricultural extension suggests that the impact on productivity and poverty has been a mixed experience to date. Although many farmers seem to have adopted the packages promoted by the extension system, up to a third of the farmers who have tried a package had discontinued its use (Bonger, Ayele, and Kumsa 2004; EEA/EEPRI 2006). Indeed, Bonger et al. (2006) also find that poor extension services were ranked as the top reason for non-adoption.

Part of the problem is that the success of the extension services has been traditionally measured in terms of numeric targets for physical input use, often at the cost of emphasizing the efficiency and profitability of input use. In fact, most extension agents view their role primarily as distributing fertilizer and credit, a role that hampers the provision of technical advice (EEA/EEPRI, 2006).

The hierarchical "culture" underlying the extension system does little to encourage and exploit the inherent resourcefulness of those who work closely with farmers and rural communities (Gebremedhin et al., 2006; Davis et al., 2007). And although extension has been decentralized to the administrative control of regional governments and *woreda* administrations, continued imposition of targets from above and weak local capacity have not yet permitted the emergence of a dynamic demand-driven system.

**Table 6: Development agents (DAs) and Farmer Training Centers (FTCs), 2008**

| Region | Farmer Training Centers | | | Development Agents | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FTCs required (number of *kebeles)* | FTCs established as of 2008 | Fully functional FTCs | Crop development | | Livestock | | Natural resource management | | Other | | Total DAs |
| | | | | M | F | M | F | M | F | M | F | |
| Tigray | 602 | 588 | 55 | 544 | 65 | 526 | 52 | 574 | 29 | 235 | 42 | 2,067 |
| Oromia | 6,420 | 2,549 | 1,147 | | 5,885 | | 6,021 | | 6,080 | | 1,668 | 19,654 |
| Amhara | 3,150 | 1,725 | 318 | 2,407 | 464 | 2,438 | 493 | 2,597 | 318 | 90 | 1,389 | 10,196 |
| SNNP | 3,681 | 1,610 | 857 | | | | | | | | 13,448[a] | 13,448 |
| Afar | 558 | - | - | | 240 | | 241 | | 209 | | 58 | 748 |
| Somali | - | 2 | - | 422 | 26 | 376 | 32 | 334 | 40 | 35 | 4 | 1,269 |
| Harari | 17 | 5 | 3 | 15 | - | 15 | 3 | 15 | 2 | 2 | - | 52 |
| Dire Dawa | 25 | 7 | - | 22 | 2 | 14 | 4 | 18 | 4 | 19 | 5 | 88 |
| Total | 14,453 | 6,486 | 2,380 | 3,410 | 557 | 3,369 | 584 | 3,538 | 393 | 381 | 1,440 | 47,522 |

[a] Data for SNNP are based on figures from 2006–07.

Source: MoARD (2009).

On the positive side, several reforms have been introduced to address these deficiencies. First, in an effort to get beyond a focus on cereals, new packages have been developed to support other crop and livestock enterprises, improve post-harvest technology adoption, and encourage natural resource management. Second, in recognition of the diversity of smallholder farming systems in Ethiopia, classifications have been developed to divide the country into several distinct agro-ecological zones to aid in the development of more appropriate zone-specific packages (Ibrahim, 2004). Third, input distribution is being shifted away from extension services to cooperatives, thus freeing extension agents to provide more technical advice. Finally, there are moves being made to strengthen and diversify the curriculum provided by the 25 Agricultural Technical and Vocational Education and Training (ATVET) colleges that are responsible for preparing DAs for deployment throughout the country (Table 7).

**Table 7: Agricultural Technical and Vocational Education and Training (ATVET) colleges graduates, 2003–04 to 2007–08**

| Year | Number of ATVET graduates |
|---|---|
| 2003–04 | 9,368 |
| 2004–05 | 13,899 |
| 2005–06 | 11,095 |
| 2006–07 | 15,099 |
| 2007–08 | 9,404 |
| Total | 59,364 |

Source: MoARD (2009).

## 6. Conclusions and policy implications

In spite of nearly two decades of policies that placed high priority on boosting agricultural production and productivity, Ethiopia has yet to see payoffs in terms of higher and more stable cereal yields, lower consumer prices for food staples, and reduced dependence on food aid. Yet there is little doubt that intensification and commercialization of agriculture is needed in Ethiopia given its precarious food situation and acute land scarcity. The challenge is finding ways to strengthen smallholder access to inputs, technology, and information, and improving the incentives for their use and adoption, all within highly heterogeneous agroecologies characterized by high risks.

State-led policies to promote improved seed and fertilizer through regional, state-run input supply and extension systems initially generated some positive impacts in

Ethiopia over the last two decade. But experience to date suggests that an increasing role of the state will not provide the intended growth stimulus to the agricultural sector. The current approach reduces the quality of input services to smallholders, incurs many hidden costs to the government, and generates significant risks to both smallholders and the government.

This is not to say that the public provision of information, input, credit, and administration is unnecessary: Rather, public sector involvement in Ethiopia's agricultural sector will remain critical where smallholders have poor access to markets, weak purchasing power, and asymmetrical access to market information. Moreover, public leadership in encouraging private investment in market-based systems remains necessary in Ethiopia, where modern market institutions are still under development.

Nonetheless, more consideration should be given to long-term policies designed to build a dynamic private sector to promote fertilizer, seed, credit, and market information systems. A greater degree of flexibility in how inputs and services are provided, and a greater degree of choice for smallholders, can open up new market and technological opportunities in the agricultural sector.

Thus, the development of an efficient input marketing and rural financial system will be a difficult, time-consuming and expensive undertaking that will require significant support for institution-building activities, capacity strengthening and training, and financial sector infrastructure development. Several measures would facilitate the transition.

First, policies to open the market (and pricing) for hybrid maize seed—taking a page from successful experiences in the region—should be explored more actively. This transition would have to be gradual: ESE's capacity to produce seed during a transition into privatization could drop dramatically, while private seed multipliers aiming to fill the gap would struggle to expand into upstream breeding activities, scale up multiplication, and build their distribution and retailing networks. But if reforms were accompanied by new procurement procedures that encouraged regional extension and input supply systems to purchase seed more extensively from the private sector, and if commercial lending was made more readily available to encourage private seed companies to expand their production and distribution, then smallholders could benefit from a larger choice and better quality of maize seed. There are positive signs suggesting that both the government and are pursuing such reforms with support from the donor community; however, close monitoring of the reform's progress remains vital to success.

Second, policies to liberalize the fertilizer market should be pursued. This includes liberalizing collateral requirements for fertilizer imports and reducing the credit guarantee to 50 percent and gradually lowering it further until an eventual phase-out; opening the credit guarantee to other certified financial institutions; and liberalizing interest rates. In the short term, risk-averse commercial banks might shy away from financing fertilizer imports and distribution. However, with the long run development of a liberalized and competitive financial sector, these short-term issues would likely give way to greater investment in fertilizer importation and distribution.

Third, deep reforms in the extension system should be explored sooner than later. Such reforms would need to extricate the system away from single-minded, top-down, package approaches to cereal intensification, to more dynamic, responsive and competitive service provision. These approaches will require greater flexibility within the current system that can only be done by investing time, effort, and resources in changing the cultures and practices of the extension system, and are likely to yield results over a much longer-term period. However, without such changes, the extension and education system in Ethiopia will become increasingly irrelevant to the needs of intensive, commercial smallholder production systems. Again, the signs suggest that both the government is pursuing reforms in this area, although close monitoring of progress is vital to success.

Fourth, innovative programs should be continually explored. Given the risks posed by production and price variability in Ethiopia, price risk mitigation based on a combination of market and non-market management tools should also be a major policy priority for the country. Non-market-based options will only work in the short-term if combined with long-term improvements in physical infrastructure, information and communications technology, contract enforcement, and strengthening of the markets for credit and insurance. Innovative programs include investments to scale up the weather insurance schemes currently being piloted, develop a comprehensive market information system to support the new commodity exchange, and liberalization of the telecommunications sector to improve rural access to information and communications technologies.

Finally, significantly more resources should be invested in regular and methodical assessments of the impact of the extension and input supply system. This near absence of independent impact assessment makes it difficult to evaluate where the disincentives, bottlenecks, and structural issues are in the system, and how they can be remedied.

These findings reinforce other studies conducted in the region of the need for complete, rather than half-hearted, liberalization of input supply markets to support

smallholders' efforts to intensify cereal production. Moreover, these recommendations detail the intricacies of the liberalization process, and the need to be deeply aware of the peculiarities—both the inherent market failures and the potential profit opportunities—that describe input markets and extension services. Finally, the findings recognize both the necessity of continued public engagement in input markets and extension services, while carving out new space for private investment in providing goods and services for smallholders in a potentially efficient manner.

In conclusion, while Ethiopia has an admirable record of supporting agriculture, the continued state-led policies to boost agricultural production and productivity have now outlived its usefulness. A rethinking of approaches is needed, one that reallocates the roles of the public and private sectors in the promotion and regulation of the agricultural input sector. This rethinking requires a nuanced understanding of the complex issues involved, evidence-based analysis and policy recommendations, and continuous debate on the pros and cons of alternatives and options. Lessons learned from this process can do much to inform Ethiopia's long-term development strategy.

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# FOREIGN EXCHANGE RATIONING, WHEAT MARKETS AND FOOD SECURITY IN ETHIOPIA[1]

Paul Dorosh[2] and Hashim Ahmed[3]

*Abstract*

*In spite of remarkable growth in Ethiopia's agricultural production and overall real incomes (GDP/capita) from 2004/05 to 2008/09, prices of major cereals (teff, maize, wheat and sorghum) have fluctuated sharply in both nominal and real terms. International prices of cereals also fluctuated widely, particularly between 2006 and 2008. However, the links between Ethiopia's domestic cereal markets and the international market are by no means straightforward. Among the major staples, only wheat is imported or exported on a significant scale. And frequent changes in trade and macro-economic policies, movements in international prices and fluctuations in domestic production have at times eliminated incentives for private sector imports of wheat.*

*From July 2005 to March 2007, private sector wheat imports were profitable and domestic wheat prices closely tracked import parity prices. Then, from April 2007 to May 2008, good domestic harvests coincided with increase international wheat prices, so private sector wheat imports were no longer profitable. Most recently, rationing of foreign exchange for imports effectively stopped private sector wheat imports beginning in about April 2008. Partial equilibrium analysis shows, however, that government imports and sales in 2008-09 effectively increased domestic supply and lowered market wheat prices. These sales at the low official price also implied that recipient households, traders and flour mills enjoyed a significant subsidy. Allowing the private sector access to foreign exchange for wheat imports or auctioning government wheat imports in domestic markets would eliminate these rents and generate additional government revenue, while having the same effect on market prices as government subsidized sales.*

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[3] Ethiopian Development Research Institute, (EDRI)

# 1. Introduction

Ethiopia enjoyed remarkable growth in agricultural production and overall real incomes (GDP/capita) from 2004/05 to 2008/09, due to a combination of factors, including good weather, increased efforts in agricultural extension, increased usage of fertilizer, and foreign capital inflows that funded major increases in private and public infrastructure investments. In spite of these developments, prices of major cereals (teff, maize, wheat and sorghum) have fluctuated dramatically in both nominal and real terms. International prices of cereals also fluctuated dramatically, particularly between 2006 and 2008. However, among Ethiopia's major cereals, only for wheat is international trade a major source of supply (or demand).

Nonetheless, the links between Ethiopia's domestic wheat market and the international market are by no means straightforward. Frequent changes in trade and macro-economic policies, movements in international prices and fluctuations in domestic production have at times eliminated incentives for private sector imports of wheat. In particular, after major external shocks to Ethiopia's economy (including increases in world prices of fuel in 2007 and early 2008) exacerbated foreign exchange shortages, access to foreign exchange for imports was restricted (rationed) in March 2008 to avoid excessive drawdown of foreign exchange reserves. As a result, the private sector was not able to freely import wheat, even though high domestic prices relative to international prices made imports potentially very profitable. Instead, the government imported wheat commercially in mid-2008 (in addition to food aid inflows) to increase total supplies and stabilize rising domestic cereal prices.

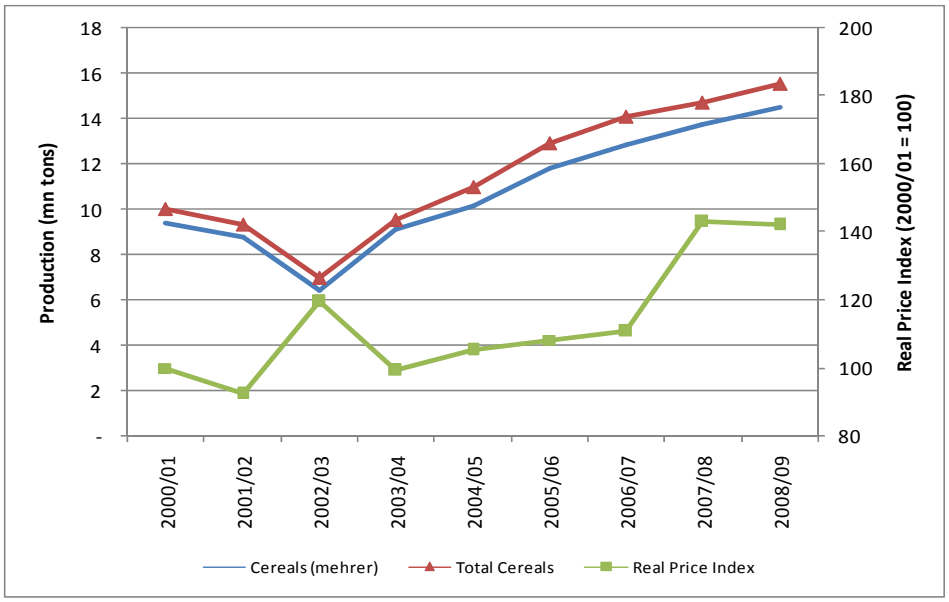
This paper examines these developments in Ethiopia's wheat markets, including the links between international and domestic prices for wheat, the implications of foreign exchange rationing (that effectively stopped private sector wheat imports), and the effects of sales of government wheat imports in 2008-09. Section 2 discusses the evolution of production and prices of cereals in Ethiopia, from 2000/01 to 2007/08, a period characterized by substantial increases in production accompanied by an upward trend in real prices. The macro-economic setting is described in Section 3, focusing particularly on developments from 2004/05 to 2008/09. Section 3 also includes a discussion of the basic analytical framework for assessing the effects of rationing on real exchange rates and domestic prices of wheat. Section 4 focuses on wheat markets, and includes a decomposition of nominal and real wheat prices over time and a description of the various wheat trade regimes that determined the relationship between domestic and international wheat prices in recent years. This section also includes results of a partial equilibrium analysis of the effects of alternative levels of government import sales on domestic prices and

consumption of wheat. The final section summarizes the results of the analysis and presents policy implications.

## 2. Cereal production, availability and prices

Cereal production has increased rapidly in Ethiopia since the 2002/03 drought year (Table 1 and Figure 1). Production in that year was only 7.0 million tons, more than 30 percent below the previous peak of 10.0 million tons achieved in 2000/01. With good rains, production recovered in 2003/04, and by 2004/05, production had reached 10.96 million tons, 9.3 percent greater than the 2000/01 harvest. Although growth in production decelerated from 18 percent in 2005/06 to only 5 and 6 percent in 2007/08 and 2008/09, respectively, production in 2008/09 was still 55 percent higher than in 2000/01. Overall, production grew by an average of 5.6 percent per year between 2000/01 and 2008/09. Sorghum (7.7 percent per year), teff (7.1 percent per year) and wheat (6.2 percent per year) increased at the fastest rates; barley and maize increased by 4.9 and 3.3 percent per year, respectively.

**Figure 1: Production and Real Prices of Major Cereals in Ethiopia, 2000/01 to 2007/08**




Source: Calculated from Central Statistical Authority (CSA) production data and Ethiopian Grain Trading Enterprise (EGTE) wholesale price data for Addis Ababa. 2008/09 belg season production is estimated.

**Table 1: Cereal Production in Ethiopia, 2000/01 to 2007/08**

| Crop Year | 2000/01 | 2001/02 | 2002/03 | 2003/04 | 2004/05 | 2005/06 | 2006/07 | 2007/08 | 2008/09 | 2000/01 -08/09 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ethiopian Calendar Year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | |
| Teff | 1,764 | 1,658 | 1,450 | 1,692 | 2,044 | 2,379 | 2,511 | 3,027 | 3,063 | 7.1% |
| Wheat | 1,738 | 1,571 | 1,192 | 1,740 | 2,377 | 2,683 | 2,720 | 2,572 | 2,820 | 6.2% |
| Maize | 3,428 | 3,147 | 2,101 | 2,830 | 2,994 | 3,569 | 4,426 | 4,337 | 4,439 | 3.3% |
| Sorghum | 1,585 | 1,608 | 1,089 | 1,826 | 1,758 | 2,200 | 2,379 | 2,726 | 2,876 | 7.7% |
| Barley | 1,115 | 988 | 816 | 1,098 | 1,388 | 1,639 | 1,483 | 1,470 | 1,635 | 4.9% |
| Other cereals | 394 | 364 | 350 | 362 | 400 | 472 | 541 | 562 | 682 | 7.1% |
| Total Production | 10,024 | 9,337 | 6,998 | 9,548 | 10,961 | 12,944 | 14,059 | 14,694 | 15,515 | 5.6% |
| (percentage change) | | -7% | -25% | 36% | 15% | 18% | 9% | 5% | 6% | --- |
| Four Major Cereals | | | | | | | | | | |
| Meher Small Farms | 8,072 | 7,499 | 5,377 | 7,659 | 8,404 | 9,823 | 10,993 | 11,807 | 12,303 | 5.4% |
| (percentage change) | | -7% | -28% | 42% | 10% | 17% | 12% | 7% | 4% | --- |
| Belg Small Farms | 224 | 311 | 330 | 247 | 550 | 761 | 761 | 538 | 538 | 11.5% |
| (percentage change) | | 39% | 6% | -25% | 122% | 38% | 0% | -29% | 0% | --- |
| Large Farms | 218 | 175 | 125 | 182 | 219 | 248 | 280 | 317 | 358 | 6.4% |
| (percentage change) | | -20% | -28% | 45% | 21% | 13% | 13% | 13% | 13% | --- |
| Total | 8,514 | 7,985 | 5,832 | 8,088 | 9,173 | 10,833 | 12,035 | 12,662 | 13,198 | 5.6% |
| (percentage change) | | -6% | -27% | 39% | 13% | 18% | 11% | 5% | 4% | --- |

Source: Calculated from CSA data.

Note: Belg production data for 2008/09 are estimates. Large farm production data for 2007/08 and 2008/09 are estimates.

Almost all of the increase in production in the four major cereals (teff, wheat, maize and sorghum) was due to increases in smallholder meher season production, which accounted for 93.2 percent of total production in 2007/08. Production of the four major cereals by large farms (2.5 percent of production in 2007/08) increased by 5.5 percent per year between 2000/01 and 2008/09, essentially the same rate as that of small farms in the meher season (5.6 percent per year). Production of major cereals (mostly maize) in the belg season grew much faster (13.3 percent per year), but still accounted for only 4.2 percent of total annual production in 2007/08.

In spite of these increases in production (and net supply[19]), however, both the nominal and real prices of major cereals rose between 2003/04 and 2007/08, with especially large price increases in 2007/08 (Tables 2 and 3; Figures 2 and 3). From 2003/04 to 2006/07, the average real price of the four major cereals (teff, wheat, maize and sorghum)[20] rose by 12 percent; including 2007/08, the real price increase was 45 percent. The average real price of the four cereals actually declined slightly (by 1 percent) in 2008/09, though.

Nonetheless, the steady increases in real cereal prices that accompanied significant increases in per capita cereal supply from 2003/04 to 2007/08 remain a puzzle. Rapidly increasing domestic demand is one major factor. Population growth averaged 2.8 percent per year and per capita incomes grew by 7.1 percent per year between 2003/04 and 2006/07. Assuming a (high) income elasticity of demand for cereals of 1.0 on average, total cereal demand would increase by 10.1 percent per year (21.2 percent over two years). This figure is still significantly less than the 31.2 percent increase in cereal production over this period, however, suggesting that real prices should have fallen significantly rather than rising by 5 percent. The surge in real cereal prices in 2007/08 is even more puzzling, though it may have been due in part to expectations of a possible poor harvest or reduced levels of imports (after the start of foreign exchange rationing in March 2008).

[19] There is very little external trade in teff, maize and sorghum, so net availability is essentially determined by production less seed use and losses. For wheat, external trade is significant, particularly food aid imports which averaged 630 thousand tons per year over this period. However, food aid plus government commercial imports in 2007/08 (about 700 thousand tons) was not much different than food aid in 2001/02 (630 thousand tons).

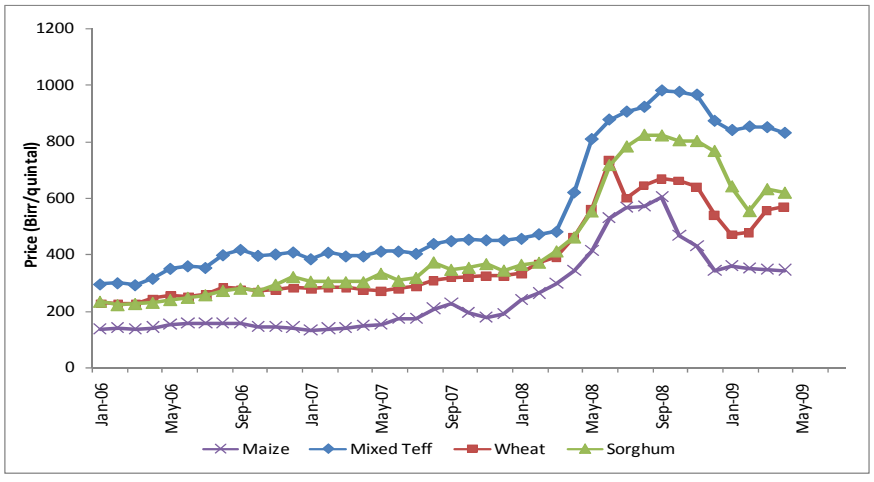
[20] The real price index reported here is a 2007-08 production-weighted average of the four major cereals.

**Table 2: Nominal Wholesale Prices of Major Cereals in Addis Ababa (birr/quintal)**

| | Nominal Prices | | | |
|---|---|---|---|---|
| | **Teff** | **Wheat** | **Maize** | **Sorghum** |
| **Oct97-Sept98** | 229.9 | 175.6 | 102.8 | 196.9 |
| **Oct98-Sept99** | 252.5 | 196.6 | 126.7 | 180.7 |
| **Oct99-Sept00** | 272.8 | 205.8 | 121.8 | 203.0 |
| **Oct00-Sept01** | 244.3 | 149.1 | 68.1 | 163.1 |
| **Oct01-Sept02** | 216.4 | 128.2 | 69.6 | 136.9 |
| **Oct02-Sept03** | 252.3 | 198.0 | 136.7 | 205.9 |
| **Oct03-Sept04** | 249.0 | 172.0 | 113.7 | 162.1 |
| **Oct04-Sept05** | 259.0 | 185.1 | 146.0 | 198.1 |
| **Oct05-Sept06** | 324.8 | 241.5 | 143.6 | 241.6 |
| **Oct06-Sept07** | 406.9 | 283.6 | 159.7 | 313.1 |
| **Oct07-Sept08** | 650.6 | 472.5 | 369.1 | 507.1 |
| **Oct08-Sept09** | 869.8 | 527.1 | 362.3 | 625.6 |
| | **Annual Change** | | | |
| | **Teff** | **Wheat** | **Maize** | **Sorghum** |
| **1997/98 - 1998/99** | 9.8% | 11.9% | 23.2% | -8.2% |
| **1998/99 - 1999/00** | 8.0% | 4.7% | -3.8% | 12.3% |
| **1999/00 - 2000/01** | -10.4% | -27.6% | -44.1% | -19.7% |
| **2000/01 - 2001/02** | -11.4% | -14.0% | 2.2% | -16.0% |
| **2001/02 - 2002/03** | 16.6% | 54.4% | 96.3% | 50.4% |
| **2002/03 - 2003/04** | -1.3% | -13.1% | -16.8% | -21.3% |
| **2003/04 - 2004/05** | 4.0% | 7.6% | 28.4% | 22.2% |
| **2004/05 - 2005/06** | 25.4% | 30.5% | -1.7% | 22.0% |
| **2005/06 - 2006/07** | 25.3% | 17.4% | 11.2% | 29.6% |
| **2006/07 - 2007/08** | 59.9% | 66.6% | 131.1% | 62.0% |
| **2007/08 - 2008/09** | 33.7% | 11.5% | -1.9% | 23.4% |
| **2004/05 - 2008/09** | **235.8%** | **184.8%** | **148.1%** | **215.8%** |

Source: EGTE data.

**Figure 2: Wholesale Prices of Cereals in Addis Ababa, 2006-09**



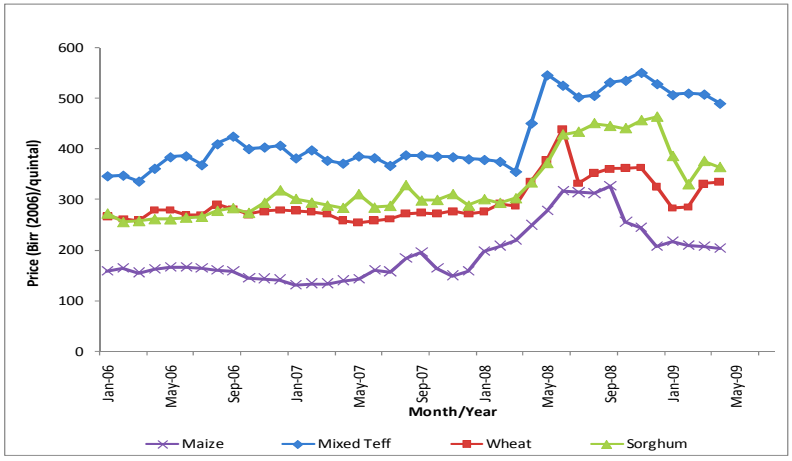

Source: EGTE data.

**Table 3: Real Wholesale Prices of Major Cereals in Addis Ababa (birr (2006)/quintal)**

| | Real Prices | | | |
|---|---|---|---|---|
| | **Teff** | **Wheat** | **Maize** | **Sorghum** |
| **Oct97-Sept98** | 388.6 | 297.2 | 173.8 | 332.7 |
| **Oct98-Sept99** | 397.6 | 309.0 | 198.4 | 285.1 |
| **Oct99-Sept00** | 417.3 | 315.1 | 186.3 | 310.4 |
| **Oct00-Sept01** | 405.7 | 246.8 | 112.6 | 270.2 |
| **Oct01-Sept02** | 368.5 | 217.5 | 117.7 | 232.3 |
| **Oct02-Sept03** | 363.7 | 285.5 | 196.6 | 296.7 |
| **Oct03-Sept04** | 343.0 | 236.7 | 156.3 | 223.0 |
| **Oct04-Sept05** | 325.4 | 232.1 | 182.9 | 248.1 |
| **Oct05-Sept06** | 361.7 | 269.7 | 160.5 | 270.1 |
| **Oct06-Sept07** | 387.4 | 269.9 | 151.1 | 297.6 |
| **Oct07-Sept08** | 440.8 | 321.3 | 244.2 | 343.5 |
| **Oct08-Sept09** | 507.8 | 307.2 | 211.0 | 364.8 |
| | **Annual Change** | | | |
| | **Teff** | **Wheat** | **Maize** | **Sorghum** |
| **1997/98 - 1998/99** | 2.3% | 4.0% | 14.1% | -14.3% |
| **1998/99 - 1999/00** | 5.0% | 2.0% | -6.1% | 8.9% |
| **1999/00 - 2000/01** | -2.8% | -21.7% | -39.5% | -13.0% |
| **2000/01 - 2001/02** | -9.2% | -11.9% | 4.5% | -14.0% |
| **2001/02 - 2002/03** | -1.3% | 31.2% | 67.0% | 27.7% |
| **2002/03 - 2003/04** | -5.7% | -17.1% | -20.5% | -24.8% |
| **2003/04 - 2004/05** | -5.1% | -1.9% | 17.0% | 11.2% |
| **2004/05 - 2005/06** | 11.1% | 16.2% | -12.3% | 8.9% |
| **2005/06 - 2006/07** | 7.1% | 0.1% | -5.9% | 10.2% |
| **2006/07 - 2007/08** | 13.8% | 19.1% | 61.6% | 15.4% |
| **2007/08 - 2008/09** | 15.2% | -4.4% | -13.6% | 6.2% |
| **2004/05 - 2008/09** | **56.0%** | **32.3%** | **15.4%** | **47.1%** |

* Real prices calculated using the national consumer price index as a deflator (December 2006=100).

**Figure 3: Real (Dec 2006) Wholesale Prices of Cereals in Addis Ababa, 2006-09**




Source: Calculated from EGTE data and CSA consumer price index.

Considering only the wheat market, the supply and demand calculations appear more consistent with the observed 30 percent increase in real prices from 2000/01 to 2007/08. During this period, population increased by a total of 21 percent and wheat production rose by 52 percent, but per capita availability of wheat increased by only 14 percent since wheat imports changed little. Given the large increase in per capita incomes over this period and a positive income elasticity of demand for wheat, it is likely that per capita demand increased faster than per capita supply. Thus higher real prices of wheat are broadly consistent with main supply and demand factors, but further analysis is needed to explain the magnitude of the real price trends.

## 3. The macro-economic setting: The investment boom and foreign exchange rationing

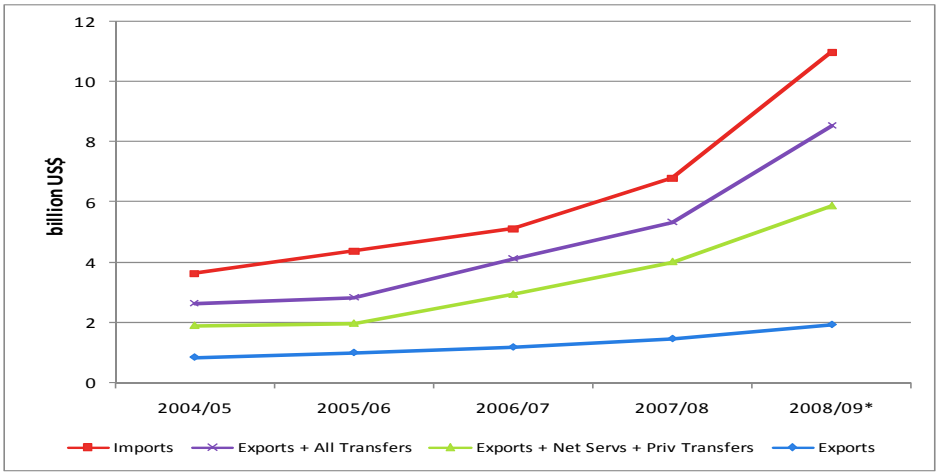
The sharp increase in cereal production in recent years coincided with rapid overall economic growth, as well. Between 2004/05 and 2007/08, government policies of expanded domestic credit to finance private investment and increased foreign borrowing to finance public investment contributed to sustained economic growth in excess of 10 percent per year. Increased investment implied increased demand for imports (and for foreign exchange), however, since private (and public) sector investors had access to foreign exchange to finance imported intermediate and capital goods. As a result, merchandise imports surged by 87 percent (US$3,178 mn) between 2004/05 and 2007/08. Half of this increase in merchandise imports was financed by a 195 percent increase in private transfers; increases in merchandise exports each financed 16-19 percent of the increase in merchandise imports (Table 4 and Figure 4).

**Table 4: Ethiopia Imports and Import Financing, 2004/05 to 2007/08**

| | 2004/05 mn US$ | 2007/08 mn US$ | Average 2004/05 to 2007/08 mn US$ | Average 2004/05 to 2007/08 Imports | Change 2004/05 to 2007/08 percent |
|---|---|---|---|---|---|
| **Imports (Merchandise)** | 3,633 | 6,811 | 3,178 | 100% | 87% |
| | | | | | |
| **Exports (Merchandise)** | 847 | 1,466 | 619 | 19% | 73% |
| **Net Services** | 242 | 160 | - 82 | -3% | -34% |
| **Private Transfers** | 811 | 2,393 | 1,582 | 50% | 195% |
| **Public Transfers** | 750 | 1,312 | 563 | 18% | 75% |
| **Capital Inflows** | 983 | 1,480 | 496 | 16% | 50% |
| **Subtotal** | 3,633 | 6,811 | 3,178 | 100% | 87% |

Source: National Bank of Ethiopia data.

**Figure 4: Ethiopia Imports and Import Financing, 2004/05 to 2007/08**




**Source:** National Bank of Ethiopia data.

Higher world prices, increased domestic credit, foreign capital inflows, changes in expectations and other factors contributed to increases in overall domestic inflation, however, which rose from 11.5 percent in 2004/05 (July 2004 to July 2005) to 64.5 percent in 2007/08 (July 2007 to July 2008), (Table 5 and Figure 5). Inflation slowed substantially thereafter, though, and between July 2008 and March 2009, the price level actually fell by 5.8 percent. Yet, with nominal exchange rates changing little relative to the US dollar, the real exchange rate appreciated by 13.8 percent between July 2004 and January 2008 and by a total of 33.8 percent through July 2008. Nominal depreciation of the Birr (from 9.83 to 11.39 Birr/US$) between July 2008 and June 2009 helped reduce real appreciation of the birr to 26.3 percent, but this still represented a major reduction in incentives for production of tradables (export goods and import substitutes) since July 2004.

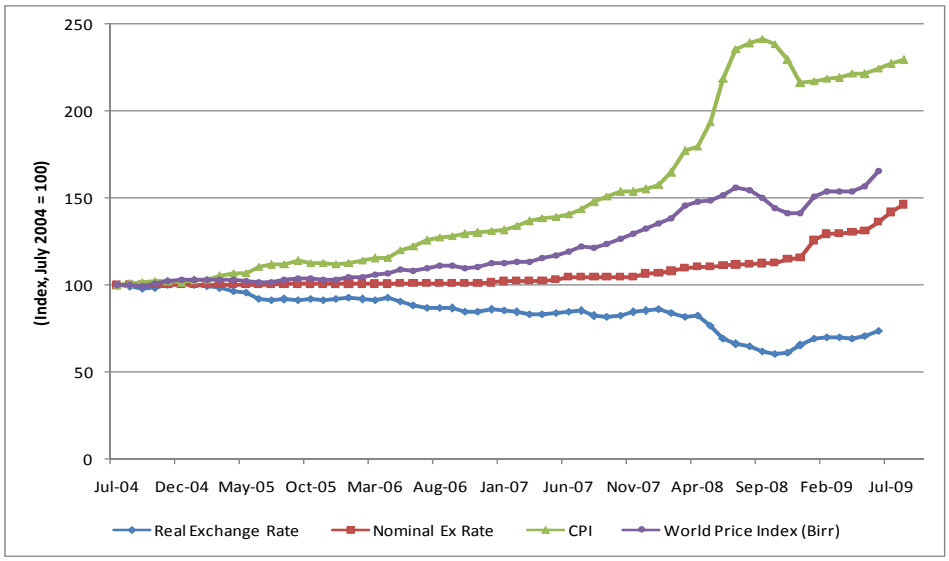
**Table 5: Ethiopia Nominal and Real Exchange Rates, 2004-2009**

| | Nominal Exchange (Birr/$) | Nominal Exchange Rate (Birr/$) (Index) | World Price Index ($) | World Price Index (Birr) | CPI | Real Exchange Rate Index |
|---|---|---|---|---|---|---|
| **July 2004** | 8.80 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| **January 2005** | 8.83 | 100.3 | 102.7 | 103.0 | 102.9 | 100.1 |
| **July 2005** | 8.84 | 100.5 | 101.4 | 101.9 | 111.5 | 91.3 |
| **January 2006** | 8.86 | 100.6 | 104.1 | 104.7 | 112.8 | 92.8 |
| **July 2006** | 8.87 | 100.8 | 108.7 | 109.6 | 125.7 | 87.2 |
| **January 2007** | 8.99 | 102.1 | 110.4 | 112.7 | 131.6 | 85.7 |
| **July 2007** | 9.21 | 104.7 | 116.8 | 122.3 | 143.6 | 85.1 |
| **January 2008** | 9.40 | 106.9 | 127.0 | 135.7 | 157.5 | 86.1 |
| **July 2008** | 9.83 | 111.7 | 139.6 | 156.0 | 235.8 | 66.2 |
| **January 2009** | 11.06 | 125.7 | 120.0 | 150.8 | 217.0 | 69.5 |
| **June 2009** | 12.00 | 136.4 | 121.3 | 165.4 | 224.4 | 73.7 |
| **July 04 - June 09 (percent change)** | **36.4%** | **36.4%** | **21.3%** | **65.4%** | **124.4%** | **-26.3%** |

**Source:** EDRI and authors' calculations.

Moreover, Ethiopia had been increasingly financing its current account deficit through drawdown of official foreign exchange reserves. From the end of June 2007 to the end of March 2008, foreign exchange reserves fell by US$381 mn (equivalent to 13 percent of the value of merchandise imports in that period). For 2007/08 as a whole (i.e. through June 2008), foreign exchange reserves fell by US$264 million in 2007/08 (an amount equal to 5% of merchandise imports in 2006/07), in spite of large inflows of private and public transfers.

**Figure 5: Ethiopia Nominal and Real Exchange Rates, 2004-2009**




Source: EDRI and authors' calculations.
Note: In this figures an appreciation of the real exchange rate is denoted as a decrease in the index.

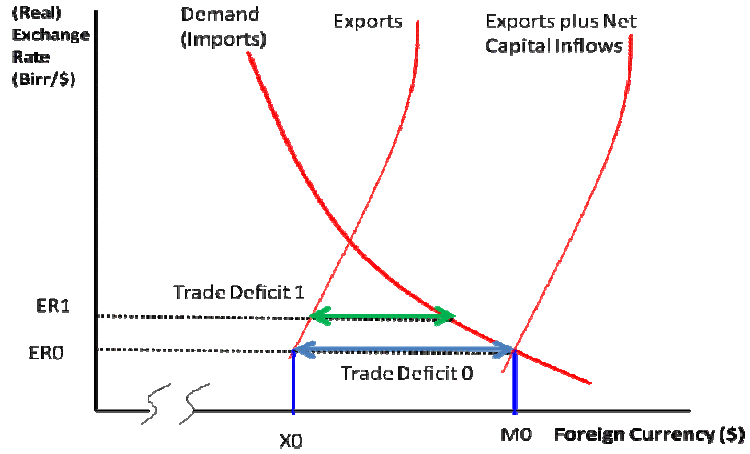
Thus, in early 2008, foreign exchange reserves were near zero and import demand was in excess of supply of foreign exchange at the prevailing official exchange rate. Rather than allowing the Birr to depreciate sharply to restore balance between supply and demand for foreign exchange, the government adopted a policy of foreign exchange controls (rationing) to restrict the effective demand for imports. The nominal exchange rate remained essentially unchanged relative to the dollar and, with continuing rapid domestic inflation, the real exchange rate continued to appreciate until late 2008, (when domestic inflation slowed and the nominal exchange rate was allowed to depreciate).

# 4. Foreign capital inflows, rationing and the real exchange rate: Analytical framework

Similar to the goods market, in the foreign exchange markets, the supply of foreign exchange from exports (which includes merchandise and services exports, foreign aid, private transfers and other transfers) plus foreign exchange net capital inflows (equal to the current account deficit) equals demand for foreign exchange from imports.[21] However, the difference between the unrestricted and rationed foreign exchange markets is in the way these market forces (supply and demand) adjust in response to exchange rate changes (devaluation). Hence, the effects of exchange rate devaluation in a market with foreign exchange rationing are much different from the effects of devaluation in an unrestricted foreign exchange market.

In an unrestricted market for foreign exchange (Figure 6), the (real) exchange rate adjusts so that supply of foreign exchange from exports (and current account transfers) (X0) plus net foreign exchange capital inflows (Trade Deficit 0) equals demand for foreign exchange from imports (M0). In such an unrestricted market, a (real) exchange rate depreciation (from ER0 to ER1) tends to increase supply of exports and reduce demand for imports, lowering the trade (current account) deficit (to Trade Deficit 1).

**Figure 6: Impacts of a Devaluation in an Unrestricted Market for Foreign Exchange**



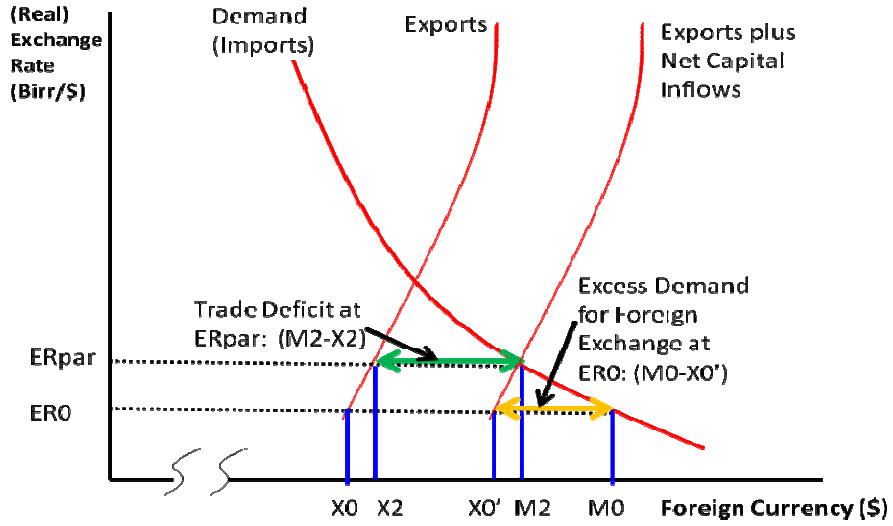

Source: Authors.

[21] Thus, the current account deficit , i.e. the difference between current account outflows (imports of goods and services, and private transfers to the rest of world) and current account inflows (merchandise and services exports, foreign aid, private transfers and other transfers), is equal to net capital inflows.

In a restricted or rationed market for foreign exchange, however (Figure 7), changes in the (real) exchange rate need not result in a reduction in imports. This is because in a ration regime, the demand for foreign exchange for imports (M0) at the official exchange rate (ER0) exceeds total supply of foreign exchange from export earnings (X0) and other sources of foreign exchange (including current account transfer earnings plus the available foreign exchange from capital inflows and reserve drawdown). This results in an unmet demand for foreign exchange (M0-X0') at the official exchange rate (ER0). A parallel market for foreign exchange will tend to develop with an exchange rate (ERpar) such that total demand for foreign exchange at this exchange rate (M2) equals total supply of foreign exchange.

In this case, (which describes the foreign exchange market in Ethiopia from April 2008 to September 2009), a small devaluation will provide additional incentives for exports. However, import demand at that new exchange rate may still be in excess of available foreign exchange, so that foreign exchange rations will still be binding. In this case, the parallel market exchange rate would remain unchanged, as would the market price of imports. Even those importers that obtain the foreign exchange at the low official rate through rations would still sell at the higher rate.[22]

**Figure 7: Demand and Supply of Foreign Exchange (Restricted Market)**



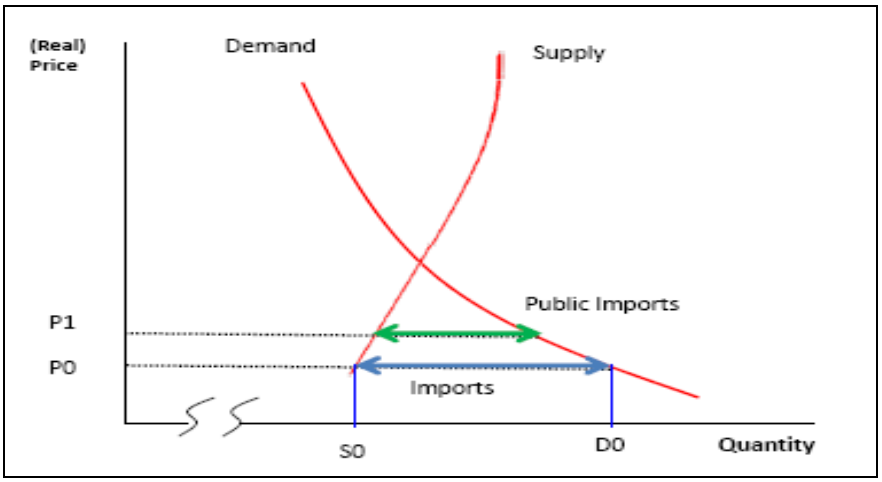

Source: Authors.

[22] In fact, the only instance that the depreciation will have an impact on prices is on those items whose import and supply are government controlled, and for which the government then passes on the higher cost to purchasers.

Only if the devaluation is large (i.e. greater than ER2 in Figure 7) will it reduce import demand and increase export supply enough so that the gap between foreign exchange demand and supply is eliminated, the trade deficit is reduced, and imports fall to less than the quota amount.

The precise effects of foreign exchange rationing for the market of each importable good, however, depend not only on the overall rationing of foreign exchange (which determines the real exchange rate), but also the size of the ration of foreign exchange for the particular importable good. Figure 8 illustrates the case of wheat imports. If the amount of the ration is less than the amount of goods that would be imported in the absence of rationing (D0 minus S0), then the market clearing price will rise (in this case from P0 to P1). This same analysis applies whether the rationed amount is imported by the public sector or the private sector, (apart from possible income effects on demand arising from additional incomes of households receiving rationed or subsidized imports). Thus, restrictions on foreign exchange have direct implications for domestic prices of tradable goods, including key food imports like wheat.

**Figure 8: Price Effects of Restrictions on Wheat Imports**




Source: Authors.

## 5. Domestic wheat price formation and international trade

From 2000 to 2009, wheat markets in Ethiopia have been governed by several different regimes of price determination (Box 1). From mid-2000 through 2004, domestic prices of wheat in Addis Ababa were generally below import parity levels

but above export parity levels, thus providing little incentive for private imports or exports of ordinary wheat (Table 6 and Figure 9). Domestic prices were on average 24 percent below import parity levels in this period, in part because food aid inflows helped to depress prices to the benefit of net wheat consumers and the detriment of net wheat producers.[23]

**Box 1: Wheat Market Regimes in Ethiopia, 2000 to 2009**

**Regime 1: January 2000-June 2005: Domestic wheat prices were generally between import and export parity**

- Given levels of official imports (including food aid), there was little incentive for private sector imports of ordinary wheat
- Domestic prices were determined by domestic supply (including official imports) and demand

**Regime 2: July 2005-March 2007: Domestic wheat prices were generally at import parity levels**

- Private sector imports adjusted to equate total supply and domestic demand at the import parity price

**Regime 3: April 2007- May 2008: Domestic wheat prices were again below import parity**

- Given sharp increases in world prices, private sector imports were not profitable

**Regime 4: June 2008 – May 2009: Domestic wheat prices were above import parity**

- Restrictions on foreign exchange for imports prevented private imports from taking advantage of profitable import opportunities

Then, from early 2005 to early 2007, domestic prices of wheat (wholesale, Addis Ababa) tracked import parity prices, as private sector wheat imports constituted the marginal supply of wheat in Ethiopia, given levels of domestic production and food aid inflows. Thus, from 2004/05 through 2006/07, domestic prices of wheat were on average only 0.8 percent higher than import parity prices (Table 6).

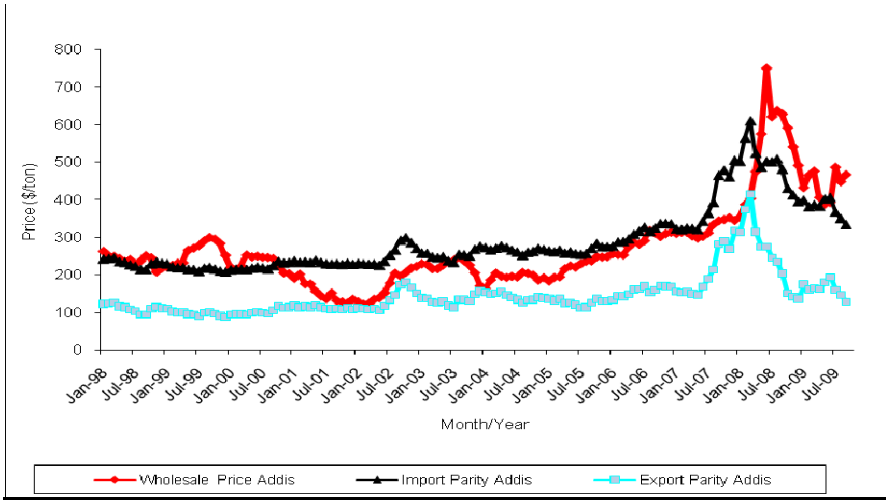
[23] See Rashid, Assefa and Ayele (2008) for estimates of price distortions in Ethiopian agriculture.

**Table 6: Domestic and Import Parity Prices of Wheat in Ethiopia, 1998 – 2009**

| Crop Year (October-September) | White Wheat Wholesale Addis (Birr/kg) | Exchange Rate (Birr/$) | White Wheat Wholesale Addis ($/ton) | Wheat Import Parity Addis ($/ton) | Nominal Protection Coefficient (percent) |
|---|---|---|---|---|---|
| **1998-99** | 1.97 | 7.87 | 248.9 | 221.8 | 12.7% |
| **1999-00** | 2.06 | 8.30 | 248.0 | 215.9 | 15.0% |
| **2000-01** | 1.49 | 8.52 | 175.4 | 233.5 | -24.9% |
| **2001-02** | 1.28 | 8.69 | 147.5 | 239.7 | -38.9% |
| **2002-03** | 1.98 | 8.72 | 227.1 | 257.7 | -11.3% |
| **2003-04** | 1.72 | 8.78 | 195.8 | 266.1 | -25.8% |
| **2004-05** | 1.85 | 8.83 | 209.6 | 262.4 | -17.7% |
| **2005-06** | 2.42 | 8.86 | 272.5 | 297.8 | -3.6% |
| **2006-07** | 2.84 | 9.06 | 313.1 | 348.7 | -2.1% |
| **2007-08** | 4.73 | 9.60 | 489.3 | 510.1 | 8.2% |
| **2008-09** | 5.27 | 11.39 | 465.2 | 387.3 | 40.5% |
| **Ave. 2000-01 - 04-05** | 1.66 | 8.71 | 191.1 | 251.9 | -23.7% |
| **Ave. 2005/06 - 07-08** | 3.33 | 9.17 | 358.3 | 385.5 | 0.8% |

***** Average of data from October 2008 through April 2009.
Source: Authors' calculations from Ethiopian Grain Trading Enterprise (EGTE) data.

**Figure 9: Domestic, Import and Export Parity Prices of Wheat in Ethiopia, 1998 – 2009**




Source: Authors' calculations from Ethiopian Grain Trading Enterprise (EGTE) data.
**Note:** Import and export parity figures are calculated using U.S. Hard Red Winter Wheat Price (fob Gulf of Mexico) plus international shipping (estimated at US$30/ton for December 2008) and domestic handling and transport from Djibouti to Addis (estimated at approximately 1,350 Birr/ton in December 2008).

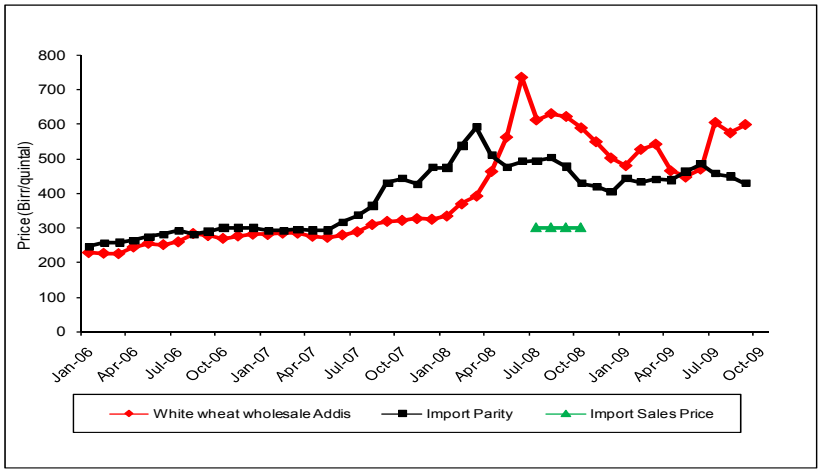
Since mid-2007, however, domestic wheat prices have NOT been determined by international prices. World prices (import parity Addis Ababa) were higher than domestic prices from mid-2007 through March 2008. Thus, during this period, there were very little imports of ordinary wheat by the private sector as private imports of ordinary wheat were not profitable.

However, when poor rains in many parts of Ethiopia in early 2008 led to a failure of the *belg* season harvest and concerns about adequacy of rainfall for planting of the upcoming 2008 *meher* crops (harvested in October-December), domestic prices rose sharply.[24] Private imports of wheat were apparently again profitable, but restrictions on foreign exchange for imports of wheat (and other goods) were imposed in March 2008.

As a result, import parity did not provide a ceiling on domestic prices of wheat. Instead, domestic wheat prices rose above world prices beginning in May 2008, reflecting the inability or unwillingness of private importers to take advantage of the profitable trade opportunity. Factors such as lack of access to foreign exchange, policy uncertainty related to government imports and domestic sales, and concern over possible seizure of private stocks all likely contributed to this lack of private sector import supply response.

In lieu of private sector imports, government policy in mid-2008 was to contract for its own imports of wheat and then sell the wheat at fixed prices in the domestic market (generally 300 Birr/quintal, only about half of the wholesale price of wheat in Addis Ababa market), (Figure 10).

**Figure 10: Wholesale, Import Sales Prices of Wheat (Addis Ababa, Birr/quintal)**




**Source:** Authors' calculations from Ethiopian Grain Trading Enterprise (EGTE) data.

[24] The *belg* harvest accounts for about 15 percent of annual maize production, but less than 2 percent of annual teff, wheat and sorghum production.

Most of this wheat (55 percent) was sold to flour mills; 23 percent of the subsidized wheat was sold to consumers and 18 percent of the wheat was sold to cooperatives (Table 7). Overall, less than 2 percent of the wheat (8,100 tons) was sold to traders, and none after September 2008, due to concerns that traders did not pass on the huge implicit subsidy to consumers.

**Table 7: Ethiopia: Distribution of Public Wheat Imports, June 2008 to April, 2009 ('000 tons)**

| | Flour mills | Cooperatives | Traders | Consumers | Others | Total |
|---|---|---|---|---|---|---|
| June | - | - | - | - | - | 9.2 |
| July | - | - | - | - | - | 9.7 |
| August | 65.1 | 9.7 | 3.8 | 16.2 | - | 94.8 |
| September | 70.9 | 15.9 | 4.4 | 30.3 | - | 121.5 |
| October | 32.9 | 19.4 | - | 12.1 | 2.1 | 66.4 |
| November | 42.6 | 12.6 | - | 12.6 | 2.9 | 70.6 |
| December | 20.4 | 7.9 | - | 7.0 | 0.4 | 35.8 |
| January '09 | 14.6 | 4.0 | - | 2.1 | 4.4 | 25.1 |
| February | 8.8 | 4.5 | - | 5.1 | 0.0 | 18.4 |
| March | 19.2 | 11.9 | - | 19.7 | 3.1 | 53.9 |
| April | 9.8 | 9.4 | - | 14.2 | 0.1 | 33.5 |
| Total | 284.3 | 95.3 | 8.1 | 119.2 | 13.1 | 538.9 |
| Total (Aug-Apr) | 284.3 | 95.3 | 8.1 | 119.2 | 13.1 | 520.0 |
| Share | 54.7% | 18.3% | 1.6% | 22.9% | 2.5% | 100.0% |

**Source:** Ethiopian Grain Trading Enterprise (EGTE) data.

Simple partial equilibrium wheat market analysis suggests that the announcement of the wheat imports and the subsequent government wheat sales accounted for the real price decline (see Table 8).[25] Given wheat production in 2007-08 of 2.31 million tons and a 17 percent adjustment for seed, feed and wastage, net wheat production was 1.91 million tons. Adding approximately 400 thousand tons of food aid and net public stock changes gives a total net wheat supply of 2.31 million tons. Average wheat consumption per month is thus about 192 thousand tons per month, and using this average for the July to October 2008 period (i.e. the four-month period before the

[25] The equations used for this partial equilibrium analysis are given in Appendix 1. This methodology is a one-commodity simplified version of the multi-market model outlined in Dorosh, Dradri and Haggblade (2009), used for Zambia. See Braverman and Hammer (1986) and Sadoulet and de Janvry (1995) for a detailed description of multi-market models. A first version of this analysis of the potential price impact of injections of government wheat imports on the domestic wheat market was first presented in Gabre-Madhin, Dorosh and Kulkarni (2008). See Diao et al. (2007) and Rashid et al. (2009) for more detailed multi-market model analyses for Ethiopia.

major *meher* season wheat harvest), wheat consumption would be 192 thousand tons per month x 4 months = 770 thousand tons.

**Table 8: Partial Equilibrium Estimates of Impacts of Government Wheat Sales in 2008**

| Simulation | 1a | 1b | 2a | 2b |
|---|---|---|---|---|
| **Assumptions** | | | | |
| **Government imports (mn tons)** | 0.200 | 0.200 | 0.300 | 0.300 |
| **Elasticity of wheat demand** | -0.35 | -0.80 | -0.35 | -0.80 |
| **Base Data** | | | | |
| **Wheat Supply (mn tons/month)** | 0.192 | 0.192 | 0.192 | 0.192 |
| **4 month wheat supply (mn tons)** | 0.770 | 0.770 | 0.770 | 0.770 |
| **Results** | | | | |
| **% change in net supply** | 26% | 26% | 39% | 39% |
| **New wheat price (Birr/quintal)** | 349 | 506 | 264 | 447 |
| **% change wheat price** | -48.3% | -25.1% | -61.0% | -33.7% |
| **Reference** | | | | |
| **Actual real price decline: June-Oct** | -19.7% | -19.7% | -19.7% | -19.7% |
| **Expected seasonality (2% per month)** | 8.2% | 8.2% | 8.2% | 8.2% |
| **Actual real price relative to expected price** | -25.8% | -25.8% | -25.8% | -25.8% |

Source: Authors' calculations.

Note: The wholesale market of price of wheat in Addis Ababa in mid-August 2008 was 675 Birr/quintal.

Injecting an additional 200 thousand tons of wheat on the market over the four month (July – October) period, as in Simulation 1, increases net supply by 26 percent. Using an own-price elasticity of demand of -0.35, simulated market prices fall by 48 percent in real terms (i.e. adjusted for overall inflation in the CPI). Using an own-price elasticity of demand of -0.8, real market prices fall by 25 percent. Sales of 300 thousand tons (almost exactly what was actually sold) would lower real market prices by 61 percent with the more price-inelastic demand (elasticity of -0.35) and 34 percent with the more elastic demand (elasticity of -0.8).[26]

Sales of government imported wheat reduced real wheat prices in domestic markets from July through October, but not by as much as initially expected, as market wheat demand ultimately proved to be quite price-elastic. Announcement of planned imports of 157,500 tons of wheat and disbursements to millers and wholesale traders

26 Ultimately, the government distributed 292.4 thousand tons of commercially imported wheat through various channels from July through October 2008.

contributed to a 12 percent fall in wholesale wheat prices in Addis in July 2008 relative to the June 2008 price (24 percent in real terms). Wheat prices rose slightly in real terms in August, but averaged about 20 percent below June 2008 real price levels from August through October 2008. October 2008 real prices were 26 percent below a projected real price without the import intervention (the June price plus an estimated 2 percent per month real seasonal price rise), somewhat less than the 33.7 percent decrease in simulation 2 using an elasticity of demand of -0.8.

Two factors likely accounted for the smaller than expected real price decline. First, wheat millers may not have milled all the wheat received or sold all the wheat flour produced by October 2008. Second, imported wheat is not a perfect substitute for locally produced wheat, so increases in imported wheat quantities would likely have smaller effects on prices of locally produced wheat than on prices of domestic sales of imported wheat.

Nonetheless, sales at below-market prices implied huge rents (excess profits) for traders and millers who were able to purchase wheat at 300 Birr/quintal and sizeable income transfer to poor households who were able to purchase government wheat directly. (If the cooperatives sold the wheat at market prices, they would also reap huge rents. Otherwise, the value of these rents would be passed on to consumers as a subsidy.) The total value of these rents and subsidies reached about 900 million Birr (about US$90 million), (Table 9).

**Table 9: Ethiopia: Subsidy on Government Wheat Sales, August-October, 2008**

| | Quantity Sold ('000 tons) | Sales Price (Birr/ton) | Market Price (Birr/ton) | Subsidy (Birr/ton) | Total Subsidy mn Birr | Total Subsidy mn $ |
|---|---|---|---|---|---|---|
| **August** | 94.8 | 3,000 | 6,600 | 3,600 | 341 | 34.3 |
| **September** | 121.5 | 3,000 | 6,375 | 3,375 | 410 | 40.5 |
| **October** | 66.4 | 3,000 | 5,375 | 2,375 | 158 | 15.5 |
| **Total (Average)** | 282.7 | 3,000 | 6,215 | 3,215 | 909 | 90.4 |

Source: Authors' calculations from EGTE data.

Following the 2008 *meher* harvest, domestic wheat prices fell sharply, but nonetheless have still remained above import parity levels in spite of a 16 percent depreciation of the birr relative to the US dollar and a 27 percent reduction in the international price of wheat (fob US Gulf) from October 2008 to April 2009. Thus, the divergence between international and domestic prices remained.

Nonetheless, in real terms, domestic wholesale prices in Ethiopia in 2008-09 were at essentially the same level as in 1999-2000 and 2000-01 (Table 10). Real domestic prices have increased by 17.7 percent since 2003-04, the year after the major drought of 2002-03, however. International wheat prices (cif Djibouti), which rose steeply in 2007-08 have again returned to more normal levels and in 2008-09 were only 19.5 percent higher than in 2003-04. If not for the real exchange rate depreciation of 13.7 percent during this period (and changes in transport costs), import parity prices would have increased by a similar amount in real terms.

**Table 10: Real Domestic and Import Parity Prices of Wheat in Ethiopia, 1998 – 2009**

| | Import Price CIF Djibouti ($/ton) | Real Import Price CIF Djibouti ($2004/ton) | Real Exchange Rate (Jly 2004=100) | Real Import Price CIF Djibouti (Birr 2004/qntl) | Real Import Parity Price (Birr 2004/qntl) | Real Wholesale Price (Birr 2004/qntl) |
|---|---|---|---|---|---|---|
| **1998-99** | 161.8 | 186.2 | 94.3 | 149.1 | 204.4 | 228.9 |
| **1999-00** | 155.9 | 180.7 | 95.2 | 146.7 | 203.2 | 233.4 |
| **2000-01** | 173.5 | 209.1 | 95.8 | 181.9 | 244.8 | 182.8 |
| **2001-02** | 179.7 | 215.2 | 99.4 | 196.8 | 262.7 | 161.1 |
| **2002-03** | 197.7 | 220.4 | 94.7 | 185.2 | 241.2 | 211.5 |
| **2003-04** | 204.6 | 208.8 | 99.8 | 183.6 | 238.8 | 175.3 |
| **2004-05** | 195.2 | 190.9 | 96.4 | 161.0 | 216.3 | 172.0 |
| **2005-06** | 222.5 | 209.6 | 90.4 | 163.2 | 218.6 | 199.8 |
| **2006-07** | 262.4 | 232.4 | 84.2 | 167.0 | 222.1 | 199.9 |
| **2007-08** | 401.5 | 307.2 | 77.2 | 204.6 | 258.4 | 238.0 |
| **2008-09*** | 272.4 | 223.6 | 67.9 | 133.9 | 190.0 | 227.6 |
| **Ave 00-01 to 04-05** | 190.1 | 208.9 | 97.2 | 181.7 | 240.7 | 180.6 |
| **Ave 05/06 to 07-08** | 295.4 | 249.7 | 83.9 | 178.3 | 233.0 | 212.6 |
| **03/04-08/09 %change** | **55.4%** | **19.5%** | **-13.7%** | **-1.9%** | **-3.2%** | **17.7%** |

* Real exchange rate data are from October 2008 through June 2009.

**Note:** Import and export parity figures are calculated using U.S. Hard Red Winter Wheat Price (fob Gulf of Mexico) plus international shipping (estimated at US$30/ton for December 2008) and domestic handling and transport from Djibouti to Addis (estimated at approximately 1,350 Birr/ton in December 2008).

**Source:** Authors' calculations from Ethiopian Grain Trading Enterprise (EGTE) data.

## 6. Conclusions

Wheat price formation regimes have changed several times between 2000 and 2009: For most of this period, domestic prices have not been determined by international border prices. Given foreign exchange rationing starting in March 2008, private sector wheat importers have had restricted access to foreign exchange. Domestic wheat prices have been above wheat import parity prices since May 2008, indicating that it would be profitable for private traders to import wheat if they had access to foreign exchange at the official exchange rate.

The partial equilibrium analysis in this paper shows, however, that government imports and sales in 2008-09 effectively increased domestic supply and lowered market wheat prices. These sales at the low official price also implied that recipient households, traders and flour mills enjoyed a significant subsidy. Allowing the private sector access to foreign exchange for wheat imports or auctioning government wheat imports in domestic markets would eliminate these rents and generate additional government revenue, while having the same effect on market prices as government subsidized sales.

Although government imports and sales reduced market prices from their extremely high June 2008 levels, market prices still averaged 36 percent above import parity prices from July to October, 2008. Inhibiting private sector imports through foreign exchange rationing thus resulted in lower wheat imports, higher wheat prices, lower wheat consumption, and reduced welfare for net wheat consumers.[27] Depreciation of the nominal and real exchange rates from December through June 2009 substantially reduced the gap between domestic wholesale market prices and import parity and thus the negative effects of foreign exchange rationing on net wheat consumers. Restoring a liberalized trade regime would likely completely eliminate the gap between import parity and domestic wholesale prices, while allowing the private sector to respond to future production shocks with timely imports.

[27] The efficiency and distributional effects of foreign exchange rationing go far beyond the wheat sector, however. See Dorosh, Robinson and Ahmed (2009) for an economy-wide analysis of these impacts.

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## Annex 1: Model Equations

**Supply**

$S = \underline{X} * (1\text{-loss}) + MPRIV + ( \underline{GOVSALE} - \underline{GOVPURCH} ) + \underline{\Delta STOCKS}$

**Demand (Consumption)**

$D = C = C0 * (P/P0)^{ed} (\underline{Y}/Y0)^{ey}$

**Equilibrium**

$S = D$

**Trade**

Under free trade: $MPRIV = C - \underline{X} * (1\text{-loss}) - ( \underline{GOVSALE} - \underline{GOVPURCH} ) - \underline{\Delta STOCKS}$

$P = \underline{PM}$

Under quotas: $MPRIV = \underline{MPRIV}$

P is endogenous

*Variable names*

C = wheat consumption
C0 = base level of wheat consumption
D = total wheat demand
GOVPURCH = government domestic wheat purchases
GOVSALE = government domestic wheat sales and distribution
MPRIV = net private wheat imports
P = wheat price
P0 = base wheat price
S = total wheat supply
ΔSTOCKS = changes in private sector wheat stocks
X = wheat production
Y = household income

*Parameter names*

ed = own price elasticity of demand for wheat
ey = income elastity of demand for wheat
loss = combined rate of storage loss and use as animal feed

# FARMERS' ORGANISATIONS IN AFRICA: LESSONS FROM ETHIOPIA, KENYA AND MALAWI[1]

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Future Agricultures Consortium[3]

*Abstract*

*Farmers' organisations (FOs) are increasingly being asked to play a central role in driving agricultural transformation processes in Sub-Saharan Africa, despite their mixed record of success. This paper draws on findings of a study of the roles, functions and performance of FOs in Ethiopia, Kenya and Malawi to suggest some principles and practices for supporting FOs in Africa.*

*With often meagre resources and limited organisational and technical capacities, many FOs need external support to start-up and/or expand their operations. But striking the right balance between reliance on external and internal resources, between accountability and proactive leadership, between adaptive and effective governance and between over- and under-ambition is a challenge for all farmer-led groups. External support therefore needs to be well targeted, sensitive, consistent and, above all, patient if FOs are not to be yet another development disappointment. For this reason, we conclude by outlining some partnership strategies for supporting FOs in four key areas: (1) seed/input provision; (2) extension and education; (3) market access; and (4) advocacy and policy engagement.*

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## 1. Renewed interest in farmers' organisations

After years of neglect, many African countries are pursuing efforts to rapidly modernise their agricultural sector, as it is once again seen as a vital contributor to economic growth, food security and poverty reduction. Consequently, new policies and public and private initiatives are focusing on promoting increased and sustainable food production, with farmers' organisations being portrayed as key catalysts in these processes.

Most governments and international agencies agree on the importance of inclusiveness and authentic participation of farmers in agricultural research and development programmes and policies. But there are a number of challenges to achieving this goal. One arises from the reduced role of the state in service provision following the economic liberalisation policies and structural reforms of the 1980s and 1990s. Farmers are now being encouraged to take on roles previously played by governments, for example, in input provision, extension and marketing, but many are not be equipped to do so because of limited leadership skills, weak organisational capacity and severe resource constraints. Furthermore, with the decline of farmers' cooperatives which were common in Africa in the 1970s and 1980s, many smallholder farmers lack a collective voice. They often cannot gain access to affordable and vital resources and infrastructure, such as land, water, credit, seeds, fertiliser, post-harvest storage facilities or transport and are locked out of lucrative markets. As a result, many small-scale farmers in Africa remain caught in poverty traps and are unable to influence policies that affect their livelihoods or benefit from emerging market opportunities.

In some parts of Africa, the state's withdrawal has been significant, opening the way for a robust and dynamic agricultural sector, as is found in Kenya, but this has often focused on high-value export agriculture in global value chains which limited participation of large numbers of small producers. In other countries the state's withdrawal has been tentative at best, limiting private entry and in some cases even launching major public-sector agricultural support programmes, such as in Malawi. Elsewhere, the private sector has emerged only slowly and partially – as in the case of Ethiopia – mainly serving the interests of commercial farmers but leaving many, if not most, smallholders exposed to extensive market failures, high transaction costs and risks and huge service gaps. These have been only partly filled by the rise of NGOs and other civil society groups. Incomplete markets and institutional gaps impose huge costs in forgone growth and welfare losses for smallholders, threatening their competitiveness and, in many cases, their livelihoods.

The last decade has seen a broad resurgence in institutional innovations in agriculture to fill the deficits in input provision, extension and education, marketing and policy advocacy. Although significant progress has been made, this institutional reconstruction and transformation of African agriculture is still incomplete, especially for smallholders, pastoralists and herders in the more complex, diverse, risk-prone areas. Moving forward requires more clarity on the roles of the state, the private sector – and, crucially, on farmers' organisations themselves – and more analysis of what works, what doesn't and why.

## 2. Changing roles of farmers organisations

In rural societies, traditional organisations have an inward-oriented or 'bonding' function to build social capital and facilitate collective action to respond to the uncertainties of agricultural production, and to regulate relationships within the group. In contrast, formal farmers' organisations perform a kind of 'bridging' function to organise relationships between the group and the outside world. In the context of Africa, FOs typically share elements of both traditional and formal organisations. They are rooted in local contexts and customs, but organised around economic principles. Inclusion is characteristic in traditional groupings, where everyone is inherently a member, but formal farmers' organisations – be they cooperatives, unions, associations, federations or groups – tend to be more exclusive, as they are membership-based organisations created by specific groups of farmers to provide services to and represent the interests of their own members. They differ from NGOs, which also provide services to farmers, but are not necessarily membership based. Further, they can be local and serve only at village and inter-village levels, or can operate at regional and national levels (as unions and federations) and some are even global in scope, such as the International Federation of Agricultural Producers (IFAP) and La Via Campesina.

By encouraging their members to 'cooperate to compete', FOs can provide opportunities to small producers and livestock keepers to effectively play a role in Africa's emerging market economy and benefit from it. Moreover, strong and vibrant farmers' organisations that genuinely represent their constituencies can play a vital part in informing and influencing agricultural policy and practice. However, identifying and promoting *authentic* farmers' organisations that can empower their members is a major challenge for governments and public and private development partners. With limited resources and facing a very challenging socio-political and economic environment, many FOs need external financial, technical and institutional support, but what kind of support and in what form remains a challenge for these organisations and their supporters. This FAC Policy Brief draws on a larger study which attempts to

provide some insights into the roles FOs can play in agricultural transformation in Africa, with a spotlight on three very different countries, Ethiopia, Kenya and Malawi, each with its own unique history of agrarian change.

# 3. Lessons from farmers organisations in Ethiopia, Kenya and Malawi

## 3.1 Study objectives and methods

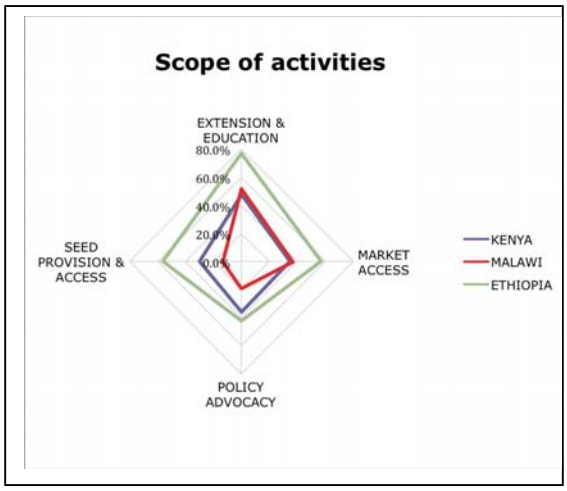
The objectives of the study were to examine the key internal and external factors shaping FOs performance and distil a set of practical lessons and principles to guide future investments and strategic partnership with FOs.

To this end, the study team in the three countries prepared a standard spreadsheet based format for inventory and profiling FOs. Accordingly, a rapid inventory of 472 FOs in the 3 countries was produced (141 = Ethiopia; 238 = Kenya; 93 = Malawi). Some 65 FOs were profiled in more depth (18 = Ethiopia; 30 = Kenya; 17 = Malawi) based on their engagement in the 4 priority areas, namely seed/input provision, extension and education, market access and advocacy and policy engagement.
The teams also carried out a desk review of relevant technical reports and studies and interviewed FO leaders and other key informants in the three countries.

## 3.2 Overview of findings

The FOs profiled in this study deliver a wide range of services and benefits to their members:

- 60% -agricultural extension and education
- 43% -market access and commercialisation activities
- 33% -provision of seeds and other farm inputs
- 32% -policy advocacy and engagement, though this tended to be limited to larger FOs (federations, cooperative unions, etc.)



The roles of farmer-led groups in Ethiopia, Kenya and Malawi are highly diverse and appear to be changing as a result of recent upheavals in the agricultural sector. In East and Southern Africa generally, governments have a history of encouraging farmers to assemble under a 'cooperative' banner. They still retain much of this heritage today, but they are also adjusting to profound shifts in the sector, such as the withdrawal of the state from service provision, economic liberalisation and widespread privatisation, increasing globalisation and integration, democratic reform processes, and the influence of international donors on national policy making.

**Table 8: Examples of Farmers Cooperative Unions**

| Name of Union | Profile | Critical elements of success |
|---|---|---|
| **Liben Farmers Cooperative Union, Ethiopia (LFCU-E)** | LFCU was formed in 2001 with support from the Oromiya Cooperatives Agency.<br>It has 21 member cooperatives in 4 districts serving 19,000 farmers<br>The GoE has shifted responsibility of importing fertiliser to unions and LFCU is one of the few that has taken up the challenge –recognised by other unions as the major player in input supply | An effective board that gives strategic direction –marketing focus<br>Professional management<br>Access to bank loans to bulk purchase inputs<br>Sells inputs at a reasonable profit margin –enough to cover costs |
| **National Association of Smallholder Farmers of Malawi (**NASFA-M) | NASFAM is a national farmer membership organisation that supports the formation and operation of 'farm clubs' to improve members' access to profitable farming opportunities. Formed in 1997 by 14 associations that emerged from a USAID programme. By2008 it had 37 associations (108,000 members) in 6,740 clubs | Works with motivated farmers who take farming as a business activity.<br>Professional management<br>Democratic governance from club level to national association<br>Participation of farmers in policy engagement and advocacy |

Many of the FOs have been evolving in a rather predictable way. Most continue to share a common heritage – the farmer-run cooperative – which has been a mainstay of government policy for many years, but they have adjusted as well to take on new responsibilities in terms of, for example, extension and input provision. Moreover, in the case of Malawi and to a lesser extent Kenya and Ethiopia, they are increasingly serving as key partners to the private sector, particularly in the production of high-value horticultural and commodity crops.

Our analysis also reveals how FOs have adjusted their roles over time, with some narrowing their focus to specialise in different sub-sectors, while others have broadened their scope to become 'multi-purpose' organisations. In some cases, they begin with a limited mandate – e.g. input access and provision – and progressively take on other activities and functions that serve the interests of either members or the wider community (e.g. agro-processing, transport, access to markets, land or water, etc.). In other instances, they start by undertaking a broad range of activities (aimed at filling the gap in availability of public goods) and narrow their field of activities gradually as the socio-economic and institutional environment improves.

Finally, the study highlights significant changes in the interface between government and farmers' organisations. In Ethiopia, for example, the *Dergue* considered cooperatives as a mechanism for 'rural transformation' in the 1970s and 80s.[4] Similarly, the Government of Kenya encouraged farmer cooperatives through the Cooperative Societies Ordinance in 1945 and the Swynnerton Plan in 1954, resulting in the substantial growth of these farmer groups. Malawi, too, had a history of farmer cooperatives, though the liberalisation of government services under Structural Adjustment eventually led to the collapse of the extension-based 'farmer club' system and a move toward commercialisation of farmers' organisations.

## 4. Current status of farmers' organisations

Ethiopia is the most centralised of the three study countries in terms of government administration. Thus, it remains true to a collective model of agriculture, operating in a legislative and regulatory environment that favours the farmer-run cooperative. Although professionals increasingly manage these FOs, national government still plays a major role in their operation and oversight. In contrast, a close connection between government and the cooperatives in Kenya meant that problems with central administration (e.g. interference, corruption, etc.) directly affected those organisations. Today, the cooperative model remains as Kenyan farmers continue to value group solidarity and collective self-help, but these organisations are also being transformed from public sector-oriented service providers to private sector enterprises with clear commercial leanings. The result in Kenya has been the proliferation of FOs with highly diverse, if not fragmented roles, many with a strong market orientation.

[4] The *Dergue* was a communist military junta that came to power in Ethiopia following the ousting of Haileselassie I. *Dergue*, which means "committee" or "council" in *Ge'ez*, is the short name of the Coordinating Committee of the Armed Forces, Police, and Territorial Army, a committee of military officers which ruled the country from 1974 until 1991.

Beginning as delivery mechanisms for government extension services, agricultural input credit and produce marketing, Malawi farmers organised activities around particular crops (e.g. tobacco, tea, milk). With a relaxation of government involvement and decisions to liberalise rights (freedom of association) there is a noticeable entrepreneurial spirit in Malawian FOs that is responding to emerging agricultural markets. This is particularly noticeable for cash crops like tobacco, paprika, dairy and tea – crops that tend to have closer ties to international markets.

In very general terms then, Ethiopian farmers remain faithfully cooperative, Kenya enjoys a blend of socially minded and enterprising FOs, and Malawi farmers are more connected to the agriculture value chain and operate, in some cases, as quasi-businesses. In each country, significant changes to FO roles in the past can suggest how these organisations will develop in the future. Though these organisations continue to change, their focus on agriculture policy, extension and partnerships for rural development remains a priority.

## 5. Challenges and opportunities for farmers' organisations

The roles of the FOs examined in all three countries have adapted to changing times. In a world increasingly dictated by the rules of globalisation and international value chains, competitiveness is not only a vital strategy it is *the* condition for survival. To confront this situation, smallholders have formed various types of producer organisations to better compete. These organisations have expanded rapidly in Ethiopia, Kenya and Malawi, and, broadly speaking, there are dispersed successes on three fronts: market access; service delivery (e.g. input supply, education and extension, etc.) and 'voice' (i.e. advocacy and policy engagement). However, the world of global market forces and dynamic economic, environmental and political change is creating new challenges and opportunities for their organisations, some of which we outline below.

**Table 2: Challenges and opportunities of farmer organisations**

| Challenges | Opportunities |
|---|---|
| • In a market-driven economy, farmer cooperatives must operate in a business-like fashion or perish;<br>• Government extension services are increasingly limited in scope, thus FOs will have to assume more of these responsibilities in the future;<br>• Market entry demands (e.g. grades and standards), access requirements (e.g. transportation and credit) and adding value to production (e.g. packaging, processing, and quality control) are still difficult for many under-resourced FOs to address; and<br>• Though autonomy for FOs is seen as a positive, it also means becoming more self-sufficient, often when funding is scarce. | • Providing extension services to farmers and organising the purchase of inputs and sale of products;<br>• Representing the interests and collective voice of farmers in key policy debates and processes;<br>• Providing primary production, processing and marketing of agricultural products, or related services;<br>• Introducing farmers to global value chains (now often dominated by large-scale producers) through contract farming arrangements;<br>• Offering extension solutions such as farmer-to-farmer training (e.g. Malawi's Contact Farmer System); and<br>• Possible new entry points for farmers to access markets (e.g. Ethiopia's Commodity Exchange). |

## 6. The seven habits of highly effective farmers' organisations

A key part of our analysis of the performance and effectiveness of farmers' organisations in Africa comes from two diverse sources. The first is the **International Co-operative Alliance**, an independent NGO which claims to unite, represent and serve cooperatives worldwide (ICA 2007). It encourages cooperatives to operate according to seven basic principles:

1. **Voluntary, Open Membership:** Open to all without gender, social, racial, political, or religious discrimination;
2. **Democratic Member Control:** One member, one vote;
3. **Member Economic Participation:** Members contribute equitably to, and democratically control, the capital of the cooperative. The economic benefits of a cooperative operation are returned to the members, reinvested in the co-op, or used to provide member services;
4. **Autonomy and Independence:** Cooperatives are autonomous, self-help organisations controlled by their members;
5. **Education, Training and Information:** Cooperatives provide education and training for members so they can contribute effectively to the development of

their cooperatives. They inform the general public about the nature and benefits of cooperation;

6. **Cooperation among Cooperatives:** Cooperatives serve their members most effectively and strengthen the cooperative movement by working together through local, regional, national and international structures; and
7. **Concern for the Community:** While focusing on member needs, cooperatives work for the sustainable development of their communities through policies accepted by their members.

The Ethiopian cooperatives were particular organised around these principles. Although the IAC focus is specifically on cooperatives, we think these principles offer important insights for all forms of membership organisations, including farmers' organisations.

The second point of reference is a more unlikely source **– *The Seven Habits of Highly Effective People***, a self-help book written by Stephen R. Covey (Covey 1999). In his book, Covey lists seven principles which he claims, if established as '*habits*' will help a person achieve true effectiveness. Covey argues this is achieved by aligning oneself to what he calls 'true north' principles of a character ethic that he believes to be universal and timeless.

Given these insights, we asked ourselves, "What would the 'seven habits' of a highly effective farmers' organisation look like?" Based on our analysis of FOs in Ethiopia, Kenya and Malawi, the table below outlines what we see as those essential **'**habits' and the critical components of each of them. It is by no means comprehensive, but does provide some insights into what could be described as the 'critical elements of success.

However effective and well governed a farmers' organisation may be internally in terms of adopting and applying these 'Seven Habits', it cannot successfully promote the interests of its members without an enabling legal, regulatory and policy environment that guarantees its autonomy. This requires changing the mindset of policy makers and staff in government departments, private companies and donor agencies about the role of FOs. Farmers' organisations must neither be seen as 'instruments' of either state policies designed and implemented without consulting them, nor as channels for implementing donors' or companies' agendas, rather they should be recognised as fully fledged actors and embraced as equal partners in the agricultural development process.

Public services must therefore also be made more demand-driven, with mechanisms that allow equitable negotiations between the farmer organisations and other actors,

as appears to be developing in Malawi and Kenya. Governments' interference in cooperatives management must be removed, as is slowly happening in Ethiopia, a difficult process that requires confronting powerful, vested individual and political interests. Hence, an effective use of farmers' organisations as part of a broader programme of agricultural modernisation and transformation requires a strong, proactive state setting the conditions for this to happen successfully and a supportive donor community willing to work with the state and the farmers.

## 7. Options for partnership strategies to support FOs

A key issue for FOs is how to respond to these and other new challenges and opportunities. For governments and donors it is how to assist these organisations without undermining their autonomy. Below we provide a several 'partnership strategies' for supporting FOs that are oriented towards the market, input access and delivery, extension and education, and policy and advocacy. These strategies are based on assessments of FOs and their interactions with external public and private actors in the three study countries.

**Partnership Strategy 1: *Market Oriented FOs* -** Support value-adding investments in well-managed cooperatives and farmers' organisations. Locate high-value market and staple market linkages for FOs, determine the requirements of these markets and then provide the necessary technical assistance to meet (or exceed) these requirements (e.g. training on compliance, investments in small processing plants, group certification, etc.). Possibilities include:

- Supporting development of systems to provide farmers with timely market information to reduce the price differentiation seen with graded produce;
- Encouraging FOs to take the lead role in finding markets and developing buyer relations and contracts that improve access to domestic and regional markets by supporting programmes to introduce grades and standards compliance;
- Assisting FOs and higher-level federations to develop capacities to lobby for market development policies as well as sensitise FO leaders and their members on how to improve market access from their own efforts.

**Table 3: The Seven Habits Of Highly Effective Farmers' Organisations**

| 'Habit' | Critical Elements |
|---|---|
| **1. Clarity of mission** | • The strategic objectives of the farmers' organisation will be clear and unambiguous.<br>• Its mission will be determined by its legal status and the needs and priorities of its members:<br>o A multi-purpose FO will respond to the diverse economic and social needs of its members, often in the absence of local government or effective public services<br>o A commodity-specific organisation will focus on economic services and defending their members' interests in a particular commodity sector, such as coffee, dairy or cotton<br>o An advocacy-focused FO, such as national farmers' unions or federation, will represent its members interests in key policy and programming arenas at different levels |
| **2. Sound governance** | • To assure democratic control of the organisation, there will be one member, one vote.<br>• The FO will have coherent and consistent rules to establish norms of behaviour by officials and members, with systems for monitoring and applying sanctions. These clear<br>• Clear rules will allocate costs and benefits to each member on the basis of her or his farming performance and market conditions; enforce agreements between the FO and the individual; and reduce the transaction costs of negotiating, monitoring and enforcing agreements between the organisation and its members.[32]<br>• Governance structures determining the relationship between voting rights or control, equity investment and use of FO services will match the critical resource and market opportunities and constraints facing the organisation.<br>• These will change over time as the FO matures and responds to new service demands and opportunities, but they are likely to have a strong business service focus and motivation for members, and solid structures to separate the FO from private business service operations. |

[32] This is particularly important for multi-purpose farmers' organisations, which typically operate in the context of rural communities (at local or regional level) where they are subject to the norms and values of social inclusion and solidarity (see 'Habit 4' below). This may clash with the requirements of professional, business-oriented organisations that must help members compete in the marketplace. In the name of inclusion, FOs often have difficulty excluding members who do not comply In the name of solidarity, they are pressed to cross-subsidise poorer performing members at the expense of better performers, thereby weakening rewards for efficiency and innovation. They are also frequently pressed to deliver public goods and services to the community, putting a strain on their resources.

| | |
|---|---|
| **3. Strong, responsive and accountable leadership** | • The FO will have strong leadership from professional staff, trustees and donors, which is responsive and effective, but not overbearing.<br>• The FO leadership will be encouraged within clear rules and leaders will have significant capacity in terms of business and governance skills and culture. FO is serving, which means women and minority groups will be included in positions of authority, not just as token representatives.<br>• Leaders will be representative of the FO's heterogeneous membership and therefore will include women, as well as men and smaller farmers, as well as larger ones<br>• There will be strong accountability of leaders to members for effective services and representation, with professional financial audit systems to monitor income and expenditure. |
| **4. Social inclusion and raising 'voice'** | • Exercising 'voice' is not merely to speak out, but to be heard and to make a real difference. The FO will create an enabling culture that encourages previously marginal groups and individuals – e.g. women, smallholders and young producers – to influence the strategic priorities and programmes of the organisation.<br>• Through these measures, the FO will ensure that the interests of its diverse membership are fairly represented and their needs adequately served. |
| **5. Demand-driven and focused service delivery** | • Fundamentally, the FO will provide services that deliver clear, continuing and valued benefits to its members.<br>• These services will not be accessible to members from other sources on similar terms, nor will the FO offer them to non-members on the same terms as to members.<br>• The FO will not try to provide too many services, nor services that are very demanding of technical, managerial or financial resources, otherwise there is a danger that it becomes over-extended and unable to sustain effective and timely services in a cost-effective manner.<br>• Services offered by the FO will, in some cases, increase over time, to reflect changing demands from members, changing capacity of the FO, and changing services offered by other organisations, but any expansion will be carefully phased, and will match existing capacity.<br>• Advocacy and policy engagement, which often does not provide direct benefits to members over non-members, will generally be a later and higher tier activity (probably limited to larger farmers' federations, cooperatives and unions). |
| **6. High technical and managerial capacity** | • The FO leaders and programme staff will have the technical knowledge and managerial capacity to deal with sophisticated challenges and opportunities as they arise.<br>• If their technical competence is limited, these staff will be able to identify appropriate government, NGO or private sector actors with the wherewithal to strengthen the capacity of their members on a variety of fronts, such as: technical aspects of production; input procurement and distribution; meeting phyto-sanitary standards; and engaging in policy analysis, dialogue and negotiations. |
| **7. Effective engagement with external actors** | • The farmers' organisation will have clear and enforceable rules separating political interests and external pressures from its leadership.<br>• Management will be strongly independent from government and donors, but maintain close cooperation with government and donors services and programmes at an operational level. |

**Partnership Strategy 2:** ***Input Oriented FOs -*** Locate FOs with successful initiatives but whose expansion is limited – i.e. have potential for up scaling.

- Work with public and private organisations to source critical inputs – seeds, fertilisers, etc. – needed by farmers and support schemes to source these important inputs;
- Provide seed capital for a farmer-based input credit system that is member-owned and managed to allow bulk purchase of inputs;
- Support participatory plant breeding programmes that link farmers' organisations and researchers to ensure development of new varieties to meet local needs;
- Formalise seed sharing networks and seed fairs, as well as formal distribution of seeds through agro-dealers, to allow farmers to obtain a diverse range of planting materials;
- Encourage savings and investment in input-related projects supported FOs. Currently, savings in many projects are often returned to the funder after the financial year. This encourages spending rather than thrift.

**Partnership Strategy 3:** ***Extension Oriented FOs -*** Promote a farmer-centered innovation process in agriculture that involves the analysis of local problems and opportunities, the articulation of demand, the development of an innovative solution and its testing and implementation in the field. Successful innovations may be disseminated, shared and 'scaled up' by involving a broad number of actors and 'scaled out' by implementing the innovation in a different context. By 'innovations' we mean processes that add value or solve problems faced by poor producers in new ways. These can take the form of technological, organisational or policy innovations and can be either endogenous or exogenous:

- Promote a systematic and structured approach to extension, one that involves scouting, documenting, analysing, adding value to and disseminating innovations and promising practices to foster innovation among FOs and their partners;
- Support exchange visits between farmer groups and research institutions, and between FOs from different countries/regions;
- Foster farmer-to-farmer extension programmes (e.g. farmer field schools, etc.) to create opportunities for mutual learning and knowledge sharing, and develop platforms for collective and joint researcher-farmer experimentation;
- Support public and private extension services to strengthen FOs and increase their knowledge of market dynamics in relation to changing prices, grades and standards;
- Encourage development of clear and accessible impact assessment approaches and tools, testing them in different contexts and mainstreaming them to improve 'downward accountability' in formal research and extension organisations to create more demand-responsive agricultural R&D systems.

**Partnership Strategy 4: *Policy and Advocacy Oriented FOs -*** Strengthen the capacity of those FOs that have the willingness and ability to represent and advocate for farmers. Provide the necessary technical assistance to engage with government policy makers. This requires funding a period of transition from government-led processes to farmer-led processes. Specific interventions may include:

- Focus on leadership development – including of women leaders – to strengthen FOs, including sensitising members to be more self-reliant rather than dependent on external parties to provide resources and build the capacity of farmer leaders with potential;
- Develop systems to provide up-to-date information to FOs to facilitate their participation in developing agriculture and rural development policies and preparing and implementing poverty reduction strategies;
- Second professional staff to the FO to improve advocacy and policy engagement activities;
- Provide training on strategic and operational planning and on evidence-based advocacy skills; and
- Encourage formation and strengthening of national, regional and international networks of farmers' organisations.

## 8. Conclusions

In conclusion, we argue that strengthening and empowering FOs in Africa will involve a significant amount of trail and error, as there is no fool-proof recipe for success. This will require a certain amount of 'learning by doing', taking risks, making mistakes and learning from both success and failure. Appropriate systems of tracking progress and documenting lessons – both within the farmers' organisations and their development partners – are therefore necessary and a phased programme of organisational development based on transparent and mutually agreed 'terms of engagement' and a clear delegation of roles and responsibilities are recommended.

A consistent lesson from all three country scoping studies is that capacity strengthening and organisational development of FOs is a slow and uneven process at best, regulated by complex and sometimes contradictory social behaviour, cultural norms and the broader policy environment. It would be natural to get impatient and try to force the process artificially, but this, we contend, is unlikely to lead to long-term, sustained success. Thus, above all else, we recommend patience and a willingness to experiment with various investment options and organisational forms before moving to scale up major initiatives with farmers' organisations across the African region.

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## Annex 1: Estimates for the graphs in the paper

| 1 Selected vulnerable groups in Ethiopia based on estimated population of 75,000,000 | |
|---|---|
| Children | 33.00 |
| Disabled | 7.50 |
| Elderly | 3.38 |
| Direct support | 1.00 |

**2 Options**

**2.1 Direct support**

| | | **1000000** | | |
|---|---|---|---|---|
| | 6 | 12 | 6 months | 12 months |
| 30 | 180 | 360 | | |
| 40 | 240 | 480 | | |
| 50 | 300 | 600 | | |

| **2.2 Social pension** | Poverty line | 30.50% | 480 | |
|---|---|---|---|---|
| | Poor only (population) | Universal (population) | Poor only (Birr) | Universal (Birr) |
| 60+ | 732000 | 2400000 | 351.4 | 1152.0 |
| 70+ | 503250 | 1650000 | 241.6 | 792 |
| | 1235250 | 4050000 | 592.92 | 1944 |

**2.3 Child support**

| Age | Poor only | Universal | % of pop |
|---|---|---|---|
| 0-5 | 3865875 | 12675000 | 16.90% |
| 0-10 | 7365750 | 24150000 | 32.20% |
| 0-15 | 10453875 | 34275000 | 45.70% |
| | Birr | Birr | |
| 0-5 | 1856 | 6084 | |
| 0-10 | 3536 | 11592 | |
| 0-15 | 5018 | 16452 | |

# POLICY AND INSTITUTIONAL ANALYSIS OF SMALLHOLDER INDIGENOUS CATTLE PRODUCTION IN DANO DISTRICT OF WESTERN SHOWA, ETHIOPIA

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*Abstract*

*Livestock play an important role and has major contribution of agricultural GDP in some sub-Saharan Africa countries in general and in Ethiopia in particular. Ethiopia has the largest livestock resource than any other African country. Much of the livestock production in the country relies on indigenous animal genetic resources. However, much has not been done in terms of their improvement so that these traditional practices are threatened by pressure of economic development. Besides, these unique resources are believed to be at risk of loss due to genetic erosion. The main objective of this study is to analyze the existing policy and institutional environment in order to identify polices that enhance improved and sustainable use of indigenous breeds/strains, and to identify immediate strategic options to address current constraints/threats. The study was conducted in Dano district of Western Showa. A total of 150 farmers were interviewed in the study area between December 2006 and January 2007 to generate primary data for the study. Policy Analysis Matrix (PAM) and descriptive statistics were employed to analyze the data. Sensitivity analysis with various scenarios was also done to assess the effect of the different strategies on poor livestock-keepers. The study results indicate that both private (financial) and social (economic) profits of the existing production system were positive; implying that indigenous cattle production in Dano district was profitable for producers as well as for the country at large. In this study, possible policy implications were made in order to improve conservation, management and sustainable use of indigenous animal genetic resources.*

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## 1. Introduction

Livestock play an important role in Africa and contribute on average from 35 to 80 percent of agricultural GDP in some sub-Saharan Africa countries. It is also estimated that more than 70 percent of the rural poor depend on livestock as a component of their livelihoods (FAO, 2000). Around three-fourth of livestock in developing countries, including Sub-Saharan African (SSA), are under the custody of smallholder farmers. In Ethiopia like other SSA countries, livestock sector is very important. This sector function ranges from traction to cash generation for various purposes of livelihoods of the poor-livestock keepers (Delgado *et al.* 1999) and contribute about 30 to 35 percent of agricultural gross domestic product (GDP) and more than 85 percent of farm cash income. As a matter of facts, this sub sector contributes about 13 to16 percent of total GDP (Benin *et al*., 2002). The share of livestock in total export averaged 16 percent in the period between 1987 to 1988 and 1995 to 1996 (Befekadu and Birhanu, 2000).

Above all, Ethiopia has the largest livestock resource than any other African country. It has an estimated 42 million cattle, 15 million sheep, 14 million goats, and 7 million pack animals, which exists in private holdings (CSA, 2004). Although Ethiopia has the largest livestock population in Africa, performance in the production of the major food commodities of livestock origin has been poor compared with other African countries. Inadequate feed and nutrition, widespread disease and poor health, poor breeding stock, and inadequate livestock polices with respect to credit, extension, marketing and infrastructure have been cited as major constraints that affected livestock performance in Ethiopia (Befekadu and Birhanu, 2000). The policy and institutional issues are related to absence of appropriate policies and institution for conservation, management and sustainable use of animal genetic resources. The crucial reasons for failure to effectively use and conserve animal genetic resources in developing countries are, firstly lack of knowledge by policy makers regarding the important contribution of animal genetic resource to the livelihood of the poor, secondly ineffective institutional arrangement to enable livestock-keepers to manage these resources and finally lack of policies and incentives supporting their use and conservation.

Policy and institutional decision-makers frequently make development decisions based upon simple calculations of the monetary pros and cons of economic activities. But the importance of policy aspects of the livestock sector and sustainable use of animal genetic resource has traditionally been undervalued in the calculations of economic activity. The policy and institutional aspect of the livestock sub-sector is seen to be so important for the success of rural development program and hence to

increase the livelihoods of the poor livestock-keepers. The policy and institutional aspects of the livestock genetic resources cannot be separated from meat and milk aspect of livestock and crop sub-sector polices. With this background and justification, this study was proposed to assess identification of opportunities for the poor livestock-keepers through providing information on policy and institutional issues to fill the existing knowledge gap. Policy makers, researchers, extension agents, NGOs and others could use the information generated from this research. This study was undertaken in the Dano district of National Regional State of Oromia, Ethiopia, which is located about 240 km away from Addis Ababa.

1.1 Scope of the Study: This study was proposed to assess identification of opportunities for the poor indigenous livestock-keepers through providing information on policy and institutional issues to fill the existing knowledge gap. In other words, in order to improve the livelihoods of poor livestock keepers, it is significant to improving the performance of the livestock sector in Ethiopia. In line with this, the International Livestock Research Institute (ILRI) has been implementing a project called “Improving the livelihood of poor livestock keepers in Africa through community based management of farm animal genetic resource" since 2004 in Danno district of Oromia Region, Ethiopia. The goal of the project was to improve livelihoods of poor indigenous livestock-keepers through the conservation and sustainable use of indigenous animal genetic resources (ILRI, 2004). An important component of the project was analyzing the current policy framework and institutional setups of the nation and identification of policy options to come up with mechanisms for conservation and sustainable use of indigenous animal genetic resources. In other words, the study was not aimed to compare and contrast between improver and indigenous cattle breeds. Besides, this study also found out that no farmer kept improved/imported high cattle breeds in Danno district during the survey period. Thus, the study aimed just to show the advantage of keeping indigenous cattle so that all relevant stakeholders could improve the livelihood of poor livestock keepers in Ethiopia through community based management of farm animal genetic resources.

1.2 Limitation of the Study: The study would assess the policy and institutional analysis of smallholder indigenous cattle production in Western Ethiopia. However, due to time and resource limitation it covered only Danno district of Oromia Regional State. In this study household level data on demographic, socio-economic, policy and institutions was collected. Besides, due to time and resource constraints the sample size was also limited to 150 respondents.

## 2. Objective

The general objective of the study was to analyze the existing policy and institutional environment in order to identify polices that enhance improved and sustainable use of indigenous breeds/strains. The specific objectives were to analyze the existing policy environment and institutional setups in relation to indigenous cattle production and to develop policy alternatives for sustainable use of animal genetic resource. Besides, it was as well designed to describe the indigenous cattle production system and identify challenges and opportunities in the study area.

## 3. Methodology

### 3.1 Sampling technique

A multi-stage sampling technique was used to select the sample farmers. In the first stage, Dano district was selected purposively for its remoteness and indigenous livestock population. In the second stage, five peasant associations (PAs) were selected using random sampling procedure. In the third stage, the sample farmers were selected from each PA based on the sampling frame using systematic random sampling procedure. The list of the farmers was obtained from the development agents and/or offices of peasant associations and a total of 150 farmers were selected.

### 3.2 Data collection

Data were collected from primary and secondary sources. The secondary sources of data included published and unpublished documents in libraries, electronic library and internet, and regional, zonal and district offices of agriculture. Primary data were collected from sampled farmers using structured questionnaire. Before starting the actual data collection, the questionnaire was pre-tested to modify some of the questions that were either irrelevant to the existing situation or out of context. Six experienced enumerators were hired to administer the questionnaire. The enumerators were trained on the content of the questionnaire, methods of data collection and on how to approach farmers in collaboration with Bako Agricultural Research Center. The data collection was done between December 2006 and January 2007.

## 3.3 Analytical procedure

For this study policy analysis matrix (PAM) and descriptive statistics were applied. Furthermore, sensitivity analysis with various scenarios was done to assess the effect of the different strategies on poor livestock-keepers.

### 3.3.1 Policy analysis matrix

The policy analysis matrix is a product of two accounting identities, defining profitability as the difference between revenues and costs and the other measuring the effects of divergences (distorting policies and market failures) as the difference between observed parameters and parameters that would exist if the divergences were removed. By filling in the elements of the PAM for an agricultural system, an analyst can measure both the extent of transfers occasioned by the set of policies acting on the system and the inherent economic efficiency of the system (Monke and Pearson, 1989).

**Private profitability:** In an empirical policy analysis matrix, the revenue and cost categories in private prices (entries A, B, and C in Table 1) are based on the data from livestock budgets. The symbol D, profits in private prices, was found by applying the profitability identity. According to the accounting principle, D was identically equal to A- (B+C) (see Table 1).

**Social profitability:** In Table 1, E measures revenue in social prices, F stands for tradable input costs in social prices, G represents domestic factor costs in social prices, and H is social profit. Countries can achieve rapid economic growth by promoting activities that generate high social profits (large positive H). The revenue and cost categories in social prices (entries E, F and G) were based on estimates of the social opportunity costs of commodities produced and inputs used in production. These estimated social (or efficiency) prices then were applied to the original quantities of outputs and inputs (those used in the calculation of private profits in the top row of PAM). The calculation of social profits, from estimates of social prices applied input-output data in farm and processing budgets, measured the efficiency of agricultural systems. A second key result of agricultural policy thus was obtained from the second row of the PAM.

**Table 1: Policy Analysis Matrix**

| Particulars | Revenues | Costs | | Profits |
|---|---|---|---|---|
| | | Input | Domestic factor | |
| Privet Profits | A | B | C | D[1] |
| Social Profits | E | F | G | H[2] |
| Effects of Divergences | I[3] | J[4] | K[5] | L[6] |

Source: Monk and Pearson (1989)

[1] Private Profit (D) = A - (B + C)
[2] Social profit (H) = E - (F + G)
[3] Output transfer (I) = A – E
[4] Tradable input transfer (J) = B - F
[5] Domestic factor transfer (K) = C – G
[6] Net transfer (L) = D - H = I - (J+ K)

The detailed formulas of the matrix components are (Nguyen, 2002; Nguyen and Heidhues, 2004):

$$A = \sum_{c=1}^{k} P_c T_C \qquad B = \sum_{i=1}^{n} P_i Q_i \qquad C = \sum_{j=1}^{m} W_j L_j$$

$$E = \sum_{c=1}^{k} P_c(s) T_c \qquad F = \sum_{i=1}^{n} P_i(s) Q_i \qquad G = \sum_{j=1}^{m} W_j(s) L_j$$

Where: $P_i$, and $P_i(s)$: are prices of tradable input 'i' measured in private and social prices, respectively. $w_j$, and $w_j(s)$: are prices of domestic factors "j" measured in private and social prices, respectively. $P_c$ and $P_c$ (s): are prices of product 'c' measured in private and social Prices, respectively. $T_c$: is quantity of product 'c' produced per unit of observation (for example, per hectare). $Q_i$, $L_j$: is quantity of tradable input 'i' and domestic factor 'j' used in production, respectively. k, n, and m: are number of outputs, tradable and domestic inputs used in the production system, respectively.

**Policy Divergence:** In empirical PAM analysis, the effects of divergence (in the third, bottom row) are found by applying the divergence identity. All entries in the PAM under the third row (defined as Effect of Divergences) were identically equal to the difference between entries in the first row (measured in social prices). Thus, I was identically equal to (A-E), J was identically equal to (B-F), K was identically equal to (C-G), and L was identically equal to (D-H). An important contribution of the PAM was the ability to disaggregate the divergences to identify the specific impact on each policy interventions or market failure (Pearson *et al*., 2003).

**Policy analysis for livestock producers using PAM:** The policy analysis matrix could be used for any production activity for which it was possible to value input and output of production. The PAM followed a commodity approach. It could be constructed for alternative technologies at each level of activity. This method allowed an insight for the impact of policy changes for entire commodity system. Policy effects on cattle producers appeared as the difference between the price of a particular product or input valued at market price and at social prices.

**Comparisons of change of polices:** Comparison of different policy scenarios were also possible through a further extension of PAM. A number of ratios could be produced from PAM that indicated the effect of a policy scenario. The resulting ratios could be used to see the difference between different commodity systems when there are varieties of policy scenarios.

**Table 2: Selected policy distortion indicators**

| No | Ratios | Descriptions of ratios | Formula derived from PAM |
|---|---|---|---|
| 1 | NPCO | Nominal protection coefficient of output | A/E |
| 2 | NPCI | Nominal protection coefficient of input | B/F |
| 3 | PCR | Private cost ratio | C/(A-B) |
| 4 | DRC | Domestic resource cost coefficient | G/(E-F) |
| 5 | EPC | Effective protection coefficient | (A-B)/(E-F) |
| 6 | PC | Profitability coefficient | D/H |

The nominal protection coefficient on tradable outputs (NPCO) and inputs (NPCI) serve as an alternative to I and J in the previous table respectively. The ratios express the divergence between the market price and the input price (free of any distortion).

$$NPCO = \frac{A}{E} = \frac{\sum_{c=1}^{k} P_c T_c}{\sum_{c=1}^{k} P_c(s) T_c} \qquad NPCI = \frac{B}{F} = \frac{\sum_{i=1}^{n} P_i Q_i}{\sum_{i=1}^{n} P_i(s) Q_i}$$

Private cost ratio (PCR) is the domestic resources required to produce a unit of value added. The ratio indicates the comparative advantage of the farming system and its private profitability. Excess profit, those in excess of normal returns to domestic resources, is indicated by PCR less than 1.

$$PCR = \frac{\sum_{j=1}^{m} W_j L_j}{\sum_{c=1}^{k} P_c T_c - \sum_{i=1}^{n} P_i Q_i}$$

Domestic resource cost coefficient (DRC) is social return to domestic resources. It indicates whether the factors are utilized efficiently.

$$DRC = \frac{G}{E-F} = \frac{\sum_{j=1}^{m} W_j(s) L_j}{\sum_{c=1}^{k} P_c(s) T_c - \sum_{i=1}^{n} P_i(s) Q_i}$$

Effective protection coefficient (EPC) is the ratio of value added in market price to social prices. This ratio compares comparative advantage of the commodity in the given farming system over one another.

$$EPC = \frac{A-B}{E-F} = \frac{\sum_{c=1}^{k} P_c T_c - \sum_{i=1}^{n} P_i Q_i}{\sum_{c=1}^{k} P_c(s) T_c - \sum_{i=1}^{n} P_i(s) Q_i}$$

Profitability coefficient (PC) is an alternative to L and shows the extent to which private profit exceeds social profit. $PC = \frac{D}{H}$

## 4. Results and discussion

### 4.1 Estimation of shadow exchange rate

The shadow exchange rate (SER), which is the rate that would have prevailed in the absence of any trade intervention (Harrigan *et al.*, 1992 cited in Fresenbet, 2005; Gonzalese, 1993; Shahabuddin, 2000), is defined as the weighted average of the demand price for foreign exchange paid by importers and the supply price of foreign exchange received by exporters (Lagman-Martin, 2004). It reflects the consumption worth of an extra unit of foreign exchange in terms of the domestic currency (Burnt, 1998 cited in Nguyen, 2002). According to Tallec and Bockel (2005), Shadow prices are the values, which replace market prices in theoretical calculations when it is felt that market prices do not represent the true economic value of that good or service.

The shadow exchange rate, therefore, can be considered as the opportunity cost of foreign exchange.

Based on the method adopted by Gittinger (1982) and Tallec and Bockel (2005) the formula used to calculate shadow exchange rate (SER) could be given by: $SER = \frac{OER}{SCF}$ Where: SER is shadow exchange rate,
OER is official exchange rate and SCF is standard conversion factor.

Following the methodology suggested by African development Bank (ADB's) guide line for economic analysis of projects (Lagman-Martin, 2004) and also used by Selvaraj *et al.* (1999), Tallec and Bockel (2005) and Fresenbet (2005) with the assumption that the distortions in the domestic market prices are entirely due to tariffs imposed on tradable commodities, the crude approximation of standard conversion factor (SCF) is calculated using the following formula.

$$SCF = \frac{X + M}{(X - t_x) + (M + t_m)}$$

Where: X is the total export value of commodities, M is the total import values of commodities, $t_x$ is total tax on exports and $t_m$ is total tax on imports.

The data used for estimation of SCF, in this study, were obtained from National Bank of Ethiopia (NBE) annual report (2004/05) in which the total export and imports are valued at their world or F.O.B and C.I.F prices, respectively, whereas the denominator, import and export taxes are valued at their market prices. However, since proclamation No. 38/1993 and No. 287/2002 canceled all export taxes, the total tax on exports, ($t_x$), is taken as zero. Using the above information, SCF is estimated as:

$$SCF = \frac{1000.3 + 4383.4}{(1000.3 - 0) + (4383.4 + 579.03)} = 0.902$$

Taking into consideration the fact that there are different OER values, which is determined based on weekly auctions between banks, the OER selected for estimation of SER was the annual average rate of 2005/06 reported by NBE. Therefore, the rate used was ETB/US$ 8.68. The shadow exchange rate (SER) was then estimated as:

$$SER = \frac{OER}{SCF} = \frac{8.68}{0.902} = 9.62\,ETB/US\$$$

## 4.2 Decomposition of input costs

This study found out that no farmer, in the study area, kept improved cattle variety and they were not using any imported inputs for their cattle production. Hence, cattle keepers in Dano district used inputs under domestic input components. According to Monk and Pearson (1989), who suggested that decomposing all input costs is a tiresome task that can absorb substantial resources and has only a very insignificant effect on the results, however, some inputs such as land, labour and farm capitals, which are also important input components in cattle production, are assumed to be pure non-tradable cost items. Moreover, according to Lapar *et al*. (2002), in addition to the above domestic factors, other inputs, used in the production activities, which are domestically produced and are not available in the international market, such as manure, crop residue, and grazing, are also treated as pure non-tradable cost items. Moreover, the opportunity cost of manure was computed based on Tesfaye (2002), which reports that on average a single cattle could gave 1.8 kg (2.1 in dry season and 1.5 in wet season dry matter daily feces) of feces per day in Western Showa, Ethiopia.

## 4.3 Social valuation of tradable and non-tradable goods

Social valuation, of outputs and inputs, is a major segment in the building process of the PAM, which is referred to us efficiency or shadow price of commodities. To drive the social prices of tradable inputs and outputs the comparable world prices, C.I.F and F.O.B, are used as a starting point. It is because that the world prices represent the government's choice to permit consumers and producers to import, export or produce goods domestically (Monk and Pearson, 1989, Samarendu *et al.,* 2003 and Jamie and Kelvin, 2002). These border prices were then converted into local currency using shadow exchange rate instead of official exchange rate. The prices were then adjusted by their transportation, handling and other marketing costs to get the import (or export) parity prices at the farm get. The social prices of domestic factors were estimated at their opportunity costs. These principles were also applied for decomposed input cost items and then aggregated to form the social prices of intermediate inputs used (see Appendix Table 2).

### 4.3.1 Export parity price of outputs

In order to derive export parity prices of cattle, which are usually exported in live form, at farm gate was calculated using their border (F.O.B) prices as a starting point. All the costs such as transporting, handling and other marketing costs involved in the process of delivering these outputs were deducted back on the move from the port to the farm gate in Dano district of Western Showa Zone. Following Nguyen (2002), some cost items including Albendazol and butter packaging local materials costs were considered as domestic cost items and thus treated like pure non-tradable items and their social costs were assumed to be the same as their private values. In addition, storage, local churning devise (Ro'oo), cleaning, rope, overhead costs and other miscellaneous expenses also considered as being in the same category.

The social prices of transportation costs of live cattle from Dano to Djibouti port, interest paid for borrowed capital, the labour costs of loading and unloading, and transporting outputs from the farm to the market were estimated using standard conversion factors prepared by Ministry of Economic Development and Cooperation (MEDaC) (1998). The calculation result of export parity price of live cattle in Dano district is shown below in Table 3.

**Table 3: Export parity price of live cattle per average cattle TLU**

| | Description | Private price | Social price |
|---|---|---|---|
| 1 | Exchange rate (ETB/$) | 8.68 | 9.62 |
| 2 | F.O.B ($/head) | 574 | 574 |
| 3 | F.O.B (ETB/head) | 4982.32 | 5521.88 |
| 4 | Port charge | 156.24 | 170.99 |
| 5 | Transportation | 154.16 | 140.75 |
| 6 | Feed | 100 | 100 |
| 7 | Loading and unloading | 50 | 50 |
| 8 | Overhead | 50 | 50 |
| 9 | Interest | 92.67 | 92.67 |
| 10 | Other expenses (Tax and fees at different market) | 192 | 192 |
| 11 | Margin | 2521.29 | 2521.29 |
| 12 | Transport to the farm | 78.32 | 57.17 |
| 13 | Farm gate price (ETB per head) | 1587.64 | 2147.01 |
| 14 | Farm gate price (ETB per average cattle TLU) | 8573.26 | 11593.85 |

Source: Computed figures

### 4.3.2 Social prices of pure domestic resources

In most cases land, labour and domestic capital are pure domestic factors that are used in cattle production of rain fed mixed crop-livestock production system areas of Ethiopia in general and Dano district in particular. Social price of land in principle is determined, within that particular sector of the economy by taking the highest net return to land of its competitive crops (Yao, 1997 and Otto *et al,* 2007). However, complete specialization in most profitable commodity in Ethiopia in general and Dano district in particular is rarely observed, which is also indicated in Monk and Pearson (1989). Instead, farmers prefer crop rotation to reduce risk of income loss from price variability, yield loss and pest and disease infestation. Therefore, the true reflection of social price of land with the method of best alternative crop could not be estimated.

Alternatively, there could be a different way of measuring opportunity cost of land. According to Ortmann (1987), Nguyen and Heidhues (2004) and Fresenbet (2005) assuming that the market rent is competitive, market price fully reflect social scarcities and individuals are free to trade contractual agreements on land use. Moreover, state laws protect such voluntary contract and the private market rent for land then can be considered as a proxy measure of the opportunity cost of land. The state rent for land (the ostensible land use fee and agricultural income tax), which is standardized based on land holdings of the household (DBOA, 2005/06). However, the amount of this rent always been much lower than the real market land rental values and does not reflect the opportunity cost of using the land. In fact, some farmers in the study area rented out their land for grazing or others to grow agricultural products in exchange for receiving part of the harvest (in kind) or money. For that reason, the average value of formal and informal rent for land considered as a good proxy for measuring the opportunity cost of land used in the study.

The social value of labour and borrowed capital used in cattle production were estimated based on the conversion factors previously prepared for Ethiopia by the former MEDaC. However, since there was no conversion factor available to calculate, as Fresenbet (2005) pointed out, the social values for animal power, farm tools depreciation and manure, their corresponding private value was assumed to be the same as their social value.

## 4.4 Profitability of cattle production

The revenue and cost categories in private price were constructed based on average farm budgets combined with input disaggregating table. The farm budgets were established using the average farm inputs and outputs data collected from farmers at household level, and the market prices of inputs and outputs that were also crosschecked with traders at the nearest town, Bako and the district agricultural and rural development office.

The amount of particular inputs or outputs associated with the farm activity must be consistent with the choice of farm-level numeraire, usually a unit of area (acre or hectare) and/or a specified herd size for animal production systems. All information must be converted into a common numeraire and a common time frame (Monk and Pearson, 1989). Based on Perdana (2003), who suggested and applied, the first step in the PAM analysis of cattle production was to construct an input-output table showing the physical inputs that were required to produce a unit of output. In this study, average cattle TLU (i.e 5.4 cattle), was used as a common size of numeraire.

The information extracted from the system budget table, which gathers all the non-tradable input cost components for both private and social values, was again used in formulating the PAM. The system budget table constructed for cattle production is presented in Table 4 (private/social). Moreover, Private and social prices were then used to construct budgets that showed private and social profits.

**Table 4: The system budget table of cattle production (ETB per average cattle TLU)**

| Item | Private Price | Social price |
|---|---|---|
| **Revenue** | | |
| Main product | | |
| Cattle | 8573.26 | 11593.85 |
| Butter | 186.74 | 186.74 |
| Milk | 935.38 | 935.38 |
| Cheese | 66 | 66 |
| Draft animal | 2374.3 | 2374.3 |
| Byproduct | | |
| Manure | 709.56 | 709.56 |
| **Total revenue** | **12845.24** | **15865.83** |
| **Domestic Costs** | | |
| Animal feed | 2679.048 | 2679.048 |
| Farm tools | 182.86 | 182.86 |
| Storage | 78.8 | 78.8 |
| Shelter for cattle | 344 | 344 |
| Milk processing | 49.79 | 49.79 |
| Interest | 92.67 | 92.67 |
| Medication | 269.37 | 269.37 |
| Other expenses | 40.22 | 40.22 |
| Labour | | |
| Family | 2800.12 | 1400.06 |
| Hired | 300 | 150 |
| Land | 90 | 450 |
| **Total domestic cost** | **6926.878** | **5736.818** |

Source: computed data.

Given inputs and outputs along with their associated prices, technologies used, existing government policies and market imperfections, both the private and the social profits were significantly positive (Table 5). This result indicated that indigenous cattle production in the study area as well as in the country was profitable for producers. Besides, in this analysis, the social profitability of local cattle production was by far larger than private profit, implying that the net effect of policies and market factors influencing the output and input markets were imposing an implicit tax or any other elements of disincentive. In other words, the net effect of distorting policies occurred mainly due to the overvalued exchange rate and market failures due to lack of appropriate cattle production policy, undeveloped marketing infrastructures and institutions of the district and some other externalities, which made the market prices paid to the farmer were less than their social value or opportunity cost.

The profit divergences -4220.1 ETB per average cattle (in TLU) for cattle production shows that the profit per average cattle (in TLU) from these products should be increased by that figure.

**Table 5: PAM for indigenous cattle production (ETB/ average cattle TLU*)**

| Peculiarities | Revenue | Costs | | Profit |
|---|---|---|---|---|
| | | Tradable inputs | Domestic factors | |
| Private price | 12845.236 | 0 | 6926.878 | 5918.4 |
| Social price | 15875.31836 | 0 | 5736.818 | 10139 |
| Divergence | -3030.082364 | 0 | 1190.06 | -4220.1 |

Source: computed PAM results

*PAM for indigenous cattle production (ETB/ cattle TLU) is presented in Appendix Table 1.

The absence of appropriate policy, the existence of market failure, absence or inefficiencies of institution for conservation, management and sustainable use of animal genetic resources expected as a reason for the divergence between the private and social valuations of revenue, costs and profits. According to Monk and Pearson (1989), distorting or lack of policies on a specific sector of an economy refer to policies that lead to inefficient use of resources and often are introduced by decision makers who are willing to accept some inefficiencies (and thus lower total income) in order to pursue other non efficiency objectives, such as the redistribution of income or the improvement of domestic food security. Market failures are also common phenomena whenever the system is characterized by inadequate development of institutions to provide competitive service and full information and by existence of externalities (Ayalneh, 2002). Such divergences can be interpreted as transfers between groups within the society that tend to affect the competitiveness of

the commodity systems (Seini, 2004). The analysis of PAM also showed the levels of efficiency (social profitability, or H) of cattle production sub-system in the study area.

As indicated in Table 5, the output transfers of the cattle production were negative, which indicates the effect of policies and market imperfection that forced farmers to obtain less price for their products than the price prevailing in the world market. That means farmers were paying implicit tax on their respective outputs. The amount also represents saving to society and can be interpreted as transfer from farmers producing cattle to the society.

The non-tradable input transfers were positive implying that the opportunity costs (the cost to the society) of using domestic resources, mainly unskilled labour were lower than their private values. In other words, the local cattle producers were implicitly taxed for the use of domestic resources.

As Monk and Pearson (1989) indicated, the net transfer (L) is the sum of all divergences that cause private profits to differ from social profits. In this analysis, indigenous cattle production sub system, all of the transfers were the result of distorting policy, not of market failures. All three categories of policy transfers had a negative effect and this indicating that the government was not providing support/emphases to indigenous cattle production sub system in the study area.

The subsidy ratio to producers is SRP = L / E, the ratio of the net transfer to the social value of revenues. The purpose of this indicator is to show the level of transfers from divergences as a proportion of the undistorted value of the system revenues. If market failures are not an important component of the divergences, the SRP shows the extent to which a system's revenues have been increased or decreased because of policy (Monk and Pearson, 1989). In this study, the SRP was -0.27. This result implied that divergences due to distorting policies decreased the gross revenues of the system by around one-third. In other words, it indicated that the system was receiving about 27.4 percent disincentive from all the effects of divergences.

## 4.5 Policy indicators

There are policy indicators associated with the PAM such as the nominal protection coefficient on output (NPCO), Nominal protection coefficient of input (NPI), Private cost ratio (PCR), the domestic resource cost (DRC), the effective protection coefficient (EPC), and Profitability coefficient (PC) ratios were derived in this study directly by employing the formulas presented in Section 3.3.

As indicated by Monk and Pearson (1989), as a practical matter, therefore, in most contexts the measured effects of divergences in output markets are attributed solely to distorting policy. The nominal protection coefficient on output (NPC) of cattle production, (see Table 6), was below one. This implied that the net effect of government policy intervention and market distortion not corrected via efficient cattle product marketing policies. This condition, therefore, reduced market prices or private revenue, making private price lower than the world prices or social revenue. Hence, due to the reduction in revenue made farmers implicitly taxed about by an amount of 19.1 percent of their produce.

On the other hand, the nominal protection coefficient for tradable inputs (NPI) was zero. This indicated that there was not any government policy intervention and institution, thus it should be corrected via efficient cattle production input policy and institutions. Hence, in the absence of tradable inputs, this ratio implied that farmers needed to receive an implicit subsidy or an equivalent effect of a price support about 100 percent for cattle production. In other words, in the production of indigenous cattle breeds, the cost of tradable inputs was zero percent of what would have been at world prices for cattle produce.

The desirability of production of indigenous cattle under consideration relative to the international market in terms of economic efficiency was evaluated by domestic resource cost (DRC) coefficient. In this analysis, the DRC coefficient was less than one, which implied the country has comparative advantage in conservation and sustainable use of indigenous animal genetic resources in the study area. Furthermore, the social net values added were greater than the social cost of their domestic production factors and relatively low DRC value reveals a relatively high comparative advantage. For that reason, it is socially desirable to strengthening and expanding the conservation and sustainable use of indigenous cattle production which has DRC ratio of 0.362 at a given current production technology, input and output prices. This DRC ratio also implied that cattle production could be economically worth wile to investor in the study area.

The effective protection coefficient (EPC), which measures the degree of policy transfer from the tradable commodities markets, were less than one for cattle production. Moreover, this ratio equal to NPCO due to the absence of tradable input markets indicated that the overall impacts of the existing policies influencing only the output (supply side) market. Thereby, it cause a net disincentive that allow indigenous cattle production to have a value added in private price of 19.1 percent lower than the value added without policy transfers as measured in world price. In other words, indigenes cattle keepers were implicitly taxed more for their output rather than delivered and subsidized tradable inputs.

**Table 6: Summary of Policy Analysis Matrix (PAM) indicators**

| Indicators | Amount |
|---|---|
| NPCO | 0.809 |
| NPCI | 0 |
| PCR | 0.540 |
| DRC | 0.360 |
| EPC | 0.809 |
| SRP | -0.274 |
| PC | 0.580 |

Source: Computed from the PAM's results

## 4.6 Sensitivity analysis

Even though one of the basic assumptions underlying PAM is the use of fixed input-output coefficients in the analysis, these parameters are subjected to change due to different reasons. Therefore, it should be essential to undertake primary analysis in order to provide policy makers with sufficient information about the full range of potential outcomes. In other words, additional information is needed to provide policy makers to have a more comprehensive view of the potential impacts of policy alternatives and these concerns could be addressed through sensitivity/scenario analysis.

An entire sensitivity analysis such as change in exchange rate, yield, transportation, domestic and international prices of outputs and tradable inputs, credit, etc. give more indicative results of profitability, competitiveness and policy alternative analysis. However, it is difficult to handle and is usually avoided in most applied economic analysis (Ayalneh, 2002). Hence, it needs to make boundary for the sensitivity analysis to specific input parameters. Following Ayalneh (2002), partial sensitivity analysis approach was employed in this analysis.

The changes in the PAM indicators were estimated at the same time as varying a single input parameter by leaving the other input parameters at their base values. On this study, a sensitivity of PAM indicators for the change in shadow exchange rate, world price of outputs (cattle), occurrence of tradable input, subsidy, cattle yield and production cost of domestic inputs were investigated.

## 4.7 Scenario I: Change in shadow exchange rate

Exchange rate is one of the macro-economic problems that can only be handled by a central authority and never the concern of private sectors. According to ILRI (2004), exchange rate is a key variable for cattle pricing policies and affects all the PAM indicators of cattle production sub-sector (see Table 7). This is due to the fact that change in the exchange rate will be resulted in change in SER and it again will affect the output price as well as prices of importable inputs in terms of local currency.

In this scenario, assuming other things remain constant, the impact of change in the shadow exchange rate on the protection level and comparative advantage coefficients of indigenous cattle production were investigated. To make comparison with the current situation/ baseline result, two simulations were undertaken with 20 percent increase and decrease in shadow exchange rate. For instance, 20 percent increase in shadow exchange rate results decrease in NPC from 0.809 to 0.588 (27.3 percent). In other words, as the ETB value is more socially depreciated, smallholder indigenous cattle producers would be more implicitly taxed on their outputs. On the contrary, as the SER decreases by 20 percent, the result indicated that this policy has permitted or caused the private price to be 29.7 percent higher than they would have been if world price had been allowed to set domestic price. In other words, if the SER reduced by 20 percent, then the implicit taxes of 19.1 percent, in the baseline scenario, removed and the government subsidized indigenous cattle production by 29.7 percent. The result revealed that as the SER decreases and approach to the OER, farmers of indigenous cattle producers would be benefited from reduction of implicit taxes charged on their products. However, in the case of NPI, the value remains zero because there are no any tradable inputs for indigenous cattle producer system. The result also suggested that government should supply and subsidized cattle production inputs in relation to feed and health service for indigenous cattle keepers.

As to the EPC figure, which revealed in Table 7, taking into account both the output and input markets; farmers producing indigenous cattle were implicitly taxed in the simulations. Moreover, as SER increases the EPC of cattle production decreases or farmers would be implicitly more taxed on their production. In other words, a 20 percent increase in SER resulted in reduction in the EPC of indigenous cattle production by 27.3 percent and so the net implicit subsidy reduced and turned out to be an implicit tax of about 41.2 percent. In contrast, EPC is increases as SER decreases, implying that farmers would be benefited from reduction in implicit taxes.
The empirical results of this study showed the comparative advantage of indigenous cattle production, in the study area, improves as SER increases. The value of DRC figure, Table 7, was going down from their current situation/baseline value

proportionally more than the change in SER. The implied improvement in DRC was about 27.2 percent for 20 percent increase in SER. In this case, the social values added of the indigenous cattle production increases, while the costs of the domestic factors are unchanged. By contrast, the comparative advantage deteriorates as the SER decrease. However, in both simulations, the DRC are smaller than one, implying that production of indigenous cattle is economically profitable, in the study area. Besides, as SER increase by 20 percent the PC value decrease by 36.55 percent, but the profitability coefficient (PC) increase by 45 percent due to a 20 percent decrease in SER.

**Table 7: Policy distortion indicators for sensitivity analysis due to change in SER**

| Indicators | Base line value (Current situation) | With 20 percent increase in SER | With 20 percent decrease in SER |
|---|---|---|---|
| NPCO | 0.809 | 0.588 | 1.297 |
| NPCI | 0 | 0 | 0 |
| PCR | 0.540 | 0.539 | 0.539 |
| DRC | 0.360 | 0.262 | 0.579 |
| EPC | 0.809 | 0.588 | 1.297 |
| SRP | -0.270 | -0.466 | 0.177 |
| PC | 0.580 | 0.368 | 1.421 |

Source: Computed from PAM's simulation result

## 4.8 Scenario II: Change in world price of outputs

Livestock pricing policies in developing courtiers are important in four main respects. Firstly, many of the rural people derive their livelihood from livestock production and their incomes are directly affected by changes in the prices they receive. Secondly, prices serve as signals of market efficiency and performance and policy outcomes. Thirdly, prices represent a cost to consumers who spend an important part of their income on livestock products. Finally, livestock pricing policies are important to governments because of their implications for producer incentives and for government revenue and expenditure (Ehui *et al*, 2003).

The demand for and/or supply of the commodity in the world market determines the value of a given commodity. Moreover, the demand for and supply of a given agricultural product, due to different reasons, fluctuates and this results in short run fluctuations in the world (F.O.B) price. As a matter of fact, world price is one of the key input parameters used in PAM analysis. For this reason, it is sound to carry out sensitivity analysis to examine the impacts of change in the world prices of the given

agricultural product. In this scenario, keeping other input parameters constant; two simulations had been conducted to see the sensitivity of NPC, EPC, and DRC for the change in world (F.O.B) cattle prices.

The change in the world (F.O.B) price, as presented in Table 8, brings about a change on NPC, EPC and DRC while NPI remains zero due to in the absence of tradable inputs. On the other hand, the protection level of cattle product has shown change due to the relative change in its private and social values. The profitability coefficient (PC) value also increases by 21 percent because of a 20 percent increase in world (F.O.B) price of cattle.

As the world (F.O.B) prices of cattle increases, its NPC value will increase and correspondingly decrease as its price decreases. An increase of 20 percent in the F.O.B price of cattle results in rise NPC from 0.809, on the base line result, to 0.834. In other words, indigenous cattle keeping farmers were slightly less taxed by 3.09 percent on their outputs. In contrast, 20 percent reductions in world cattle price lead to 6.92 percent more implicit taxes on the indigenous cattle production.

The effective protection coefficients (EPC) of indigenous cattle production also increase as export price increases and the reverse is true for decrease in export price. A 20 percent rise in F.O.B price results in EPC to increase from 0.809 to 0.834 (3.09 percent). The result indicated that the net disincentive effect of government policies and market failure in the output and input market combined was slightly reduced with increase in F.O.B price.

**Table 8: Policy distortion indicators for sensitivity analysis (change in the F.O.B) price**

| Indicators | Base line value or current situation | With 20 percent increase in F.O.B price | With 20 percent decrease in F.O.B price |
|---|---|---|---|
| NPCO | 0.809 | 0.834 | 0.753 |
| NPCI | 0 | 0 | 0 |
| PCR | 0.540 | 0.380 | 0.928 |
| DRC | 0.360 | 0.263 | 0.579 |
| EPC | 0.809 | 0.834 | 0.753 |
| SRP | -0.274 | -0.220 | -0.367 |
| PC | 0.580 | 0.702 | 0.129 |

Source: Computed from the PAM's simulation results

In this scenario, with a 20 percent increase in world price of cattle, indigenous cattle keepers have a comparative advantage in cattle production. The DRC value in the baseline result was 0.36, due to a 20 percent increase in the world price, reduced to

0.263 (26.94 percent). Thus, it implied that the level of comparative advantage of indigenous cattle production increased. Conversely, if the world price reduced by 20 percent, other things being remains constant, DRC increases by 60.83 percent.

## 4.9 Scenario III: If government, private sectors any other bodies supply production inputs with reasonable price

Indigenous cattle producers in the study area hadn't used any tradable inputs. In this scenario, however, an assumption about tradable inputs was made. If the government, private sectors or any other bodies supplied tradable inputs like concentrates and health service with an estimated amount equivalent to 50 percent of domestic factors. Thus, the assumed amounts of private and social costs were 3463.44 and 6719.07 respectively. Therefore, the impact with the presence of tradable inputs, assuming other input parameters remain constant, indicated that both the private and social profits were significantly positive. This implied that indigenous cattle production in the study area was profitable for farmers if government, private sectors or any other bodies supplied tradable inputs. Besides, with the existence of tradable inputs the social profitability of indigenous cattle production was by far larger than private profit, implying that the net effect of input policies influencing output and input markets were imposing an implicit tax or any other element of disincentive. The profit divergence -964.51 showed that the profit per average cattle TLU equivalent should increase by the amount through policy reform to bring about great economic efficiency (see Table 9).

**Table 9: Simulated PAM for indigenous cattle production with tradable inputs (ETB/ average CTLU (the average cattle is 5.4)**

| Peculiarities | Revenue | Costs | | Profit |
|---|---|---|---|---|
| | | Tradable inputs | Domestic factors | |
| Private price | 12845.24 | 3463.44 | 6926.878 | 2454.9 |
| Social price | 15875.32 | 6719.07 | 5736.818 | 3419.4 |
| Divergence | -3030.08 | -3255.63 | 1190.06 | -964.51 |

Source: Computed from the PAM's simulation results

In Table 10, the nominal protection coefficient (NPC) of indigenous cattle production was below one. This showed that the net effect of government intervention and market distortion not corrected through efficient policy. The reduction in revenue made farmers to be implicitly taxed by 19.1 percent. The EPC was greater than one implied the price rising input tariff created a negative transfer.

**Table 10: Policy distortion indicators for sensitivity analysis with tradable inputs**

| Indicators | Base line value or Current situation | With the presence of tradable inputs |
|---|---|---|
| NPCO | 0.809 | 0.809 |
| NPCI | 0 | 0.515 |
| PCR | 0.540 | 0.734 |
| DRC | 0.360 | 0.630 |
| EPC | 0.809 | 1.024 |
| SRP | -0.274 | -0.060 |
| PC | 0.580 | 0.718 |

Source: Computed from the PAM's simulation results

In this analysis the nominal protection coefficient for input (NPCI) was less than one, indicated that the overall impact of government intervention influence both the output and input market. This also caused a net disincentive or it allows the cattle production system to have a value added within privet price of 26.6 percent lower than the value added without policy as measured in world price. The domestic resource cost (DRC) was less than one, implied that indigenous cattle production, with the given tradable inputs, competitive and the country has a comparative advantage of indigenous cattle production in the study area.

## 4.10 Scenario IV: Change in production cost of domestic inputs

In this scenario, the impact of change in production cost of domestic inputs on the comparative advantage of indigenous cattle production in Dano district was examined. As presented in Table 11, assume other input parameters remain constant, the change in the cost of domestic inputs doesn't have direct influence on the protection level of outputs and tradable inputs and as a result NPC, NPI and EPC were unchanged. However, the DRC change as a result of change in social values of domestic factors. For example, with a 20 percent increase in cost of domestic inputs, the DRC of indigenous cattle production increased from 0.360, in the baseline scenario, to 0.368 (2.22 percent). This implies that indigenous cattle production still remains economically efficient. On the contrary, as the cost of domestic inputs decreases, the comparative advantage of indigenous cattle production in the study area decreases.

**Table 11: Sensitivity of PAM's indicators due to change in domestic input costs**

| Indicators | Base line value or Current situation | With a 20 percent increase in costs of private value of domestic inputs | With a 20 percent increase in both costs of private and social domestic inputs | With a 20 percent decrease in both costs of private and social domestic inputs |
|---|---|---|---|---|
| NPCO | 0.809 | 0.809 | 0.809 | 0.809 |
| NPCI | 0 | 0 | 0 | 0 |
| PCR | 0.540 | 0.647 | 0.55 | 1.144 |
| DRC | 0.360 | 0.361 | 0.368 | 0.560 |
| EPC | 0.809 | 0.809 | 0.809 | 0.809 |

Source: Computed from the PAM's simulation results

## 4.11 Scenario V: Change in the average cattle TLU equivalent (Output)

In this scenario, assuming other input variables remain constant, change in the average level of cattle in TLU equivalent of indigenous cattle production in Dano district had an impact on some of the PAM indicators. The change in the average cattle in TLU equivalent did not have direct effect on the protection level of inputs (see Table 12). However, the protection level of output has slightly changed due to the relative change between the private and social revenues of indigenous cattle production. As the average cattle in TLU equivalent increase by 20 percent, the NPC has slightly reduced from 0.809 to 0.8 (1.11 percent). This indicated that farmers were considered as being slightly more taxed as NPC declined. This is mainly because of the relatively higher increment in the social revenue than the private one for increase in average TLU. Moreover, the EPC of indigenous cattle production also reduces as the average cattle in TLU equivalent decrease, which implied that farmers implicitly would be more taxed on cattle production, and vice-versa.

The PAM simulation result also showed that the rise in the average cattle in TLU equivalent lead to decrease in DRC. This was due to an increase in social value added while the costs of domestic resources were unchanged. A 20 percent increase the average cattle in TLU equivalent resulted in a decrease of DRC or showed an improvement in the comparative advantage by about 12.5 percent. On the other hand, the comparative advantage of these indigenous cattle production decreases as the average cattle in TLU equivalent decreases.

**Table 12: Sensitivity of PAM's indicators due to change in average cattle in TLU equivalent**

| Indicators | Base line value (Current situation) | With a 20 percent increase in the average cattle TLU equivalent | With a 20 percent decrease in the average cattle TLU equivalent |
|---|---|---|---|
| NPCO | 0.809 | 0.800 | 0.821 |
| NPCI | 0 | 0 | 0 |
| PCR | 0.54 | 0.476 | 0.622 |
| DRC | 0.36 | 0.315 | 0.423 |
| EPC | 0.809 | 0.800 | 0.821 |

Source: Computed from the PAM's simulation results

# 5. Conclusion and policy implications

## 5.1 Conclusions

Livestock play an important role and has major contribution of agricultural GDP in some sub-Saharan Africa countries in general and in Ethiopia in particular. Ethiopia has the largest livestock resource than any other African countries. Although Ethiopia has the largest livestock population in Africa, performance in the production of the major food commodities of livestock origin has been poor compared with other African countries, including neighboring Kenya. Hence, in order to improve the livelihoods of poor livestock keepers, it is significant to improving the performance of the livestock sector in Ethiopia.

In Ethiopia, Livestock sector is very important for the farming community in general and in Dano district of Western Showa, Ethiopia in particular. Much livestock production in the country relies on indigenous animal genetic resources. However, much hasn't been done in terms of their improvement so that these traditional practices are threatened by pressure of economic development. Besides, these unique resources are believed to be at risk of loss due to genetic erosion. In order to protect the genetic erosion it is important to analyze the current policy framework and institutional setups of the nation and identification of policy options to come up with mechanisms for conservation and sustainable use of indigenous animal genetic resources.

With this background, the principal objective of this study was to analyze the existing policy and institutional environment in order to identify polices that enhance improved and sustainable use of indigenous breeds/strains, and to identify immediate strategic options to address current constraints/threats. More specifically, the study was

designed to analyze the existing policy environment and institutional setups in relation to cattle production in the study area. Besides, it was as well designed to describe the cattle production system and identify challenges and opportunities.

The data used for the study were collected from 150 farm households drawn from Dano district of Western Showa, Ethiopia based on the list of the farmers that obtained from the development centers and/or offices of peasant associations. A multi-stage sampling technique with random sampling procedure was used to select sample farmers from five PAs. Primary data were collected using a structured questionnaire. In addition, secondary data were extracted from relevant sources to supplement the data obtained from the survey. For this study policy analysis matrix (PAM) and descriptive statistics were applied. Furthermore, sensitivity analysis with various scenarios was undertaken to assess the effect of the different strategies on poor livestock-keepers.

The study result suggested that both private (financial) and social (economic) profits were positive; implying that indigenous cattle production in Dano district was profitable for producers as well as for the country at large. The divergence between private and social values, which showed the net effect of policy distortion and market failure, indicated that smallholder indigenous cattle producers were implicitly taxed on their output as well as on the use of domestic inputs.

The nominal protection coefficients (NPC) of indigenous cattle production (0.809) indicate the fact that farmers were implicitly taxed overall by about 19.1 percent on their output. On the other hand, the nominal protection coefficient for tradable inputs (NPI) was zero. This indicated that there was not any government policy intervention and institution arrangement for indigenous cattle production. The DRC coefficient was less than one, which implied the country has comparative advantage in conservation and sustainable use of indigenous animal genetic resources in the study area. For that reason, it's socially desirable to strengthening and expanding the conservation and sustainable use of indigenous cattle production which has DRC ratio of 0.362 at a given current production technology, input and output prices. This DRC ratio also implied that cattle production could be economically worth wile to investor in the study area. The result also took into account the overall policy impact on output markets. Thus, it cause a net disincentive that allow indigenous cattle production to have a value added in private price of 19.1 percent lower than the value added without policy transfers as measured in world price. In other words, indigenes cattle keepers were implicitly taxed more for their output rather than delivered and subsidized tradable inputs.

## 5.2 Policy implications

Appropriate indigenous cattle breed conservation, management and sustainable use policy and strategies should ensure adequate economic returns to cattle keepers, maintenance of natural resources, minimal adverse effects on the environment, optimal production with minimal external inputs, and satisfaction of human food and income needs, as well as rural families' social needs. Moreover, there should be favorable policies that equally want to realize the intended results in technical change and minimize possible negative consequences. Based on the findings of the study, the following points need to be considered as possible policy implications in order to improve the conservation, management and sustainable use of indigenous animal genetic resources.

1. The study revealed that production of indigenous cattle breeds are competitive and profitable for both farmers as well as for the country at large, which indicates that farmers in the study area should be encouraged in their production of indigenous cattle. Follow a participatory, consultative, innovative and proactive approach that acknowledges the abilities and capacities of all stakeholders to make a valuable contribution to enhance the conservation, management and sustainable use of indigenous cattle breeds. Moreover, Promote and providing technical support to ensure the sustainable development and conservation of indigenous cattle breeds and cattle -based systems at the national and community levels;
2. The divergence between private and social profits, which have been caused by the net policy effects and market failures, should be minimized by taking measures that correct the inefficiency influences of market factors such as favorable marketing policy, marketing infrastructure and institutional underdevelopments and environmental impacts of soil degradation. In addition, in line with trade liberalization measures, the gradual foreign exchange liberalization should also be facilitated. As a result, the comparative advantage of agricultural production in general and indigenous cattle production under the study in particular can better be revealed. Moreover, the policy makers better give emphasize to promote the conservation and enhancement of indigenous cattle breeds-based products in order to derive economic, social, and cultural and health benefits for the local as well as the population of Ethiopia.
3. With the assumption that government, private sectors or any other bodies supplied tradable inputs like concentrates and health service with reasonable price then the simulation result indicated that indigenous cattle production in the study area was profitable for farmers. Thus, government, private sectors or any other bodies better to supply tradable inputs like health service, concentrate and others with reasonable price for farmers who keep indigenous cattle breeds.

Besides, increase public awareness of the contributions that indigenous cattle breeds-based systems make to food security, better nutrition, poverty alleviation and livelihood improvement.

4. As the change in average cattle TLU equivalent yield also brings substantial effect on the comparative advantage and profitability of indigenous cattle breeds. Therefore, the technologies that improve and conserve the yield of indigenous cattle breeds should be given greater concern. In addition, farmers should be encouraged to produce and handle the quality of products that can fit the export standards. In this case, farmers' institutions and public institutions such as quality and standard authority, ministry of agriculture, research centers and other stakeholders should integrate together. Moreover, realize and appreciate the coordination and harmonization of efforts, contributions and participation among all stakeholders, through an agreed framework. These would help farmers to conserve these indigenous breeds and improve their profitability in a sustainable way as well as these help to improve the recourse use efficiency of the country.
5. The fluctuation in the world cattle price also has substantial effect on the comparative advantage of indigenous cattle breeds' production. Therefore, information about the world cattle market price including both the demand and the supply side should be considered to reduce the possible revenue loss for the farmers as well as for the country as a whole.

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**Appendix Table 1: PAM for indigenous cattle production (ETB/ cattle TLU)**

| Peculiarities | Revenue | Costs | | Profit |
|---|---|---|---|---|
| | | Tradable inputs | Domestic factors | |
| Private price | 2569.05 | 0 | 1385.38 | 1183.68 |
| Social price | 3175.06 | 0 | 1147.36 | 2027.8 |
| Divergence | -606.02 | 0 | 238.012 | -844.02 |

Source: Computed PAM results

**Appendix Table 2: Average yield and average major inputs used per year in Dano district (2005/06)**

| Particulars | Amount |
|---|---|
| Yield | |
| Products | |
| Main product | |
| Average Cattle in TLU equivalent (in number) | 5.4 |
| Butter (in Kg) per cattle per year | 51.6 |
| Milk (in litter) per cattle per year | 155.9 |
| Cheese (in litter) per cattle per year | 33 |
| Draft animal (in hr) per cattle per 0.125 ha | 96 |
| Byproduct | |
| Manure (in kg) per cattle per year | 657 |
| Material inputs | |
| Animal feed (in ETB) per cattle per year | 496.12 |
| Farm tools (in ETB) per average CTLU per year | 182.86 |
| Storage (in ETB) per average CTLU per year | 39.4 |
| Shelter for cattle (in ETB) per average CTLU | 344 |
| Milk product processing (in ETB) per cattle year | 49.79 |
| Interest (ETB) per average CTLU | 92.67 |
| Labour | |
| Man-days family labour (in hr) per average CTLU equivalent per year | 601.9 |
| Hired labour per year in ETB per average cattle TLU | 300 |
| Land (in ha) used for average CTLU | 0.384 |

Source: Computed based on survey data

# EFFECT OF NONFARM INCOME ON HOUSEHOLD FOOD SECURITY IN EASTERN TIGRAI, ETHIOPIA: AN ENTITLEMENT APPROACH

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*Abstract*

*The study attempts to investigate the link between food security and nonfarm employment using the survey data collected from 151 randomly selected households from six villages of Woreda Gantafeshum, Eastern Tigrai, Ethiopia. Considering the objective of the study, given a household participated in nonfarm employments and its effect on food security, the Heckman selection model (two stage) is used. We examine first the household decision with respect to participation in nonfarm employment using pobit model. We found that land size, age, family size, special skill, electricity, credit, distance to the nearest market and access to irrigation are the most influencing variables in determining farmers to participate in nonfarm activities. Further we examine the effect of nonfarm employment on households' food security. Our study indicates that nonfarm employment provides additional income that enables farmers to spend more on their basic needs include: food, education, closing and health care. The result of the study implied that nonfarm employment has a role which is significant in maintaining household food security.*

**Key words:** nonfarm employments; food security; probit model: Heckman selection model; Eastern Tigrai

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## 1. Introduction

Ethiopia is one of the most food insecure countries in the world. Hunger and famine results of food insecurity have been always problems in the country. The country is renowned for its highly dependent on agriculture. According to the 2007 population census 83.8% of the population of the country derives its livelihood from agriculture, which is entirely dependent on rain fed. Of the 4.3 million hectares of the potential of irrigable agriculture only 5% is currently utilized (Kebede, 2003). Small peasants also dominate the sector. Smallholder farmers cultivate about 95% of the land (Adenew, 2006). Indeed agriculture is the main source of income and employment but it has been highly constrained by various constraints and thus leaves the country to remain food insecure. To address the food security problems, the government designed different interventions, among other things to improve agricultural productivity through irrigation schemes and food security packages. But in drought prone and degraded areas the government stand is non controversial as it clearly stated in its five year strategic plan (PASDEP), to promote non agricultural activities so as to sustain the rural livelihoods.

Likewise, agriculture is the main economic base of Tigrai region. About 80.5 % of the population earns their livelihood from agriculture. Despite the sector remains the main source of livelihood in the region, production is far from being adequate. The region has seven zones namely Eastern, Central, Western, Northwestern, Southern, Southeastern and Mekelle metropolitan zone. The Eastern zone is one of the zones known for its food insecurity. Agricultural production in the area is highly constrained by factors such as degraded environment, inadequate rainfall; lack of technology, capital, and credit. Besides, agricultural land in the area is characterized by fragile and fragmented smallholdings. In the area, agriculture production is viewed by many as marginalized.

Farming, which is the main source of livelihood of the people, is largely dependent on rain fed, and the pattern of rainfall is erratic, short and one season (usually from June to September). In the absence or little rainfall farmers constantly faced with food shortages and crises. Even in a good season, the onetime harvest or produce is too little to meet the yearly household needs as a result the majority of these rural people remain food insecure.

Thus, focusing in agricultural production alone may not be enough to combat the food insecurity problem of the area and therefore engaging in non-agricultural or nonfarm activities might be of paramount importance to sustain the people’s livelihoods.

The positive contribution of nonfarm activities in reducing poverty and improving household food security is a subject of discussion and has been rarely explored. The emphases of the earlier studies (cf: Reardon, 1998; Lanjouw and Lanjouw, 2001; Davis, 2003; Barrett et al 2001) have been on the role of nonfarm activities in poverty reduction, household income and wealth. Moreover, despite rural households tend to participate in such activities in order to fulfill their households need, their participation appear to be constrained by capital assets including human, social, financial, physical, and land property.

Hence, the contributions and determinants of involvement in nonfarm activities are issues that deserve investigation particularly in Easter Zone (the study area) which is viewed as the most food insecure zone comparing to the others zones of the region. In such area; merely depending on agriculture is not a panacea, therefore to reduce dependency on subsistence farming on fragile land, nonfarm employment could be an option and thus the study is aimed at investigating the potential of involvement in nonfarm activities to household food security in the woreda and its determinants.

The rest of the paper is organized as follows. In section two, we tried to present a brief review of role of nonfarm employments, reasons and determinants of involvement in nonfarm employments. Section 3 provides the theoretical framework and model specification. Section 4 presents results and discussions. Finally Section 5 ends up with conclusions and some policy implications.

## 2. Review of related literature

Over the last three decades, the non-farm economy has been gaining a wider acceptance in issues of rural development due to its positive implication in poverty reduction and food security (Reardon et al., 1998; Ellis, 1998; Lanjouw and Lanjouw, 2001; Davis, 2003). Participation in rural non-farm activities is one of the livelihood strategies among poor rural households in many developing countries (Mduma, 2005). Empirical research found that non-farm sources contribute 40-50% to average rural household income across the developing world. For example according to World Bank report (2008) non agricultural activities account for 30 percent to 50 percent of income in rural areas. In Ethiopia, according to Davis as cited in Deininger et al. (2003) some 20% of the rural incomes originate from non-farm sources. In Tigrai, in areas where study has been undertaken off-farm/nonfarm labor income accounts up to 35 percent of total farm household income (Woldehanna, 2000).

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The rural non-farm sector plays a vital role in promoting growth and welfare by slowing rural-urban migration, providing alternative employment for those left out of

agriculture, and improving household security through diversification (Lanjouw and Lanjouw, 1995).

For example, in the study of Barrett et al (2001) nonfarm activity is typically positively correlated with income and wealth (in the form of land and livestock) in rural Africa, and thus appears to offer a pathway out of poverty if non-farm opportunities can be seized by the rural poor. Moreover, this key finding appears a double-edged sword. The positive wealth-nonfarm correlation may also suggest that those who begin poor in land and capital face an uphill battle to overcome entry barriers and steep investment requirements to participation in nonfarm activities capable of lifting them from poverty (ibid).

Decisions by rural households concerning involvement in RNF activities depend on two main factors, i.e incentives offered and household capacity (Reardon et al., 1998). In poor rural areas, some households will make a positive choice to take advantage of opportunities in the rural non-farm economy, taking into consideration the wage differential between the two sectors and the riskiness of each type of employment. Rising incomes and opportunities off-farm then reduce the supply of labor on-farm. However, other households are pushed into the non-farm sector due to a lack of opportunities on-farm, for example, as a result of drought or smallness of land holdings (Davis, 2003).

One of the components of rural non-farm activities, in which the poor can participate because it does not require any complementary physical capital, is wage employment (Mduma and Wobst, 2005).

Different studies have investigated the factors that most influence rural household participation in nonfarm activities. For example in the study by Mduma and Wobst (2005) education level, availability of land, and access to economic centers and credit were the most important factors in determining the number of households that participate in a particular rural local labor market and the share of labor income in total cash income

## 3. Theoretical model

The starting point of the theoretical framework of this study is the Farm Household Model (FHM). It is based on a simple non-separable household model where market is imperfect (Singh et al., 1986; Sadoulet and de Janvry, 1995).

Consider a household that drives utility from consumption of home produced goods(C), purchased goods (M), and leisure (L). Hence, the household utility function can be specified as (Sadoulet and de Janvry, 1995; Woldehanna, 2000):

$$U = U(C, M, L; Z^h) \quad \textbf{(1)}$$

Note that the household utility ($U$) is a function of household consumption ($C$), (M) and leisure (L).The household is assumed to maximize utility subject to constraints imposed by 1) the production technology; 2) the total time endowment of the household; and 3) the households cash income (budget).

This model provides a theoretical framework for capturing and prediction of household's (farmer's) farm, off farm / nonfarm work participation and hours of work decisions. The intuition is that the farmer's labor supply decisions are determined by maximizing a utility function subject to technology, time and income constraints.

The production technology of the farm represents the constraint on the household's consumption possibilities. Farm output depends on the labor hours allocated to farm production, $T_f$, a vector of purchased input factors, $X$, capital employed on the farm, $K$, land, A, and farm specific characteristics, $Z^q$. The production function is assumed to be strictly concave.

The Production technology constraint can be specified as (Sadoulet and de Janvry, 1995; Woldehanna, 2000):

$$Q = Q(T_f, X, K, A, Z^q) \geq 0 \quad \textbf{(2)}$$

The household allocates its total time endowment ($T$) among farm work ($T_f$), market work ($T_m$), nonfarm employment ($T_n$) and leisure (L). Hence, the time constraint is (in vector notation**):**

$$T = T_f + T_m + T_n + L \quad \textbf{(3)}$$

Non-negativity constraints are imposed on farm work, market work, nonfarm work and leisure of household: $T_f \geq 0$, $T_m \geq 0$, $T_n \geq 0$ and $L \geq 0$.

Consumption is constrained by household income, composed of: (i) farm income ($Y_f$), which is a function of each household member's farm labor supply; (ii) off farm labor income, which is the sum of off-farm earnings of all household members ($Y_{mi}$); non farm labour income, which is the sum of non farm earnings of all household members ($Y_{ni}$); and (iii) other income ($Y_o$). The resulting budget constraint is:

$C = Y_f(T_f ; Z_f) + Y_{mi}(T_m ; Z_m) + Y_n(T_n ; Z_n) + Y_o$ **(4)**

The household optimization problem is to maximize $U(C, M, L; Z^h)$ subject to the time, budget, and non-negativity constraints, where $Z_j$ are exogenous shifters of function $j$. The optimal solution is characterized by the Kuhn-Tucker conditions, which are the first-order conditions for maximizing the Lagrange function:

$$\xi = U(C, M, L; Z^h) + \delta(L_f, L_h, K, X, A, Z^q) + \lambda [Y_f (T_f; Z_f) + \sum i\, Y_{mi} (T_{mi}; Z_{mi}) + \sum i\, Y_{ni}(T_{ni} ; Z_{ni}) + Yo - C] + \mu_t [T - T_f - T_m - T_n - L] + \mu_f . T_f + \mu_m . T_m + \mu_n . T_n \quad \textbf{(5)}$$

Where, δ = the marginal utility of the production constraint
μ*t* = the shadow wage rate (value) of every job obtained in farm, off farm, and non farm
λ = marginal utility of income (liquidity) constraint

The first order conditions for interior solutions imply:

$$\frac{\partial \xi}{\partial T_m} = -\mu t + \mu m = 0 \quad \textbf{(6)}$$

optimality condition for off farm labour

$$\frac{\partial \xi}{\partial T_n} = -\mu t + \mu n = 0 \quad \textbf{(7)}$$

optimality condition for non farm labour

$$\frac{\partial \xi}{\partial T_f} = \delta - \mu t + \mu f = 0 \quad \textbf{(8)}$$

optimality condition for farm labour

$$\frac{\partial \xi}{\partial L} = \frac{\partial U(.)}{\partial L} - \mu t + \mu l = 0 \quad \textbf{(9)}$$

optimality condition for leisure.

Assuming labor time is exhaustively used in the three activities.

# 4. Econometric model specification and data

## 4.1 Econometric model specification

Probit and Heckman selection model are used to empirically analyze and seek answers to the research questions. Probit model is used to determine the factors influence rural households to participate in nonfarm employments.

The probability of participation in nonfarm activities given the explanatory variables is captured by running a probit regression model. In this model, the response variable is binary, taking only two values, 1 if the household is participated in nonfarm employment, 0 if not.

The probit model is given by (Greene, 2005):

$$pi* = F(Ii) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{Ii} e^{-z2/2}\, dz \qquad \textbf{(10)}$$

$pi*$ Cannot be observed; it can only be observed if the farmer works nonfarm or not. Then pi = 1 if p* > 0, pi = 0 otherwise.

Considering the second objective of the study, given a household participated in nonfarm employments and its effect on food security, the Heckman selection model is used.

The Heckman selection model is specified as (Heckman, 1979):

$$y_i = x'_i \beta + u_i \qquad \textbf{(11a)}$$

Outcome/regression equation

Assume that Y is observed if a second, unobserved latent variable exceeds a particular threshold

$$z_i^* = w'_i \alpha + e_i \qquad \textbf{(11b)}$$

$$z_i = \begin{cases} 1 \text{ if } z_i^* > 0; \\ 0 \text{ otherwise} \end{cases}$$

Selection equation

**Table 1 Definition and measurement of variables**

| Variable Specification | Measurement |
|---|---|
| **Dependent variable:** | |
| Participation in nonfarm activities employment, 0 if not. | 1 if the household is participated in nonfarm |
| **Explanatory variables:** | |
| Age of household head | Age at time of interview in completed years |
| Sex of household | 1 if male and 0 otherwise |
| Years of schooling | Years of schooling |
| Possession of special skill | 1 for those with transferable skill, 0 otherwise |
| Marital status | 1 if married, 0 otherwise |
| Household size | Number of household members |
| Landownership | 1 if yes, 0 otherwise |
| Land size | Total land owned in *Tsimad* |
| Tenure security 0 otherwise. | 1 if the household has fear of land redistribution, |
| Livestock holding | Number of livestock owned |
| Credit otherwise | 1 if the household has taken credit in last year, 0 |
| Electricity | 1 if the village has electricity, 0 otherwise |
| Irrigation otherwise | 1 if the household has access to irrigated land, 0 |
| Distance to the nearest market | 1 if close to the town, 0 otherwise |
| Distance to the main road | 1 if close to the main road, 0 otherwise |

### 4.2 Data set

Both primary and secondary data were used for the study. Primary data was gathered from 151 households via structured questionnaire. In addition to this, key informant, group discussion and informal interview were made so as grasp their perception on availability and constraints of nonfarm employments and food security status. Secondary data was collected to describe the area under study, its population size, village composition and major economic occupation of the woreda.

## 5. Results and discussion

### 5.1 Descriptive analysis

The primary occupation of the majority of sample households is farming (see Table 2). Households whose primary occupation is crop production accounts for 7%, livestock rearing, 3% and both (crop and livestock) 77%.In general, farming

constitutes the major economic occupation of the households as accounts 87 % followed by trade 9% ,2% civil servant and other 3%.

**Table 2: Occupation of sample households**

| Primary occupation | Freq. | Percent |
|---|---|---|
| Crop | 11 | 7.28 |
| Livestock | 4 | 2.65 |
| Both (crop and livestock) | 116 | 76.82 |
| Trade | 13 | 8.60 |
| Civil servant | 3 | 1.98 |
| Other(such as daily labor) | 4 | 2.64 |
| Total | 151 | 100.00 |

Farmers in the study area grow crops under rain fed condition. Farmers plant a mix of crops, of which the major ones are barley, wheat, *teff*, and maize. Irrigation is also practiced by some farmers in the area. Few of them earn some cash income through the sale of vegetables like cabbage, onion tomato and potato in the near market. Livestock production is also another important means of livelihood of the people. Farmers in the area are also widely undertaking non agricultural activities as agricultural income is seasonal and low.

**Table 3: Descriptive Statistics of households' socioeconomic attributes**

| Household features | N | Mean | Minimum | Maximum | Std. Deviation |
|---|---|---|---|---|---|
| Household head sex (1= male, 0=female) | 151 | 0.78 | - | - | 0.414 |
| Household head education(years of schooling) | 151 | 2.45 | 0 | 14 | 3.301 |
| Household head age | 151 | 44.53 | 25 | 71 | 11.690 |
| Family size of the household | 151 | 5.456 | 2 | 11 | 1.945 |
| Landownership(1 = yes,0 = no) | 151 | 0.927 | 0 | 1 | 0.260 |
| Land holding size in *Tsimad*[4] | 151 | 1.826 | 0 | 6 | 1.025 |
| Oxen | 151 | 1.278 | 0 | 3 | .731 |
| Cows | 151 | 1.529 | 0 | 8 | 1.182 |
| Total expenditure per year (birr) | 151 | 4836.35 | 700 | 20670 | 3887.582 |

[4] 4 *Tsimads* are equivalent to one hectare

The survey result depicts that the average age of sample respondents is about 44.53 years with the minimum and maximum ages of 25 and 71 years, respectively (see Table 3). Further, the data revealed that that the majority of the respondents (78) percent are male headed households'. Of the respondents' also the average years of education is 2.45 which ranges from zero to maximum 14 years. The main activity of the majority of the household heads is farming. About 93% households in the study area have agricultural land. Though farming is the major source of livelihood, nonfarm activities are becoming additional source of income.

In the area the average land holding size is 1.826 tsimad (0.45 ha) ranges from zero (no land) to a maximum 6 tsimads. Household size ranges from minimum of two to a maximum of eleven individuals and the average household size 5.45. The household size of a family may suggest that the level of dependency in the household and or the labor force in the household. The average oxen and cows holding of the sample households are 1.28 and 1.53, respectively.

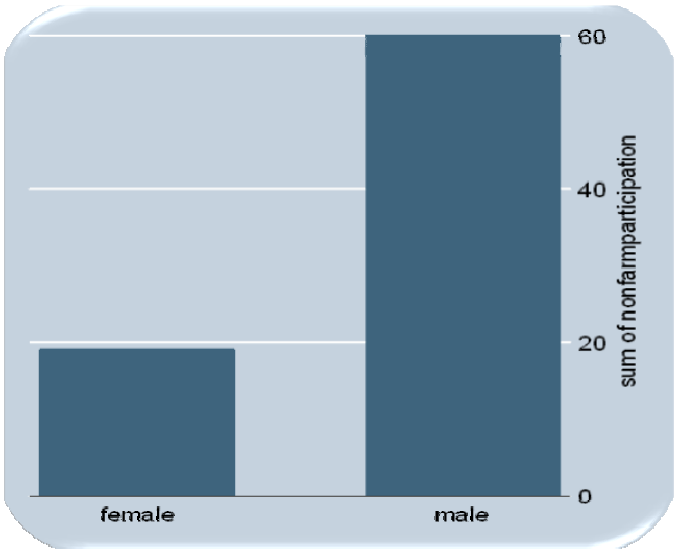
The results of the analysis showed that the annual average household expenditure (education, domestic household basic needs which include salt, sugar, soap, kerosene, edible oil, food etc, clothes and shoes and health care) totaled at 4836.358 birr per year ranges from minimum 700 to maximum 20670 birr.

**Table 4: Nonfarm participation of sample households (No = 151)**

| Participation | Food for work | Other nonfarm (non food for work) |
|---|---|---|
| Yes | 69.54 | 52.32 |
| No | 30.46 | 47.68 |
| Total | 100.00 | 100.00 |

Food for work (FFW) is the most common and widely observed nonfarm activity in the area (Table 4). As can be seen in the above table about 70 percent of the respondents participated in food for work activity. Food for work is more widespread than that of other nonfarm activities with numbers of household participated in food for work program being larger than those participated in other nonfarm activities both in the case of all village and individual households. Of the total 151 sampled households 79 (52.32%) households are participated in nonfarm employments (excluding food for work) while 72 (47.68%) households are not participated in nonfarm activities. Here it should be noted that the food for work activity is a government program and it is accessible to all households regardless of their endowments. Therefore, assuming food for work as nonfarm employment may not clearly show the possibility and constraints of household participation in the nonfarm activities. For this reason the study ignores the food for work activity in attempt to meet its objectives i.e. in this study the FFW is not considered and included as nonfarm activities.

**Figure 1: Nonfarm employments participation by sex**




Of the nonfarm participant household heads 60 (76%) are male while from 19 (24%) are female (Figure 1). Though it seems male headed households participated more in nonfarm employments than female headed households. The Pearson chi2 (Pr = 0.494) showed that no significance difference in the level of participation in nonfarm employments between the male and female household groups.

**Table 5: Ranking of reasons for participate in nonfarm employments**

| Reasons | Rank | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | Total |
| Insufficiency of income from agriculture | 26(32.91%) | 29 | 6 | 3 | 5 | 69(87.34) |
| Growing family size | 3(3.79) | 6 | 7 | 8 | 6 | 30(37.97) |
| Decline land size, soil fertility or productivity | 13(16.45) | 12 | 21 | 4 | 5 | 55(69.62) |
| Availability of credit | 2(2.53) | 8 | 7 | 1 | 2 | 20(25.31) |
| The presence of road, electricity and market in your village | 6(7.59) | 3 | 10 | 5 | 2 | 23(29.11) |
| Seasonal nature of agricultural labor | 6(7.59) | 11 | 8 | 9 | 2 | 38(48.11) |
| Shocks (rain failure, short rainy season, pests swarm, flood, etc) | 11(13.92) | 10 | 11 | 2 | 0 | 33(41.77) |
| Possession of special skill such as masonry, handcrafts, etc | 3(3.79) | 8 | 3 | 1 | 4 | 19(24.05) |
| Favorable demand for goods/services | 4(5.06) | 6 | 4 | 3 | 7 | 24(30.37) |
| Other | 5(6.32) | 4 | 3 | 12 | 6 | 30(37.28) |

Though the economy of the household is depending on farming, substantial numbers of farmers are involved in nonfarm activities to supplement farm income. Non-farm income is the income derived from source other than farming, like petty trade, handicraft, daily labor, masonry etc. From data as shown above majority of farmers are involved in nonfarm employments because they believe that agricultural income is not sufficient enough to stand households food security. About 33 percent of the farmers participated in nonfarm employment tell that insufficiency income from agriculture is the major push factor for such involvement (see Table 5). In addition to this about 16 percent mentioned that decline land size, soil fertility or productivity is the other major reason, around 13 percent indicated shocks (rain failure, short rainy season, pests swarm, flood, etc) as the major reason. While 7 percent due to seasonal nature of agricultural labor, about 5 percent, 8 percent, and 2 percent as a result of favorable demand for goods/services, the presence of road, electricity and market in your village and availability of credit respectively. Only 3 percent involved due to possession of special skill. Our study points, among others, the three main reasons that explain the extent and involvement in nonfarm employments are insufficiency of income from agriculture, decline land size, soil fertility, productivity and shocks (rain failure, short rainy season, pests swarm, flood, etc). From this, one can observe that farmers in the area participated basically due to push factor. However, from the study it is interesting to note that farmers undertake nonfarm activities during the dry or slack season.

**Table 6: Types of nonfarm activities**

| Nonfarm activities | Freq. | Percent |
|---|---|---|
| Petty trade | 17 | 21.51 |
| Masonry | 21 | 26.58 |
| Daily labor | 16 | 20.25 |
| Tannery | 4 | 5.06 |
| Craft work/Carpentry | 3 | 3.79 |
| Blacksmith | 3 | 3.79 |
| Pottery | 2 | 2.53 |
| Other activities(such as stone & mild selling, transportation etc) | 13 | 16.45 |
| **Total** | **79** | **100.00** |

According to Table 6 above, as an alternative means of income smoothing strategy, other than food for work, more than half of the respondents are involved in nonfarm employments. More specifically, of the participant 27 % engaged in masonry, 20 % in daily labor, 22% run petty trade (like Brewery, tea and food, kiosks, Wood and charcoal, grain trading and other) and,5 %, 4%, 4% and 3% tannery, craft

work/carpentry, blacksmith and pottery respectively. The remaining 16% of the farmers are engaged in other nonfarm activities to supplement their farm income.

**Table 7: Nonfarm participation and food security**

| Food security improved due to participation | No of households involved | Percent |
|---|---|---|
| Yes | 64 | 81.01 |
| No | 15 | 18.98 |
| Total | 79 | 100.00 |

Respondents were asked to state whether their food security status has improved after participated in nonfarm activities and accordingly, about 81 % of the respondents perceived that their food status improved as a result of nonfarm participation while 19 % of the respondents said that their food security status has not been improved even after participation (See Table 7). Hence, it is evident that nonfarm employments improve households' food security status.

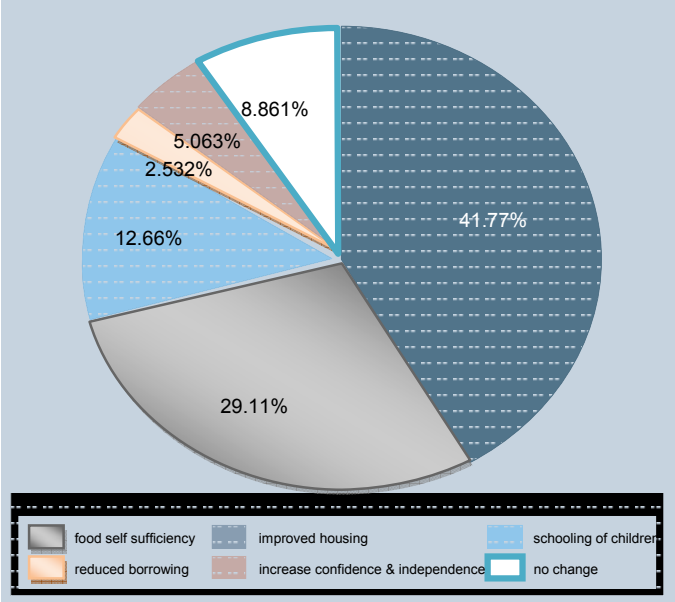
Respondents were also asked about perception of food habit change after participation in nonfarm activities. Accordingly, as shown in table below about 73 % of the respondents said that there has been an improvement in food habit. While 23% said there has been no change and about 4 % perceived as deteriorating (see Table 8).

**Table 8: Perception of food habit after participation**

| Perception of food habit change after participation in nonfarm activities | Freq. | Percent |
|---|---|---|
| Improved | 58 | 73.42 |
| Unchanged | 18 | 22.78 |
| Deteriorated | 3 | 3.79 |
| Total | 79 | 100.00 |

Among the respondents that are involved in the nonfarm activities it is indicated that nonfarm employment improve farmers' livelihood. Farmers participated in nonfarm employments have shown improvements in daily food self sufficiency, housing, schooling of children and other (See Figure 2). Accordingly, about 42% of the respondents mentioned that their households' daily food sufficiency improved as a result of participation in nonfarm activities. 29 % improved housing and 13%, schooling of children. About 5 % and 3% reported that involvement in nonfarm resulted in increase confidence and independence, and reduced borrowing respectively, while 9% of the participants reported no change.

**Figure 2: Nonfarm participation and livelihood change**




An attempt has been made to see whether there is difference in total expenditures per year between the farmers participated in nonfarm employments and those that did not participate. As a result the average yearly total expenditure for households participated in nonfarm activities found to be as twice as non- participants. Households that participate in nonfarm activities are more likely to spend for education, food, closing and health care than those who do not participate at all. Statistically there is significant difference in total expenditure per year between the participants and the non participants group. A two-sample t-test confirmed that the differences at 5 % level.

**Table 9: constraints to nonfarm employments**

| Constraints in accessing nonfarm activities | Freq. | Percent |
|---|---|---|
| Lack of employment opportunities | 25 | 34.72 |
| Lack of skill | 14 | 19.44 |
| Lack of nearby towns and transportation | 11 | 15.27 |
| Low level of demand for labor | 5 | 6.94 |
| Lack of credit | 5 | 6.94 |
| Low profitability of products | 2 | 2.77 |
| Other (being aged, health problems and time constraints) | 10 | 13.88 |
| Total | 72 | 100.00 |

A frequently cited reason for the nonparticipation in nonfarm activities is absence of employment opportunities. As could be seen in Table 9 above, 35 % of the non participant mentioned that lack of employment opportunities is one and the major constraints in accessing nonfarm activities followed by, lack of skill 19 %. Lack of nearby towns and transportation 15%, low level of demand for labor 7%, lack of credit 7%, low profitability of products3% and other 14%.

## 5.2 Econometric results

In this section we present estimation/econometric results of nonfarm participation model and of the effect of nonfarm participation on food security. As it has been explained in the preceding section, the probability of participation in nonfarm activities given the explanatory variables is captured by running a probit regression model. Literature suggests that there are several factors which can influence farmers to participate in nonfarm activities many of these are socio-economic characteristics of the farm household. In the econometric model used, potential variables expected to influence nonfarm employment participation are included.Regression results for participation in nonfarm activities, the corresponding marginal effects and elasticities are presented in Tables 10 and 11 and 12, respectively, below.

**Table 10: Probit estimates for participation in nonfarm employments**

| Variable | Coefficient | Standard Error | P>\|z\| |
|---|---|---|---|
| Age of household head | -.0344856 | .6601097 | 0.005*** |
| Sex of household | -.7228009 | .6601097 | 0.274 |
| Married | .6326218 | .8105869 | 0.435 |
| Divorced | -.3652991 | .7491794 | 0.626 |
| Years of schooling | .1486609 | .0915144 | 0.104 |
| Special skill | 1.858289 | .5360464 | 0.001*** |
| Family size | .292024 | .1050676 | 0.005** |
| Land ownership | 1.707182 | 1.254839 | 0.174 |
| Land size | -.4820135 | .2783972 | 0.083* |
| Perception of tenure security | .3006271 | .2993647 | 0.315 |
| Cow | -.1179172 | .1768825 | 0.505 |
| Oxen | .0176708 | .280086 | 0.950 |
| Credit | .8328926 | .3886724 | 0.032** |
| Electricity | .979403 | .4948543 | 0.048** |
| Irrigation | -1.028937 | .4173368 | 0.014** |
| Distance to the nearest market | .9558707 | .369862 | 0.010*** |
| Distance to the main road | .2990218 | .4520805 | 0.508 |
| Constant | -2.273986 | 1.60396 | 0.156 |

**Table 10: continued**

**Notes:**
* ** 1% significance level ** 5% significance level * 10% significance level
LR chi2(17) = 119.58
Prob > chi2 = 0.0000
Log likelihood : -44.711451
Pseudo $R^2$: 0.5722

As indicated in the Table 10 above, participation in nonfarm employments is influenced by variables age, family size, skill, land size, irrigation, credit, electricity, and distance to market.

All the above mentioned variables are found in line with our a priori expectorations. The variable age has significantly negative effect on participation in nonfarm employments. This may indicate that younger headed households tend to participate in such activities. Family size is found to be significant positive influence in participation in nonfarm employments. This is in line with expectations, in the sense that having more family size in a limited and marginalized land agricultural income alone could not meet food security/livelihood and hence farmers might tend to involve in activities that bring additional income. Land size is negatively and significantly influence the involvement in nonfarm employments. Possessing a special skill positively and significantly influences the nonfarm employment participation

The result of the regression shows that access to irrigation negatively influences participation in farm employments. This might be due to the fact that irrigation is labor intensive and hence farmers might not have labor time to be supplied in nonfarm activities.

Distance to the market influence positively farmers participation in nonfarm employments. This seems reasonable because the presence of opportunities for labor market in the town and being far away from the town increase the transaction costs of involving nonfarm activities.

Variables access to credit and availability of electricity are turned out to be significant and positive as far as the decision to participate in nonfarm employments is concerned. This could be due to the fact that access to credit and availability of electricity enables and promote households to engage in nonfarm self employment

**Table 11: Marginal Effects for Probit Estimates of nonfarm participation[a]**

| Variable | Dy/dx | Standard Error | P>\|z\| | X |
|---|---|---|---|---|
| Age of household head | .1037776 | .0075 | 0.102 | 44.5364 |
| Sex of household | -.2255261 | .17419 | 0.195 | .781457 |
| Married | .2385992 | .3124 | 0.445 | .807947 |
| Divorced | -.136791 | .29035 | 0.638 | .119205 |
| Years of schooling | -.0122553* | .03056 | 0.084 | 2.44371 |
| Special skill | .5110921*** | .09638 | 0.000 | .331126 |
| Family size | .1037776 *** | .03715 | 0.005 | 5.45695 |
| Land ownership | .5922529 ** | .28588 | 0.038 | .927152 |
| Land size | -.1712949* | .09899 | 0.084 | 1.82616 |
| Perception of tenure security | .106835 | .10614 | 0.314 | .543046 |
| Cow | -.0419047 | .06287 | 0.505 | 1.5298 |
| Oxen | .0062797 | .09963 | 0.950 | 1.27815 |
| Credit | .2759075** | .11518 | 0.017 | .384106 |
| Electricity | .3168532** | .14187 | 0.026 | .370861 |
| Irrigation | -.379891*** | .14587 | 0.009 | .298013 |
| Distance to the nearest market | .3408428 *** | .12352 | 0.006 | .612931 |
| Distance to the main road | .1071878 | .16197 | 0.508 | .582781 |

**Table 12: Elasticitities of nonfarm participation[a]**

| Variable | ey/ex | Standard Error | P>\|z\| |
|---|---|---|---|
| Age of household head | -.7971271 | .51027 | 0.118 |
| Sex of household | -.2931556 | .2703 | 0.278 |
| Married | .2652781 | .34125 | 0.437 |
| Divorced | -.0226005 | .04621 | 0.625 |
| Years of schooling | .1885473* | .10523 | 0.073 |
| Special skill | .31936 *** | .08954 | 0.000 |
| Family size | .8270716*** | .32162 | 0.010 |
| Land ownership | .8214956 | .61926 | 0.185 |
| Land size | -.4568484* | .27368 | 0.095 |
| Perception of tenure security | .0847304 | .08501 | 0.319 |
| Cows | -.0936238 | .14123 | 0.507 |
| Oxen | .0117223 | .18616 | 0.950 |
| Credit | .1660406** | .07877 | 0.035 |
| Electricity | .1885154 * | .09954 | 0.058 |
| Irrigation | -.1591472*** | .06477 | 0.014 |
| Distance to the nearest market | .2891207*** | .11366 | 0.011 |
| Distance to the main road | .0904447 | .13575 | 0.505 |

[a] *, **, *** represent significance at 10, 5 and 1 % levels, respectively

[a] *, **, *** represent significance at 10, 5 and 1 % levels, respectively

In terms of marginal effects, the regression results showed that the probability of non-farm employment participation positively increases with family size and is significant at 1 percent. As shown in table 11 the marginal effect of a unit change in family size, computed at mean of household size, enhances the probability of nonfarm participation by 0.103. This implies that the probability of nonfarm participation increases by 10.3 percent for one person increase in family size. This might suggest that households with more family size (perhaps greater availability of labor for farming) may have the labor power to participate in the nonfarm activities as agricultural income or activity is seasonal and not sufficient to meet their needs. This is from the fact that higher family size in a limited land (0.4ha) leads to greater surplus of the labor resource and, hence farmers try to seek additional income from non agricultural activities.

Age plays an important role as a determinant of nonfarm employment participation. The result indicates that, age of the heads of the household negatively influences the possibility of involvement in nonfarm employment and is significant at 10 percent. This could be due to various reasons; firstly, majority of the nonfarm works in the area are casual works and demand hard labor and hence it is obvious to observe that younger households to participate more. Secondly, probably due to the increasing scarcity of farmland particularly to younger (landless) household and hence, they tend to seek other employment alternatives than farming.

Ownership of land is not significant in household decision making with regard to involvement in nonfarm employment but land size is found to be a strong influencing factor. Farm households with small plot sizes are more likely to participate in nonfarm employment than others.The marginal effect of a unit change in land size, computed at sample mean of holding size, on the probability of nonfarm participation is -0.171.This means that the probability of nonfarm employment participation decreases by about 17 percent for a one *Tsimad* decrease in land size (see Table 11.) This is plausible explanation. Because of the small size of farm land that farmers own, and decline in land productivity (92 percent own less quality land), majority of the households do not produce enough yields for the year to meet food security on this limited land. And thus, in order to supplement the household income, farmers are forced to engage themselves in other activities apart from farming.

A special skill positively and significantly influences the nonfarm employment participation, i.e. it increases the probability of involvement in nonfarm activities and suggests that skilled households are likely to engage themselves in more paying self-employment activities. More specifically possessing skills such as masonry, handcrafts and merchants increase the probability of involvement in nonfarm

activities to the villages that are close the nearby towns while skills such as tannery, pot making, and goldsmith are associated to the villages that are far from towns.

Results of the regression model tell that distance to the nearest market has become one of the strong and major determinants of involvement in nonfarm employments. The significance and positive coefficient of the distance to the nearest market variable confirm that the concentration of the majority of the nonfarm activities to the town. The probability of nonfarm participation increases with proximity to towns. Put differently, households residing in the nearby the town are more likely to participate in nonfarm employments. This is due the fact that the opportunities for labor market and less commuting cost.

Access to a formal credit market is found to be one of the strong and major determinants of participation in nonfarm activities. Households with access to formal credit are more likely to participate in nonfarm activities than those without access. Access to the credit market gives opportunities to farm households to get the necessary capital to start up or to be participated in nonfarm employments.

A positive influence of village electrification on nonfarm employment participation was expected due to the fact that villages having electricity are close to the town/city and thus more nonfarm employment opportunities and labor market. The variable electricity is consistent with our prior expectation. Positive and significant influence of electricity on nonfarm employment participation is evident from the result.

Availability of irrigation seems to discourage participation in nonfarm employment. It is found to be negative and significant at 5 percent. Households with access to irrigation are less likely to participate in nonfarm employment. In other words household with a likelihood of a high income from agriculture do not participate in nonfarm activities. This makes sense because availability of irrigation requires more labor time to be spent in farming and also unlike crop production which is seasonal in nature, irrigation demands labor time throughout the year. On the top of this, farmers adopted irrigation in the area believed that irrigation income is better than such nonfarm activities income.

Finally, variables sex, education, marital status, perception of tenure security, livestock ownership and distance to the main road do not have a statistically significant relation with the probability of nonfarm employment participation

To estimate effect on food security given a household participated in nonfarm employments, the Heckman selection model is used. The results from the regression using the model are given in table below.

**Table 13: Heckman estimations of nonfarm participation and household expenditure**

| Variables | Expenditure | | Nonfarm participation | |
|---|---|---|---|---|
| | Coefficient | P>\|z\| | Coefficient | P>\|z\| |
| Household head sex | 1382.751 | 0.376 | -.7228009 | 0.274 |
| Household head education | 69.56429 | 0.551 | .1486609 | 0.104 |
| Married | 1727.64 | 0.389 | .6326218 | 0.435 |
| Household head age | -63.99532 | 0.243 | -.0344856 | 0.098* |
| Family size | 483.8913 | 0.041** | .292024 | 0.005*** |
| Special skill | 1162.157 | 0.210 | 1.858289 | 0.001*** |
| Land ownership | -4170.23 | 0.001*** | 1.707182 | 0.174 |
| Land size | 1168.752 | 0.058* | -.4820135 | 0.083* |
| Tenure security | | | .3006271 | 0.315 |
| Cows | 632.6635 | 0.018** | -.1179172 | 0.505 |
| Oxen | -406.6525 | 0.488 | .0176708 | 0.950 |
| Irrigation | 3656.588 | 0.000*** | -1.028937 | 0.014** |
| Credit | -72.50531 | 0.924 | .8328926 | 0.032** |
| Electricity | 248.7872 | 0.782 | .979403 | 0.048** |
| Distance to market | -3179.817 | 0.000*** | .9558707 | 0.010** |
| Distance to main road | 654.2338 | 0.423 | .2990218 | 0.508 |
| Constant | 8369.945 | 0.010 | -2.273986 | 0.010 |

Number of observations = 151
Censored observations = 72
Wald chi2(32)= 161.00
Prob > chi2= 0.0000
***, **, *** represent levels of significance at 10, 5 and 1 percent respectively**

The statistically significant parameter, mills lambda, confirms the superiority of Heckman selection model (two stage) above the ordinary least square alternative. The role of nonfarm participation in improving food security is positive and significant. From the results, variables family size, land ownership, land size, cows, access to irrigation and distance to the market are found to be significant in explaining household yearly expenditure. Given that a household participated in nonfarm employments a one person increase in family size results in an increase in yearly expenditure by 483.89 birr. Landownership decrease yearly expenditure by 4170 birr. This is because land owners are less likely to spend for grains in comparing to those do not have land. In other words the landless households are basically buyers of agricultural outputs and one would expect for such households to spend more expenditures for food items. However, an increase in land size results in an increase in expenditure by birr 1168. One possible reason for this is a higher land size may result more production or agricultural income and which might result higher

expenditure for household basic needs. Provided that a household participated in nonfarm work, an access to irrigation increase household yearly expenditure by 3656. Access to irrigation results more agricultural income which in turn results more expenditure. For a household participated in nonfarm employments an increase in cow results to an increase in yearly expenditure by birr 632. Distance to the nearest market affects yearly households' expenditure. For a household being seven km or one hour further from the town results in an increase in expenditure by birr 3179.This is basically due to high transportation cost.

## 6. Conclusions

The study attempts to investigate the link between food security and nonfarm employments whilst examining factors influence farmers to participate in nonfarm employments using the survey data collected from 151 randomly selected households from six villages of Woreda Gantafeshum, Eastern Tigrai, Ethiopia. Both descriptive analysis and econometric estimation results have been used to answer the stated key research questions. The following conclusions can be drawn.

Substantial numbers of farmers are involved in nonfarm activities to supplement farm income though the economy of the household is depending on farming.The result of the study shows that about 52 percent of the sampled households participated in nonfarm employments. The result also reveals that no significance difference in the level of participation in nonfarm employments between the male and female household groups.

Apart from food for work, masonry, daily labour and petty trade are the major nonfarm employments undertaken in the study area. The study points, among others, the three main reasons that explain the extent and involvement in nonfarm employments are insufficiency of income from agriculture, decline land size, soil fertility or productivity and shocks (rain failure, short rainy season, pests swarm, flood, etc) and thus farmers apparently participated in nonfarm employments due to push factors. But it should be noted that farmers undertake nonfarm activities during the dry or slack season.

The result of the study suggests that nonfarm employment improve farmers' livelihood. Farmers participated in nonfarm employments have shown improvements in daily food self sufficiency, housing, schooling of children and other. Further the statistical analysis confirms households that participate in nonfarm activities are more likely to spend for education, food, closing and health care than those who do not participate at all.

Nonetheless, farmers have been constrained by various factors while accessing the nonfarm employments. A frequently cited reason is absence of employment opportunities followed by lack of skill, and lack of nearby towns and transportation.

We found that land size, age, family size, special skill, electricity, credit, distance to the nearest market and access to irrigation are the most influencing variables in determining farmer's/household's participation in nonfarm activities.

Regarding the effect of nonfarm employment on households' food security, our study indicates that nonfarm employment provides additional income that enables farmers to spend more on their basic needs include: food, education, closing and health care. The result of the descriptive statistics also shown that there is a statistically significant difference in expenditures on basic needs between the participants and the non participants group. The result of the study implied that nonfarm employment has a role which is significant in maintaining household food security.

At household level, food security is maintained either by adequate production or earning sufficient income that enable household to purchase the required food. Here the policy option towards food security at household level is either to promote agricultural production or creating accesses to additional source of income such as nonfarm employments or a combination of both. In areas where agricultural production is not viable household should try to seek additional cash by involving in nonfarm employments. In line to this the study generally highlighted that nonfarm employments have positive contribution in meeting household food security. However, nonfarm employment opportunities are found to be limited. Therefore, rural development policy should promote nonfarm employments in attempt to address issues of food security.

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# INFORMAL LAND MARKETS AND EFFICIENCY IN RICE PRODUCTION IN WEST AMHARA REGION: THE CASE OF FOGERA DISTRICT

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*Abstract*

*In this paper we analyze the factors that affect choices of farm households for sharecropping tenancy and the differences between own-cultivated plots and sharecropped ones in regards to rice yield and inputs intensities. The analysis is based on the responses of randomly sampled 120 farm households in Fogera district of West Amhara Region whereby 398 plots cultivated by the sample households were considered. A multinomial logistic regression and a log-linear multiple regression models were employed. The results show that the decision to share-in land is positively related to labor-land ratio whereas it is negatively related to age of household head, sex of household heads (taking observations from male-headed households as a base) and the perceived value of farm plots. The decision to share-out land is positively related to sex of household head and access to credit whereas it is negatively related to oxen-land ratio, absence of disabled adult household member and the perceived value of farm plots. Moreover, our results show that own-cultivated plots do not significantly differ from sharecropped plots in terms of rice yield and intensities of major farm inputs in the area (i.e. labor, draft power, and seed). The latter result rejects the Marshallian arguments against sharecropping tenancy which states that sharecropping reduces production efficiency since it doesn't motivate tenants to put maximum efforts in the production process while landlords face prohibitively high monitoring costs to reduce inefficiency.*

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## 1. Introduction

One of the central policy challenges facing economies like Ethiopia is the issue of land ownership. This importance emanates from the fact that economic growth, employment and basic survival of the majority of the population depend on the productive efficiency of the agricultural sector. Significant improvements in agricultural productivity are crucial to address the worsening conditions of poverty and food security in Sub-Saharan Africa (Omit et al., 2000). In Ethiopia, improvement in land productivity is vital to enhance and sustain the welfare of the largely agrarian population.

Major issues of the existing land tenure system such as declining farm size, tenure security, and subsistence farming practices are linked to the causes of the poor performance of the agricultural sector. In many studies the land tenure system is cited as the major holdup to the adoption of sustainable and long-term land improvement and management practices. As a result, the land tenure issue has remained one of the sources of disagreement and focus of debate among politicians, academicians and other concerned parties in Ethiopia.

Much of the debate on land tenure in Ethiopia does not seem informed by sound theoretical foundations and empirical evidences; rather, they are largely guided by ideological outlooks that lack serious considerations for the social and economic implications (Yigremew, 2001). Moreover, land tenure debates are fixated in the state versus private ownership dichotomy though these are the only two polar end points of several possible tenure arrangements (Berhanu et al, 2004).

Nowadays, three options are available for smallholders to access farm lands in Ethiopia: land distribution for which peasant associations are mandated, inheritance, informal land use arrangements (sharecropping and fixed rent). Accessing land through land distribution is less likely because land distribution is officially pended by most regional governments including Amhara region at present for the reason that farmlands are getting fragmented as a result of continuous redistributions in the past. Moreover, available potential lands are dwindling through time to accommodate the growing number of rural youth. The allocation of the limited lands available is also conditional on proof of permanent physical residence, ability to farm continuously, and meet administrative dues and obligations which many may not fulfill (Tesfaye, 2004). Meanwhile, farmlands are getting fragmented as a result of informal distributions within family members. These situations made informal land use arrangements quite important in Amhara region in general and Fogera district in particular. Thus we are interested in informal land use arrangements in this study.

For the sake of analytical advantage we classified informal land use arrangements into six categories namely: (1) pure owners (autarkies), (2) pure share-in croppers (pure tenants), (3) pure share-out croppers (pure landlords), (4) mixed owner/share-in croppers (owner-cum sharecroppers), (5) mixed owner/share-out croppers and (6) mixed owner/ share-in croppers/ share-out croppers. The core objective of our analysis is to know what factors determine farmers' choice of one form of land use arrangement over the other. We were also interested if we could find supporting evidences for the so-called Marshallian argument against sharecropping which states that sharecropping is inefficient as compared to fixed rent tenancy since it doesn't provide the highest incentive for the tenant to put maximum efforts in the production process while monitoring costs are usually high to be fully incurred by the landlord (see below for discussion). The results show that the decision to share-in land is positively related to the size of adult family labor while negatively related to age of household head, female headship and the perceived value of a plot. The decision to share-out land is positively related to female headship and credit access but it is negatively related to oxen ownership, absence of disable adult family labor and the perceived value of a plot. Our analysis which compares sharecropping tenancy with other forms of arrangement with respect to three major inputs (labor, draft power, and seed) doesn't support the Marshallian argument.

The rest of the paper is organized as follows. Section 2 provides a brief discussion on land rights in rural areas of Amhara region. Section 3 discusses theoretical and empirical literature. Section 4 describes the methods used in the study. Section 5 presents and discusses the results and Section 6 concludes the paper.

## 2. Land rights in rural areas of Amhara Region

The state is the owner of all land in Ethiopia. The land is granted with holding rights by the government to the population of the region. There are three types of land rights. The first is landholding right which is defined as "a right of any farmer, semi pastoralist, or any other body (=person) vested with right on it to be the holder of a land, to create all asset on land, to transfer an asset he created, not to be displaced from his holding, to use his land for agriculture and natural resource development and other activities, to rent a land, to bequeath same to transfer it as a gift and includes the likes" (ANRS, 2006). A landholder can transfer his use right to another person in three different ways; by in heritance, gift and rent. Holding rights also be transferred in land exchange, so called consolidation of plots. For example, two farmers can exchange land parcels of equal value to improve and simplify farming.

The second is the use right. There is no clear definition of use right in the legislation, but according to the woreda officers and Environmental Protection, Land Administration and Use Authority (EPLAUA) staff, a use right is the right to exploit land for a certain purpose stated in an agreement between the user and the holder. The purpose of the use right can be for individual needs, for example, cultivating and living. It can also be a use right made out for an institution or an organization, for instance, schools and churches often have use rights to their land. Any person, both natural and legal person, vested with rural land use right can transfer as a gift or in rent to another person.

The third one is rent and lease. A land holder has the use right of his or her land, but a person can also get a use right of land by renting or leasing it from a land holder. A lease or rent agreement can be made out for maximum of 25 years. If the agreement is for more than three years it must be registered at the woreda desk office. A written agreement explains the location of the land, the duration of the agreement and the amount to be paid. It is possible to sub-contract the land if the land holder approves. The reason for including rent in the regional proclamation as one of form of land use arrangements is to formalize informal land markets. However, only tacit recognition has been given by local and regional officials to sharecropping which is the dominant form of land use contracts in the region. Actually, not only sharecropping but also most of the fixed rent contracts are undertaken informally as very few formal agreements are documented at woreda level offices responsible for this purpose.

A system for registration of properties and land users has been developed and is in use in all woredas in Amhara region. The land administration project started in 2002. When the plots have been registered the land holder receives a certificate called “book of possession”. By mid of 2005 five million landholders got their book of possession. The purpose of the book of possession is to strengthen tenure security and to give the farmers an incentive to protect their land and natural resources on it. It contains information about the land holder(s), fertility and use of land, the location of the parcels and borders defined by geodetic coordinates or bordering properties. While issuing the book of possession, the woreda keeps own records with the same information in another book called the “book of registration”.

When the land redistribution started, land was first grouped in three categories depending on the quality of the soil. The land was then handed out to the people with equal shares from every category of land. Because of the categorization of the land, the land parcels given to the people were spread over a quite big area. This has later on led to a big demand of consolidation of land parcels between the farmers to

improve the property structures and make farming more efficient. The land redistribution process is the basis of the current land rights registration.

## 3. Literature review

### 3.1 Theoretical issues

The debate against sharecropping tenancy dates back to the times of Alfred Marshall in the late 19th century. Marshall and subsequent followers argue that sharecropping is inherently an inferior tenancy when compared to the fixed-rent tenancy as well as pure cultivator-owned system. The argument for the inefficiency (or inferiority) of sharecropping relies on the assumption that the application of inputs by the tenant, such as labor, cannot be perfectly monitored and enforced by the landlord. If perfect monitoring were possible, the form of the tenancy contract would be irrelevant for our understanding of productive efficiency, because the efficient use of labor would be dictated by the landlord, irrespective of the particular choice of contract. It is based fundamentally on the appropriate provision of incentives. If the effort of the tenant cannot be monitored and controlled by the landlord, the tenant has an incentive to undersupply his effort as part of the output produced by him gets siphoned off to the landlord. Thus, proponents of the Marshallian thesis argue that a prohibitively high cost of monitoring the tenant's activities under sharecropping tenancy will lead to technical inefficiency in production (Shaban 1987).

If a fixed rent system is reasonably superior to a sharecropping arrangement, not only from a social efficiency angle, but also from the point of view of the landlord's individual rationality, then what is the reason behind the enduring popularity of sharecropping in real world agricultural practices? This is a theoretical puzzle which can be answered only through empirical studies. However, there are some theoretical speculations in this regard. Several theoretical reasons are given among which the prevalence of risk and uncertainty in agriculture is the dominant one (Ray 1998; Newberry and Stiglitz, 1979). In this regard, sharecropping is generally considered as a risk sharing instrument between the landlord and the tenant. Considering agriculture in developing countries as full of uncertainty, scholars in this line reasoning argue that despite its high output advantage to both the tenant and the landlord, fixed-rent tenancy is less preferable to the tenant. This is because under the fixed-rent tenancy the tenant is the one who takes the full burden of risk associated with natural shocks that might adversely affect the level of production from the land under the contract while the landlord is free from this burden. The landlord can play on this preference by cutting the tenant's share a bit more, but not too much, so that the tenant still prefers the sharecropping contract. This situation makes sharecropping to be rationally acceptable for both parties. Thus, as Ray (1998:434)

puts it, “sharecropping emerges as a way to share, not just output of the productive activity, but the risk associated to it as well”.

The line of argument of the so-called monitoring approach (sometimes labeled as “the new school”) forms the other theoretical reason for the existence of sharecropping tenancy. In contrast to the Marshallian arguments, proponents of the monitoring approach argue that sharecropping is as efficient as fixed-rent contract (Cheung, 1968; 1969; Newberry, 1974; Stiglitz, 1974). Their argument is based on the assumption that the landlord can monitor the tenant’s activities effectively and inexpensively. According to these scholars, landlords can stipulate the intensity of labor input per unit of land and devise effective monitoring mechanisms to extract the maximum benefit from their land. The theoretical discussions of this approach are extensively made in Newberry (1974, 1975, and 1977) and Stiglitz (1974).

## 3.2 Empirical evidences

Theoretically many factors can be considered to be responsible for the incidence of tenancy. For example, depending on the tenant’s age it is expected that the youngest tenants would prefer to work for wage, those in the intermediate age would go for the fixed-rent contract and the oldest would go for sharecropping contract (Chaudhuri and Maitra, 1997; Fujimoto, 1996). Moreover, the quality of land affects the choice of the contract. Chaudhuri and Maitra (1997) find that plots with high value are more likely to be under tenant cultivation (i.e., cultivated under a share or rental contract). This result is in contrast to some other studies (e.g. Shaban, 1987; Abebe, 2000). Other important factors for the incidence of tenancy are the disability status and credit access of an adult member of the household. In this regard, Chaudhuri and Maitra’s study shows that if an adult member is unable to work, then the probability of that family working as tenant goes down and if a farmer has better access to credit, the farmer would most likely be working for a rental contract. Similarly, Fujimoto (1996) found that the older the age of the landlord, the smaller the area of rented land, the closer the field to the landlord’s house and the smaller the size of the tenant’s farm, the more likely was a particular contract to take the form of share tenancy. Fujimoto’s study also suggests that a tenancy contract was more likely to take the form of fixed rent when the landlord resided in a village different from the tenant’s.

Most land-related studies in Ethiopia focus on land tenure security, farmers’ willingness to pay for institutionalizing more secured land tenure arrangements and the effect of land reform under different regime of the country. However, we accessed only a few notable studies on informal land markets (Bereket and Croppenstedt, 1995; Abebe, 2000; 2004; Dessalegn, 1984; and Deininger et al, 2006). These

studies addresses different aspects of informal land use arrangements and try to test the importance different factors vis-à-vis farmers' choices of one form of land use arrangement over the other.

Some of these studies reveal that the quality land matters in land contractual choices (Abebe, 2004; Tesfaye, 2004; Bereket and Croppenstedt, 1995). Abebe (2004) argues that land that is exposed to erosion or drainage problems is often leased out. Similarly, in his study in Southern Ethiopia, Tesfaye (2004) posits that farmers who lease out land tend to share out eroded or poor quality land. These results are consonant with the results obtained by Shaban (1987) in eight Indian villages.

Informal land markets are indispensable mechanisms of accessing agricultural land for the majority of oxen-rich and/or newly established landless households (Abebe, 2000; 2004). Abebe (2000) argues that rental land markets play an entitlement-redistributive role among members of rural communities. However, he could not try to investigate whether informal land markets do have an efficiency enhancing function. In his latter study, Abebe attempts to examine the factors that influence households' scope and pattern of participation in informal land markets and explores the likely impacts of agricultural growth, equity and rural livelihood in general (Abebe, 2004). However, he discussed informal land markets with the concept of agrarian differentiation in lump sum without separately analyzing the effect of different types of these markets such as sharecropping and fixed rent.

Bereket and Croppenstedt (1995) also conducted a similar study. They argue that sharecropping can bring the ratios of various inputs in line with efficient production. Their results generally suggest that sharecropping is used as a form of adjusting land size to factor endowments. However, one cannot be sure how important this adjustment is in disposing excess endowments from the results since ownership categories (share, non-share) are not clearly indicated. A contrasting result to Bereket and Croppenstedt's (1995) study is that of Deininger et al (2006). Deininger et al (2006) found that the extent to which rental markets allow households to attain their desired operational holding size is extremely limited. The possible reasons underlying such behavior are factor market imperfections (e.g. weak rental market for oxen), lack of alternative employment opportunities, and tenure insecurity.

## 4. Methods of the study

### 4.1 Data collection

The study mainly depends on primary data collected in November 2008 through a household survey. A two-stage stratified random sampling technique was used to

select representative samples. While the primary sampling units are rice producing kebeles in Fogera district, households are the ultimate sampling units of this study. First, three kebeles—namely: Shina, Avoana Kokit and Kuhar Michael—were selected purposively since rice is produced there. Thereafter, households in each of the selected kebeles were categorized into two strata based on the sex of household heads using member lists of the kebeles. Forty households were selected from each kebele—30 from the stratum of male-headed households and 10 from the female-headed ones—which yields a total sample size of 120 households. A structured questionnaire was developed and used to collect the data. In order to supplement the primary data, secondary data were collected from different offices such as Fogera district agriculture and rural development office.

## 4.2 Data analysis

This study uses two types of econometric models. We apply a multinomial logit model to analyze determinants of land contractual choice whereas we use a multiple linear regression (with OLS estimation technique) to examine whether input and output intensity differences exist between owned and sharecropped land.

Our multinomial logit model constitutes a dependent variable with three discrete values: own cultivation, share-in cropping, and share-out cropping. Here we assume that there is an underlying response variable $Contract^*$ defined by the following relationship:

$$Contract^* = \beta^* X + U.. \quad \textbf{(1)}$$

where $X$ denotes a vector of explanatory variables (such as age, sex, farm size, ox-ownership, household size, access to credit, plot value, irrigation status and soil fertility of the plots under cultivation) and $U$ is the error term assumed to be distributed normally with zero mean and unit variance. However, in practice $Contract^*$ is unobservable and what we can observe is the multinomial variable $Contract$ such that:

$$Contract = \begin{cases} 0, if & Contract^* \le 0 \\ 1, if & 0 < Contract^* < \mu \\ 2, if & Contract^* \ge \mu \end{cases} \quad \text{..... ..... ..... ....(2)}$$

Following Greene (2003), the log likelihood function is:

$$L(\beta,\mu)=\sum_{CONTRACT=0}\log\Phi(-\beta X)+\sum_{contract=1}\log\Phi(\beta X-\mu)+\sum_{contract=2}\log\{\Phi(\mu-\beta X)-\Phi(-\beta X)\}\ldots(3)$$

The estimates of the model parameters are computed by maximizing equation (3). We included both household and plot level characteristics as the explanatory variables in order to see the effect of household characteristics on contract choice while the variation in plot characteristics is controlled.

The comparison of a household's average inputs and outputs per unit area on owned and sharecropped land was first proposed by Bell (1977) in testing the implications of the monitoring and the Marshallian approaches for sharecropping. Such a test holds constant family-specific characteristics such as management, access to non-traded inputs, and prices of traded inputs and outputs. Latter, this method was effectively demonstrated by Shaban (1987). We also adopt this approach to compare the input intensities and productivities on owned and sharecropped land of the same household. The estimated model is the following:

$$Y_{ij} = \theta S_{ij} + \beta X_{ij} + D_t + U_{ij} \quad \ldots\ldots\ldots \quad \ldots\ldots\ldots \quad \ldots\ldots\ldots \quad .(4)$$

where, $Y_{ij}$ denotes the value of crop output produced per hectare by household $i$ on plot $j$ (also denotes the value of variable inputs—such as human labor, draft power, or seed—used per hectare by household $i$ on plot $j$); $S_{ij}$ is a dummy variable that equals 1 if the plot $j$ of household $i$ is owner-cultivated and 0 if the plot is sharecropped; $X_{ij}$ is a vector of exogenous plot characteristics such as irrigation, plot fertility status, and the perceived value of the plot; $D_d$ is a vector of district dummies; and $U_{ij}$ is the error term which represents unobserved plot and household variables and assumed to be identically and independently distributed with mean zero and finite variance.

A test between the competing approaches to sharecropping will be carried out by testing for the coefficient of the ownership dummy (i.e. θ). The assumption of perfect monitoring of sharecroppers' activities is taken as the null hypothesis that predicts: $H_0$: θ = 0. The Marshallian productive inefficiency of sharecropping would prevail if the mixed sharecroppers supplied more inputs per hectare to their owned relative to sharecropped land or produced more output per hectare from own land as compared to shared-in land i.e. $H_A$: θ > 0. Table 1 shows definitions of the variables used in multinomial logit model and multiple regression models.

**Table 1: Definitions of Variables**

| Short hand | Definition |
|---|---|
| Age of household head | Age of household head |
| Age square | Square of age of household head |
| Sex | A dummy variable which takes on a value of 1 if the household head is female and 0 otherwise |
| Size of adult family labor | Number of household members between 15 and 60 years old |
| Number of oxen owned | Number of oxen owned |
| No disabled household members | A dummy variable which takes on a value of 1 if a household doesn't constitute a disabled member and 0 otherwise |
| Access to credit | A dummy variable which takes on a value of 1 if the household has access to credit and 0 otherwise |
| Off-farm employment | A dummy variable which takes on a value of 1 if the household has access to off-farm employment and 0 otherwise |
| Plot value | The value of farm plots (in Birr) as perceived by the respondent |
| Irrigation | A dummy variable which takes on a value of 1 if a plot is irrigated and 0 otherwise |
| Soil fertility status | A dummy variable which takes on a value of 1 if a plot is perceived to be fertile and 0 otherwise |
| Draft power | Draft power (oxen days/ha) |
| Hired labor | A dummy variable which takes on a value of 1 if a household uses hired labor and 0 otherwise |
| Female labor | A dummy variable which takes on a value of 1 if a household uses female labor and 0 otherwise |
| Family labor input | Amount of family labor used in farm activities (mandays/ha) |
| Hired labor input | Amount of hired labor used in farm activities (mandays/ha) |
| Ownership dummy | A dummy variable which takes on a value of 1 if a farm plot is owned and 0 if it is shared-in. |

# 5. Results and discussions

## 5. 1 Household characteristics

Table 2 compares pure-owner-croppers and non-pure-owner-croppers (i.e. share-in-croppers and share-out-croppers) with respect to a number of variables. Pure-owner-croppers are significantly differs from the other two in terms of demographic variables (i.e. age, sex, and education level of household head, family size, number of dependents and size active labor force), asset ownership (land size and number of oxen owned), and access to institutional services (access to credit and access to

extension services). In regards to demographic characteristics, the results show that share-in-croppers are relatively young as compared to pure-owner-croppers; that larger proportion of female-headed households are share-out-croppers; that share-out-croppers have lower size of labor force and have lower level of education.

There exist significant differences between pure-owner-croppers and the other two categories of households in terms of oxen ownership. The majority of share-out-croppers either own only one ox or no ox at all. In contrast to this result, the percentage of share-in-croppers who own a pair of oxen is significantly higher than that of pure-owner-croppers. On the other hand, significantly small percent of share-out-croppers own a pair of oxen as compared to pure-owner-croppers. In terms of the average number of oxen ownership, share-in-croppers take the highest position while share-in-croppers take the least; both are significantly differ from pure-owner-croppers. This is an important indicator that oxen are critical resources which determine households' decisions to participate in informal land rental markets as share-in-croppers or as share-out-croppers.

Both share-in-croppers and share-out-croppers are significantly different from pure-owner-croppers in terms of land ownership. As expected, share-in-croppers own lower size of land than pure-owner-croppers indicating that land scarcity is the driving factor for sharecropping. Similarly, share-out-croppers own lower size of land than pure-owner-croppers. However, share-out-croppers are better-off in terms of the absolute size of land owned. When the total size of land is considered to compare the two categories of households with pure-owner-croppers, the result is a bit different. In this case, share-in-croppers converge to pure-owner-croppers in terms of the size of cultivated land whereas share-out-croppers diverge from pure-owner-croppers in this regard. This implies informal land markets have some distributive role though their impact on the overall distribution of operational land is inconclusive from this study.

Based on the perception of the local people, the sample households in each kebele were classified into better-off, medium, and poor strata. The results show that the poor constitute the largest percent of the share-out-cropper category whereas better-off households are relatively large in the share-in-cropper category. This implies that the poor participated mainly on the supply side whereas better-off households participated mainly on the demand side of land rental markets. This is a reasonable result given that the poor are usually in short of some critical farm resources (e.g. oxen) to cultivate large size of land whereas the better-off are relatively more capable. Since the other factor markets (such as labor, ox and credit) are missing or incomplete in the study areas, farmers use land markets as a substitute for those missing or incomplete markets. On the other hand, households in the medium wealth category constitute the majority of pure-owner-croppers as well as share-in-croppers

implying that their position is precarious; they join the share-in-cropper category when resources are better (because of some opportunities) but remain autarchic in terms of operational land when resources are poor (because of some external shocks).

Access to institutional services and off-farm employment are the another points of comparison. Contrary to expectations, share-out-croppers are better than pure-owner-croppers in terms of the percent of households who had access to credit. However, the two groups are not significantly different in terms of the average amount of loan received. On the other hand, share-in-croppers are not as such different from pure-owner-croppers in terms of the percent of households who had access to credit as well as in terms of the average amount of loan received. In terms of the access to extension services pure-owner-croppers are significantly better than share-out-croppers but they are not different from share-in-croppers. Off-farm employment is not as such an important factor to distinguish pure-owner-croppers from the other two categories.

The distributions of the three categories of households vary across the target kebeles. Relatively high percent of share-out-croppers are found in Shina kebele whereas pure-owner-croppers are more concentrated in Avoana Kokit. Kuhar Michael contributes equally to the share-in-cropper and share-out-cropper categories but it is lower than the two districts in terms pure-owner-croppers.

**Table 2: Characteristics of Sample Households with respect to Land-use Categories**

| Variable | Pure-owner-cropper (N = 42) | Share-in cropper (N = 52) | Share-out cropper (N = 49) |
|---|---|---|---|
| **Demographic characteristics** | | | |
| Age of household head (years) | 44.86 | 40.42** | 47.58 |
| Female-headed household (%) | 23.81 | 1.92*** | 73.08*** |
| Education level of household head (years) | 2.36 | 2.40 | 0.96** |
| Household size (No.) | 5.90 | 5.96 | 4.23*** |
| Number of adult female in the household | 1.43 | 1.40 | 1.19* |
| Number of adult male in the household | 1.69 | 1.75 | 0.69*** |
| Number of dependents (<15 years & >60 years) | 2.79 | 2.81 | 2.35 |
| No disabled household member (%) | 97.62 | 94.23 | 96.15 |
| **Wealth status** | | | |
| Poor (%) | 21.43 | 9.62 | 69.23 |
| Medium %) | 64.29 | 69.23 | 26.92 |
| Better-off (%) | 14.29 | 21.15 | 3.85 |

**Table 2: continued**

| | | | |
|---|---|---|---|
| **Oxen ownership** | | | |
| Own one ox or none (%) | 45.24 | 15.38*** | 80.77*** |
| Own two oxen (%) | 35.71 | 57.69** | 15.38** |
| Own more than two oxen (%) | 19.05 | 26.92 | 3.85** |
| Number of oxen owned | 1.71 | 2.17*** | 0.62*** |
| **Land ownership** | | | |
| Owned land (ha) | 0.88 | 0.59*** | 0.72** |
| Shared-in/share-out land (ha) | 0.00 | 0.41*** | 0.54*** |
| Total cultivated land (ha) | 0.88 | 1.00* | 0.19*** |
| **Access to institutional services** | | | |
| Access to credit (%) | 26.19 | 28.85 | 42.31* |
| Amount of credit received (birr) | 661.90 | 425.38 | 411.54 |
| Access to extension services (%) | 100.00 | 98.08 | 84.62*** |
| **Off-farm employment** | | | |
| Access to off-farm employment (%) | 9.52 | 11.54 | 3.85 |
| Amount of income earned (birr) | 7.14 | 119.23* | 103.85 |
| **Kebele dummies** | | | |
| Shina (%) | 26.19 | 30.77 | 50.00 |
| Avoana Kokit (%) | 57.14 | 26.92 | 7.69 |
| Kuhar Michael (%) | 16.67 | 42.31 | 42.31 |

**Note:** Cultivated area is defined as the sum of area of owned and shared-in plots minus area of shared-out plots.

***, **, and * denote significance at 1%, 5%, 10% levels, respectively, when share-in-croppers or share-out-croppers are compared to pure-owner-croppers with respect the corresponding variable. T-tests and Chi-square tests were used for continuous variables and dummy variables respectively.

Source: Computed from survey data

## 5.2 Nature of sharecropping contracts and plot-level differences

Majority of the sample households (65 %) participate in sharecropping either as share-in-croppers or as share-out-croppers. The duration of the sharecropping contract is less than three seasons. Opinions of the sample households show that the demand for rice land in Fogera woreda is increasing from time to time. Hence, some tenants are willing to pay cash on top of the stipulated proportion of output they should share to the landlord. As a result of the high level of demand for land, landlords usually prefer to shorten the period of the contract in order to maximize their benefit. The majority (80%) of the demand arises from the same village.

Kinship plays a crucial role in fixing sharecropping contracts. About two-third (67%) of the sample households, who participated in sharecropping, responded that they have

some kinds of relationship (related by blood or have conjugal ties) with the person with whom they had contract agreements. Friendship accounts for about 18% in this regards whereas 15% of the contracts were fixed within non-kinship and non-friendship structure. The fact that such considerable percent of contracts operate out of the kinship domain implies that land rental markets are to some extent competitive; and hence if the tenant has a reputation for trustworthiness and hardworking, s/he will acquire land through informal markets. According to the responses sharecropping partners are selected based on the following qualities: trustworthiness (54 % of the responses), hard work (18 %), willing to help each other (7%), trustworthiness and hard work (4%), and other reasons (17%).

There is no considerable variation among the three kebeles regarding the rules for sharing outputs and inputs. Outputs are shared equally by landlords and tenants in Shina and Kuhar Michael whereas the landlord's share of output in Avoana Kokit is about 45 %. The landlord takes on average about 40% of crop residues; his/her share is 35% in Avoana Kokit, 37% in Shina, and 45% in Kuhar Michael. The costs of major inputs—labor, draft power, seed, and farm implements—are almost entirely borne by tenants with little variation across kebeles; in Shina and Kuhar Michael, landlords contribute on average less than 3% of the total input cost whereas they contribute nothing in Avoana Kokit. This situation could have a significant impact on the difference of intensities of inputs and output among sharecropped plots and own plots.

Table 3 presents descriptive results on the type and amount of inputs and output produced and various attributes of 398 sample plots cultivated by the sample households in the production year of 2007/08. The first 3 columns are based on the whole sample whereas the last two columns represent the sub-sample of owner-cum-sharecroppers. Columns 3 and 6 show statistical significance of the difference in means between owned and sharecropped plots.

The results show that productivity (output per hectare) is on average significantly lower on shared plots than owned plots for the overall sample as well as for owner-cum-sharecroppers. The reason could be the difference between the fertility level of own-cultivated plots and sharecropped plots: own-cultivated plots are of significantly higher value (about 5599 birr/ha) than share-in (about 3951 birr/ha) and shared-out plots (about 3557 birr/ha). Moreover, it may be because of lower intensities of some important inputs (e.g. seed rate and draft power) in shared-in plots as compared to owned ones. However, the difference in productivity is not attributable to labor input (both family labor and hired labor) and soil fertility since the own-cultivated plots and sharecropped plots are not significantly different from each other with respect to these variables.

**Table 3: Differences in Plot Characteristics, Output, and Input Use across Land-use Categories**

| Variables | Total sample | | | Owner-cum-sharecroppers | |
|---|---|---|---|---|---|
| | Owner cultivated (N =262) | Shared-in (N = 85) | Shared-out (N = 51) | Owner cultivated (N = 113) | Shared-in (N = 78) |
| Crop yield (Kg/ha) | 5255 | 4582*** | | 5264 | 4706** |
| Plot area (ha) | 0.27 | 0.25** | 0.28 | 0.27 | 0.25* |
| Irrigated-land dummy (%) | 42.37 | 32.94* | 3.92*** | 47.79 | 33.33** |
| Fertile-plot dummy (%) | 29.39 | 29.41 | 25.49 | 27.19 | 32.05 |
| Plot value (birr/ha) | 5599.24 | 3950.59 | 3556.86*** | 5415.93 | 3997.44*** |
| Seed rate (kg/ha) | 173.24 | 149.68*** | | 160.14 | 148.24** |
| Draft (pair of oxen-days/ha) | 19.13 | 16.84*** | | 19.43 | 17.16** |
| Female labor dummy (%) | 87.40 | 91.76 | | 92.11 | 91.03 |
| Female labor amount (MD) | 256.17 | 305.05 | | 262.68 | 302.69 |
| Male labor input (MD) | 1113.48 | 1055.69 | | 1188.18 | 1095.40 |
| Total family labor amount (MD) | 1369.65 | 1360.74 | | 1450.87 | 1398.09 |
| Female hired labor dummy (%) | 19.08 | 22.35 | | 23.68 | 23.08 |
| Female hired labor amount (MD) | 26.31 | 41.21* | | 41.57 | 44.46 |
| Male hired labor dummy (%) | 58.02 | 45.88** | | 56.14 | 47.44 |
| Male hired labor amount (MD) | 261.59 | 192.16 | | 197.33 | 201.76 |
| Hired labor dummy (%) | 58.02 | 45.88** | | 56.14 | 47.44 |
| Total hired labor amount (MD) | 287.90 | 233.37 | | 238.91 | 246.22 |
| Total labor amount (MD) | 1657.55 | 1594.11 | | 1689.77 | 1644.31 |
| **Kebele dummies** | | | | | |
| Shina (%) | 32.06 | 41.18 | 49.02 | 32.74 | 37.18 |
| Avoana Kokit (%) | 45.80 | 23.53 | 5.88 | 34.51 | 25.64 |
| Kuhar Michael (%) | 22.14 | 35.29 | 45.10 | 32.74 | 37.18 |

**Note:** ***, **, and * denote significance at 1%, 5%, 10% levels, respectively. T-tests and Chi-square tests were used for continuous variables and dummy variables, respectively. Comparisons have been made with respect to owner cultivated category.

MD represents man-days. Source: Own computation from survey data 2007/08

## 5.3 Econometric results

### 5.3.1 What determines decision to share-in or share-out land?

Table 4 presents the maximum likelihood results of the multinomial regression. A positive sign of the estimated coefficient indicates that the variable increases the probability that the plot is shared-in or shared-out whereas a negative sign indicates the variable increases the probability that the plot is kept under owner cultivation. Column 2 and 4 present the estimated coefficients. Among the explanatory variables included in the model age of household head, number of adult household members, sex of household head, and perceived value of plot significantly influence farmers decision to share-in land whereas age of household head, age square, number of oxen owned, sex of household head, access to credit, absence of disabled person in the household, and plot value significantly influence farmers decision to share-out their land.

Age of household head is negatively significant at 10% and 5 % level for the incidence of share-in and share-out cropping, respectively. On the demand side this implies that as age of household head increases the probability of that family working as tenant goes down whereas on the supply side it implies that the probability that a plot being under owner cultivation increases instead of being shared-out as age of household head increases. Both cases imply that as age of household head increases odds ratio of participation on land rental markets goes down.

Age square positively influences framers decision to share-out their land but it doesn't influence their decision to share-in. The significance of age of household head and its square with respect to the decision to share-out land indicates the existence of a 'U' shape relationship: i.e. first the probability that a household shares-out its land decreases up to a certain level of the age of household head and then it increases after that level of age.

**Table 4: Multinomial Logistic Regression Results for Choice of Land Use Arrangements**

**CONTRACT = 0, if plot is under owner cultivation (used as a base in this analysis)**
**= 1, if plot is under share-in cropping**
**= 2, if plot is under share-out cropping**

| Variables | Shared-in | | Shared-out | |
|---|---|---|---|---|
| | **Coefficient** | **Marginal effect** | **Coefficient** | **Marginal effect** |
| Age of hh head | -0.19896* | -0.0290946 | -0.3547015** | -0.005425 |
| Age square | 0.0017634 | 0.0002565 | 0.0035582** | 0.0000552 |
| No. of adult hh member | 0.0495893* | 0.0077005 | -0.0493215 | -0.0010061 |
| Number oxen owned | 0.0309369 | 0.0056788 | -0.2991966*** | -0.0052238 |
| Sex of hh head | -1.453708* | -0.1756585 | 2.538932*** | 0.127935 |
| Access to credit | 0.417187 | 0.0621358 | 0.9622968* | 0.017917 |
| Off-farm employment | 0.1305082 | 0.0159064 | 0.8966674 | 0.0217278 |
| No disabled member | -0.1003698 | 0.0114959 | -2.39662** | -0.1320589 |
| Plot value | -0.99069*** | -0.1455796 | -1.548981** | -0.0232937 |
| Fertile Plot | 0.2280992 | 0.0356994 | 0.0099477 | -0.0005985 |
| Plot irrigated | -0.1576031 | -0.0199151 | -1.30014 | -0.0193113 |
| Constant | 11.33308*** | | 22.01364*** | |
| Number of observations | 398 | | | |
| LR chi2 | 229.72 | | | |
| Prob > chi2 | 0.0000 | | | |
| df | 22 | | | |
| Pseudo R2 | 0.3324 | | | |

***, **, and * show significance at 1%, 5%, and 10% levels, respectively
Source: Computed from survey data

The perceived value of a plot is negatively related to share-in and share-out cropping. This implies that the probability of a plot being under sharecropping decreases with an increase in the perceived value of the plot. The marginal analysis also shows that as the perceived value of the plot increases by 1% the probability that a plot would be shared-in decreases by 15% and that the plot would be shared-out decreases by 2%. Ghosh (1995) also predicts a sharp testable relationship between land quality and contractual form. He argues that the best quality land will be cultivated by the owner, medium grade land will be sharecropped and the poorest quality land will be rented out on fixed rent basis. The empirical result of this study on this regard goes in favor of this direction.

The number of adult household members relative to the size of own land (labor-land ratio) is positively related to the dependent variable. This implies that those households with relatively abundant labor show high tendency to cultivate others' lands through sharecropping arrangements. For the sake of comparison, we also regressed the dependent variable on absolute size of the household labor force by removing the labor-land ratio variable from the model. However, the latter variable was not significant implying that what matters for the incidence of sharecropping tenancy is that of the relative size of adult family labor to land but not its absolute size. This is a reasonable result given that land is getting scarce in the study areas while productivity is still low.

The number draught animal relative to the size of own land (oxen-land ratio), negatively influence the decision of farmers to share-out their land ($P < 0.01$). This strongly suggests that if oxen-land ratio increases, odds of participation on share-out cropping will go down. However, this variable doesn't have a significant relationship with farmers' decision to share-in land.

The other important variable in our regression is sex of household head. The results show that female-headed households are more likely to share-out their land and less likely to share-in others' land for cultivation. The possible reason is that the role of women in managing farm activities is quite limited in Ethiopia because of cultural reasons. The domestic role of women is more pronounced in rural areas and those who are engaged in farm management usually focus on backyard vegetable production or other petty productions.

Those households which constitute adult disabled members have higher chance of sharing-out their land as compared to their counter parts. In other words, households which are free from physical disability are less likely to share-out their land. The probability that a plot being under owner cultivation instead of being shared-out for

those households who do not have any disable adult family labor will be on average 13% larger than those households who have disabled member(s). Indeed, this is a reasonable relationship given that most agricultural activities in Ethiopia require physical strength since the use of modern machineries is negligible.

The access of farm household to credit is another important factor in our regression. Contrary to expectations, it has a positive and significant relationship to farmers' decision to share-out land. The marginal analysis in Table 4 indicates that the probability that a household shares-out its land will increases by 2% if it gains access to credit.

### 5.3.2 Does sharecropping tenancy matter for efficiency?

In order to examine whether share-cropping tenancy determines the level of efficiency among the sample households, we used a log-linear multiple regression model. We included an ownership dummy variable to test for the difference between owned plots and sharecropped ones in terms of output per hectare, labor input per hectare, draft power input per hectare, and seed rate. In this case, we only considered the data collected from those households who simultaneously cultivated their own plots and shared-in plots (hereinafter termed as owner-cum-sharecroppers). Thus, our valid data constitutes observations corresponding to 191 farm plots operated by 49 owner-cum-sharecroppers.

The results are displayed in Tables 5 and 6. Though the coefficient of the ownership dummy is positive, it is not statistically significant at any acceptable level which implies that owned plots and shared-in plots do not differ from each other in terms of rice yield (Table 5). Similarly, the two types of farm plots do not differ from each other in terms of all the three major inputs considered (Table 6). Altogether, our analysis doesn't provide any supporting evidence for the Marshallian inefficiency argument against sharecropping. Rather our results tend to support the monitoring approach. The possible reasons are: (1) Monitoring of tenants is relatively easy as the majority of sharecropping agreements are made between relatives and, in most of the cases, landlords and tenants reside within the same village; (2) most of the costs are borne by the tenant which would lead him/her to pay adequate attention to the sharecropped land; (3) the high demand for farm land in the area might have also forced the tenants to increase their efforts on sharecropped lands to buy approval of the landlord for the next round.

**Table 5: Determinants of Rice Yield for Owner-cum-sharecroppers**

| Variables | Excluding input use | All variables |
|---|---|---|
| Ownership dummy | 0.1086953 | 0.0790253 |
| | (0.099) | (0.091) |
| Seed rate (Kg/ha) (log) | | 0.5795998*** |
| | | (0.180) |
| Hired labor (MD/ ha) (log) | | -0.0364344 |
| | | (0.082) |
| Family labor (MD/ha) (log) | | 0.1957634*** |
| | | (0.041) |
| Draft power (Pair-of-oxen days per ha )(log) | | -0.010732 |
| | | (0.175) |
| Female family labor (dummy) | | -0.0853434 |
| | | (0.182) |
| Hired labor (dummy) | | 0.3179732 |
| | | (0.476) |
| Irrigated plot (dummy) | 0.3196197*** | 0.2995173*** |
| | (0.111) | (0.103) |
| Fertile plot (dummy) | -0.5583705*** | -0.5562065*** |
| | (0.118) | (0.112) |
| Plot value (log) | -0.00473 | -0.111326 |
| | (0.142) | (0.132) |
| Shina (dummy) | 3.693442*** | 0.2628244 |
| | (1.114) | (1.298) |
| Avoana Kokit (dummy) | 3.767037*** | 0.5131879 |
| | (1.261) | (1.407) |
| Kuhar Michael (dummy) | 3.858686*** | 0.7000399 |
| | (1.197) | (1.329) |
| F | 983.16 | 634.59 |
| $R^2$ | 0.974 | 0.9789 |
| Adj $R^2$ | 0.973 | 0.9773 |
| No. of observations | 191 | 191 |
| No. of households | 49 | 49 |

**Note:** Figures in parenthesis represent the standard error. ***, **, * denote significance at 1%, 5%, and 10%, respectively
Source: Computed from survey data

**Table 6: Determinants of Input Intensity per Hectare for Owner-cum-sharecroppers**

| Variables | Seed rate (kg/ha) (log) | Draft power (Pair-of-oxen days per ha) (log) | Total labor (MD/ha) (log) |
|---|---|---|---|
| Land Ownership (dummy) | 0.0548675 | 0.0414691 | -0.145414 |
| | (0.039) | (0.043) | (0.155) |
| Irrigated plot (dummy) | -0.0155208 | 0.0726939 | 0.1283556 |
| | (0.044) | (0.048) | (0.174) |
| Fertile plot (dummy) | -0.0018624 | -0.0987842* | -0.0199993 |
| | (0.047) | (0.051) | (0.185) |
| Plot value (log) | 0.0864196 | 0.0020091 | 0.1807098 |
| | (0.056) | (0.061) | (0.223) |
| Shina (dummy) | 4.464846*** | 2.488049*** | 5.810494*** |
| | (0.439) | (0.481) | (1.746) |
| Avoana Kokit (dummy) | 4.264563*** | 3.20312*** | 5.454455*** |
| | (0.497) | (0.544) | (1.976) |
| Kuhar Michael (dummy) | 4.035139*** | 2.760828*** | 5.69443*** |
| | (0.472) | (0.516) | (1.875) |
| F | 11087.69 | 3025.05 | 1424.66 |
| $R^2$ | 0.9976 | 0.9914 | 0.9819 |
| Adj $R^2$ | 0.9975 | 0.9911 | 0.9812 |
| No. of observations | 191 | 191 | 191 |
| No. of households | 49 | 49 | 49 |

**Note:** Figures in parenthesis represent the standard error. ***, **, * denote significance at 1%, 5%, and 10%, respectively

Source: Computed from survey data

## 6. Conclusions

In this paper we presented empirical evidences using data collected from three rice producing kebeles in Fogera district of Amhara region. We first analyzed the factors that affect the incidences of sharecropping tenancy and then we analyzed the difference between owned and sharecropped plots in regards to rice yield and input intensities. The results indicate that the decision of the farmers to share-in land, share-out land, or opt for autarchy is determined by the following explanatory variables: the perceived value of farm plots, labor-land ratio, oxen-land ratio, sex of household head, age of household head, access to credit, and whether a household doesn't constitute disabled adult members. The decision to share-in land is positively influenced by the size of household labor relative to the size of own land but negatively influenced by sex of household head (taking observations for male-headed households as a base) and the perceived value of farm plots. Similarly, the decision

to share-out land is positively influenced by sex of household head, age of household head above some threshold point, and access to credit whereas it is negatively affected by oxen-land ratio, age of household head below some threshold point, the perceived value of farm plots, and absence of disabled adult in the household.

Our results suggest that informal land markets are strongly interlocked with other important factor markets (such as oxen, human labor and credit), which are incomplete or missing particularly in the study areas. This implies that farmers use informal land markets as a substitute for those incomplete factors' markets. Thus, farmers who face shortage of labor and draft power are forced to share-out their land whereas those household who possess adequate and oxen tend to be either share-in-croppers or pure-own-croppers.

As an important part of this study, we also examined if operator owned plots differ from sharecropped ones in terms of rice yield and selected inputs (family labor, draft power, and seed). The results show that there is no difference between owned plots and sharecropped plots in regards to rice yield and the major inputs. Thus, our results do not provide support for the Marshallian argument against sharecropping; they are rather in favor of the monitoring approach which argues that sharecropping doesn't hamper the realization of technical efficiency in agricultural production. Furthermore, the results suggest that sharecropping serves not only as a means of sharing farming related risks but also helps to use farm resources more effectively by transferring land from labor-scare households to labor-abundant ones, from older to younger households, and from relatively land-abundant households to land-constrained ones (e.g. landless youth). However, inserting a caveat is necessary at this point to inform readers: only a narrow inference can be made from the results because of the narrow geographical coverage of the study and small sample size.

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# SMALLHOLDER BANANA MARKETING IN SOUTHERN ETHIOPIA: A TRANSACTION COST ECONOMICS PERSPECTIVE

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*Abstract*

*Problems such as high transaction costs, poor roads, information asymmetry, and other market imperfections are detrimental for smallholders' market integration. High transaction costs, particularly, are major obstacles for smallholder market integration. Transaction costs in the form of information and search, bargaining and negotiation, as well as monitoring and enforcement costs are likely to influence smallholders´ marketing behavior. This study hypothesizes that the level of income generated from banana sales in southern Ethiopia is strongly influenced by transaction costs. Regression analysis shows that the depth of marketing is significantly influenced by transaction costs. Results from two stages least square estimation (2SLS) show that the level of income generated from selling banana is indeed determined by the depth of marketing. The implication of the finding is that households with lower transaction costs are expected to generate higher income from banana. Hence, investments in public goods such as roads, telecommunications and appropriate institutions, as well as farmer support services in terms of input supply and marketing information, may enhance farm income by and in turn improve the livelihood of the rural poor.*

**Key words:** transaction costs, market integration, banana, Ethiopia
JEL Classification: D23, Q12, Q13

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## 1. Introduction

A rapid growth in the international trade of high value crops, particularly of fruits and vegetables, is an incentive for a significant rise in production and export of these crops compared with the traditional cearial production. To this end, World wide export of fruit and vegetables, which are the major components of high value crops increased from US$ 69 billion in 1997 to US$ 124 billion in 2006 with an annual growth rate of 6 percent (FAOSTAT, 2008). Exports of traditional cereals on the other hand only grew by 1.8 percent from 1997-2006. There has been a similar trend in Sub-Saharan African economies regarding the importance of the horticulture sector. For instance, the contribution of fruits and vegetables in the total value of agricultural export increased from an average of 7 percent in the early 1980's to 16 percent in 2001 (Temu &Temu, 2005).

In the Ethiopian case, given the declining export earnings from traditional exports of coffee in particular, flori-horticulture and other non-traditional, high-value, agricultural export expansion represents an important area of potential income growth. Statistics from the customs authority shows that the growth in the export volume of fruits and vegetables have been growing by 7.5 percent since the beginning of the new millennium while coffee exports grew by only 5.4 percent. It is interesting to note that the growth rate for fruits and vegetables in the 1980's was negative 5.8 percent while the corresponding figure for coffee was higher by more than 5 percent. The trend suggests that fruits and vegetables could become an even more important sub-sector in such economies.

The agriculture-development-led-industrialization strategy (ADLI) of the country envisages significant scope for achieving greater commercialization of smallholder agriculture (ADLI; MoFED 2002, 2006). One of the main objectives of the recent economic policy of the government of Ethiopia under a plan for Accelerated and Sustained Development to end Poverty (PASDEP, MoFED, 2006) is also the diversification and specialization of production and exports. Fruits and vegetables are among the main agricultural products that are targeted by the development strategy and plan (MOFED, 2006).

After the end of the planning period of PASDEP, fruit and vegetables are expected to be the third important crops in terms of foreign exchange earnings next to coffee and oil seeds. Given this goal, shifting farmers from traditional farming practices to cash crop production such as fruit and vegetables is required. A shift from traditional crop production to high value crops is considered as an important and alternative option in increasing smallholders income, in particular and rural development, in general,

because high value agricultural products regarded as having higher market values than traditional cereal grains and export crops.

Jaleta (2007) has corroborated the assertion that focusing on high value non-traditional crop production and marketing has a positive impact on the overall stability of export earnings and hence promotion of the horticultural sector is of a paramount importance. Following such export promotion , particularly in the horticulture sector, production of banana for instance has recorded a tremendous growth in the last 15 years. Despite its market share mainly limited to the domestic markets , banana production increased from 80 thousands tones in 1993 to 215 thousands of tones in 2005; as well as area harvested increased from 10000 hectare to about 29000 hectares for the corresponding period (FAO, 2008). In this regard, it has been argued that Ethiopia has a huge potential in high value crop production particularly in the banana sector (Gabre-Mariam, 1999). The Country is considered to have the potential to achieve trade gains in this sub-sector because of agro-climatic advantages, existence of cheap and surplus labor, and proximity to the Middle East and the major European markets. However, it should be noted that the production and marketing of fruits and vegetables in general and banana, in particular by smallholders in the major producing areas are predominantly traditional. It faces marketing and production bottlenecks which inevitably results in low yield and low quality products with negative implications on the level of farmers' income. Previous studies show that marketing constraints to smallholders are diverse and interrelated (see for instance Woldie, 2006). Among others, (1) lack of integration of smallholders to regional and export markets, (2) weak bargaining power, (3) absence of competitive buyers, (4) entry barriers to new entrants both into the regional and central markets, (5) price information asymmetry between the central traders and the regional traders; and between the regional traders and the producers, (6) a stagnant and buyer determined farm- gate price, and (7) high transaction costs are the major marketing constraints. They widen the marketing margin and reduce the benefit, which farmers would reap from the sector. Similar studies show that limited marketing outlets and lack of price information are the major factors that hindered the move from subsistence farming to vegetable crop production (Jaleta, 2007). Furthermore, Emana & Gabremedhin (2007) described the lack of local markets to absorb supply, low produce prices, plethora of intermediaries, and lack of marketing institutions and coordination among farmers as the major constraints on the marketing of horticultural crops in Ethiopia. In addition, Emana & Gabremedhin(2007) argued that poor product handling and packing, imperfect pricing systems, and lack of transparency in market information are also among the impediments in the marketing of horticultural crops in Ethiopia.

All these factors expected to contribute for smallholder income diversification and poverty alleviation. A policy that loosens those constraints is believed to improve farm gate prices, response of smallholder to policy incentives and in turn improving productivity gains through specialization and exchange that increases the benefit of smallholders. But the fact is that designing leveraged intervention measures that help the growth of income of small-holders in the sub-sector requires detailed understanding of the existing production and marketing structures, their constraints, the role of information and transaction costs in improving the bargaining power of smallholder producers in trading their produce and analyzing existing potential opportunities as well as identifying key intervention points and potential partners.

In the ethiopian context little attempts have been made so far to investigate the role of transaction costs on smallholder banana marketing behavior. There are only some attempts to emprically investigate marketing behaviour under transaction costs in grain market, milk market and livestock market. A study by Gabre-Madhin (2001) vividly demonstrates the relationship between transaction costs, market institutions and social capital in the Ethiopian grain market. The author using the New Institutional Economics framework tried to show basically how buyers and sellers find each other and coordinate the transfer of goods. That study shows trader's arbitrage activity is mainly limited to transport, with an average distance of 200 kilometers and traders have been found to be competitive in physical marketing costs related to transport, handling, and other marketing activities, which represent about 85 percent of gross margins. It has also been shown that the weak public market information, lack of standard and grade, the oral nature of contracts, and limited legal enforcement of contracts increase the risk of failure. Hence, traders either choose partner whom they know very well or employ a broker. Investigation of the norms and rules underling the relationship between brokers and traders shows that relationships are long-term, exclusive and non-ethnic based. The study also show that transaction costs related to search are significant representing 19 percent of total marketing and transaction costs. The institution of brokerage in this case has been found to be important in minimizing transaction costs and facilitating exchange. Social capital, measured by the network of trading contacts available to each trader, is also found to be important in enabling traders to find trading partners more easily.

Staal et al. (1997) also attempted to demonstrate milk marketing failure in Ethiopia and Kenya where they found out that small-scale milk producers face many hidden costs that make it difficult for them to gain access to markets and productive assets. This has again a devastating impact on commercialization of milk production. The study illustrates that dairy cooperatives play an eminent role in reducing transactions costs. Analysis of the determinants of producer prices received by a sample of dairy producers also suggests that different levels of access to infrastructure, assets, and

information explain why smallholders contemporaneously accept widely different producer prices for fluid milk.

A similar study by Hollway et al. (1999) on the relationship between transactions costs, cooperatives and milk-market development in the Ethiopian highlands tried to explore the impact of household-level transactions costs and the choice of production technique on the decision of farmers. The case was on selling fluid milk to marketing cooperatives. The study used a Tobit specification. It empirically confirmed that transaction costs in the form of time to market are important and cooperatives have a significant impact in reducing the milk delivery time from farm to collection point.

A recent and key contribution by Bellemare and Barrett (2006) also attempted to model participation of pastoralists in the Ethiopian and Kenyan livestock markets using an Ordered Tobit approach. The study was mainly undertaken to test if rural households in developing countries make participation and volume decisions simultaneously or sequentially. The result confirmed the role of transaction costs on market participation. Transaction costs have a significant impact on market participation. Variable costs have a significant and negative impact on sales volume while fixed costs affect purchase volumes negatively and sales volume positively.

Jabbaare et al.(2008) in their study on market institutions and transaction costs, influencing trader performance in live animal marketing in rural ethiopian markets, have demonstrated that traders' financial and human capital and trading practices ( including use of brokers and regular suppliers and customers) had varying effects on margins and costs of cattle and small ruminant trade.

To the best of our knowledge, little quantitative analysis has been undertaken on transaction costs and institutions in Ethiopian fruit sector. This may be due to the fact that it is difficult to measure these costs. This study redresses the gap, using primary data collected in the main banana producing areas in Southern Ethiopia from producers, wholesalers and brokers in 2007. Using the New Institutional Economics framework, particularly Transaction Cost Economics, this study sets forth an empirical analysis of the relationship between transaction costs, marketing method used by smallholders, and the income generated from the sale of their produce.

This paper attempts to trace out the important transaction cost variables that affect income of the households through its impact on the depth of the marketing methods used by households. The rest of the paper is organized as follows. next, the analytical framework and methodology used is discussed followed by discription of the data and some discriptive analysis. In section four, empirical results and discussion of the

major findings are sketched. Finally conclusions and policy implications from the key findings are presented.

## 2. Analytical framework

The literature in institutional economics particularly that of transaction costs economics is vast and different methodologies and theories have been developed over time. The influential works of Coase (1937, 1960), Williamson (1984, 1979, and 2000), Alchian and Demsetz (1972), and North (1984, 1990) are appealing in this regard. Transaction cost has been both theoretically and empirically analyzed based on the theory of New Institutional Economics (NIE) which deals with the economics of transaction costs and the appropriate institutions to lower such costs. Both the theoretical and empirical literature acknowledges that transaction costs are detrimental for the efficient operation or existence of markets for inputs and outputs. The costs of information and the costs associated with the search to trade partners , the physical infrastructure and the way institutions are formed that includes enforcements of contracts all are likely to affect marketing and supply decisions by households.

Banana producers in the study area sale their produce through two major channels at farm gate i.e., regional wholesale traders vis-à-vis marketing cooperatives ( see annex 1 for detailed banana market chain in the study area). However, that does not mean that smallholders are limited to these channels to sell their produce. In spite of the fact that the volume traded is negligible and the quality and type of banana is different, farmers still generate income from selling to the nearby local markets, at roadside, and to neighbors either for direct consumers or for village petty traders who sells banana in their shops. However, the income generated in this form mainly depends on different situations like the extent to which households are near to local cities and markets, being in the main road to Addis Ababa and other major cities where most passengers pass through it. Cognizant of the fact that the depth of marketing methods, used by households, mainly depends on transaction costs and other socioeconomic variables and this marketing method in turn expected to affect income generated from selling banana, in this section, the analytical framework is traced out.

In Transaction Cost Economics literature, it has been shown that high transaction costs are deterimental to the efficient operation of markets. In this regard, the costs of information, negotiation with trade partners and contract enforcement are found to influence the marketing of banana in the study area. This study hypothesizes that the level of income generated from banana sales by smallholders is influenced by

transaction costs as well as household and farm characteristics variables. The model followed in this section is therefore explains the relationship between revenue generated from the sale of banana in all possible markets and measures of transaction costs and household characteristics.

The basic model is conceptualized as follows: First a marketing method is specified as a function of transaction cost and farm and household characteristics variables. Then, revenue generated from sale of banana is specified as the function of marketing method and farm and household characteristics variables.

$$MM = \beta_0 + \beta_1 X + \beta_2 Z + \varepsilon_i \quad [1]$$

$$REV = \alpha_0 + \alpha_1 MM + \alpha Z + \mu \quad [2]$$

where MM, REV, X, and Z refer to marketing method, revenue, transaction cost variables and household characteristics respectively while β's and α's are parameters to be estimated. μ and ε are normally distributed error terms. In this case the two equations can empirically be regarded as a block-recursive model (Gujarati, 1995:680) and can be estimated consistently using a two stage least square (2SLS) estimation technique.

Regarding the variables description, crop revenue is defined as the total income generated from the annual sale of banana in birr per household while marketing methods describes the quality and variety of channels used by the given household in marketing of banana. These include both informal and formal channels. The informal channel may comprise selling in the road side while the formal ones are selling via wholesalers, cooperatives, shops, local markets. our data suggests that, despite the fact that the large proportion of banana is sold through cooperative and regional wholesale traders, there are reports that farmers indeed sell banana in local market, roadside, and their own small shops for direct consumers. It is an undeniable fact that such small markets provide a better opportunity to smallholders in terms of income generation. The price is also higher when farmers selling to direct consumers compared with selling to those middlemen. Therefore, a due attention is given on the role of such markets in enhancing farm income.

For the above models a marketing method index which is used as a dependent variable for equation one is calculated following Matungul et al., (2001) procedure i.e. marketing methods index = {(Zchan*n)} where Zchan is a standardized value of channel scores and n represents the number of channels used by the households. The initial scores range from 1 to 3 where a highest score is atached to a farmer who

sells to wholesale traders and cooperatives. These channels are the major channels where households sell a bulk of their produce. If a household sells to a local or near by city market, a score of two is given as the volume of sale in such markets are not higher compared with the two major channels. A score of one is attached for a household who sells in shops or road sides for direct consumers. The voulme of sales in this type of channels are not that much significant as farmers sell only the leftovers from other markets. A low score on the index infers that a household uses few, thinly traded markets to sale its produce while a high score tells us a greater depth in marketing methods as the household is using a number of channels. To avoid biased in the score, we took the standardized value of the scores.

Finally, the marketing method index is calculated and regressed against different transaction cost variables, household characteristics, different physical and human capital asset specificity. Once estimates for the marketing methods are obtained the crop income equations can be estimated using the two stage least squares (2SLS) to capture possible correlations with the error terms.

## 3. The data and some descriptive analysis

### 3.1 Data

In order to address the stated problems and objectives, both primary and secondary data are collected using household survey questionnaires. The main household survey employed to 203 smallholders banana and other fruit growers in Southern Ethiopia particularly from 13 peasant associations (villages) in Arba Minch and Mirab Abaya Districts of the Chamo-Abaya Irrigated Banana Livelihood Zone. The household questionnaire mainly consists issues related with households general characteristics, household resource endowments, the state of crop production and input use by the household, labor and land market participation issues, water use and irrigation, market access issues, and a brief questions on transaction cost related variables in relation to the banana market. Other general issues like access to credit and extension are also included in the main household questionnaire. With regard to the sampling procedure, particularly in conducting the main household survey, a purposive multistage random sampling procedure was employed. First two districts from the Chamo-Abaya irrigated banana livelihood zone are purposely selected based on the fact that production and marketing of banana is dominant. In the second stage peasant associations which are again known for banana cultivation are identified. In the final stage 220 households in 13 peasant associations are randomly selected and appropriate and well responded 203 questionnaires are used for the study.

Apart from the above primary data, secondary data on Ethiopian agriculture from Central Statistics Authority (CSA), from international organizations like FAO and the World Bank and different agricultural offices of the study area are extensively explored to facilitate the study.

## 3.2 Descriptive analysis

Different household specific socioeconomic characteristics, farm and production characterstics as well as market access related variables are well thought-out here. Regarding socioeconomic characterstics, age, education, family size of the household, family labor, average household wealth, transportation equipments, ownership of communication and media technology are particularly explored and presented in Table 1. Accordingly, it has been found that the mean age of the head of the household is 46. 4 years. With regard to the education status, a household head in the study area has on average a 2.6 years of schooling.

**Table 1: Socio Economic Characteristics of Households**

| Variables | All (N=203) |
|---|---|
| Mean of Age of the head of the household | 46.4 |
| Education level of the head of the Household | 2.6 |
| Number of Children | 5.4 |
| Family Labor (Adult Equivalent Scale) | 4.3 |
| Value of transportation equipments( in Birr ) | 792.7 |
| Households with Radio (%) | 91.1 |
| Households with Telephone (%) | 3.4 |
| Households with TV (%) | 24.1 |
| Households with Mobile phone (%) | 10.3 |
| Average household wealth (in Birr)* | 22579 |
| Mean annual gross income from banana(in Birr) | 8800.9 |

**Birr is Ethiopia´s Currency and 1 Euro= 12 birr during data collection*

Source: Authors, 2007

The average number of children in a household is found to be 5.4. The amount of family labor is also estimated based on an adult equivalent scale to take into account the difference in the contribution of women, children and elders. According to the estimation, a household has a family labor of 4.3 on adult equivalent scale basis. The average wealth of the household is also estimated to be 22,579 birr. This includes houses, livestock assets and other movables.

Some information communication and transportation facilities are also considered here and it has been found that 91 percent of households have radio, while 24.1 percent own television. The proportion of households who have telephone estimated to be 3.4 while those with mobile are 10.3 percent. An attempt is also made on how much households invest on transportation related equipments like bicycle and carts. Households on average own transportation equipments of value birr 792.

In this sub-section, a farm level and production related variables are also summarized in Table 2 and discussed below.

**Table 2: Farm Level and Production Characteristics of Households**

| Variables | All (N=203) |
|---|---|
| Mean Farm land Owned by the Household (in hectare) | 1.9 |
| Average Number of Plots Cultivated by the Household | 2.3 |
| Average Size of Irrigated Land (in hectares) | 1.6 |
| Farming Experience ( in years) | 26 |
| Average Fruit Production or Marketing Experience ( in Years) | 9.8 |
| Value of Production and farm Implements ( in Birr) | 369.2 |
| Mean Farm size of Banana Plot under cultivation (in hectares) | 0.8 |
| Mean Annual banana Production ( in quintal) | 103.6 |

Source: Authors, 2007

A household in the study area on average owns 1.9 hectare of land of which 1.6 hectare is irrigated and 0.8 hectare is cultivated for banana. This does not surprise as the region is an irrigated banana-livelihood zone where production is mainly based on irrigation particularly of banana production. In terms of the number of plots cultivated, a household cultivates on average 2.3 plots of land.

Farming experience is also considered here as a variable that affect production. To this end, the average farming experience of a given household is found to be 26 years out of which a household on average involved in producing and marketing fruit for about 9.8 years. Quantity of annual banana production is also considered and it has been shown that a household on average produces 103.6 quintals of banana per annum and invests on farm and production implements of value of birr 369.2.

Market access and transaction related variables are also given due emphasis in this section. Table 3 summarizes market access and participation in the available market by these farm households in the survey. Farmers who produce banana, sale their produce mainly at farm-gate and some to nearby local markets for direct consumers and retailers.

**Table 3: Access to Market and Transactions related Variables**

| | **All (203)** |
|---|---|
| Average Distance of farm to main road(Km) | 3.72 |
| Average distance to local City(Km) | 22.42 |
| Sales transaction in respect of Markets | |
| Total number | 1491.0 |
| Farm gate (%) | 88 |
| Local Markets (%) | 12 |
| Sales Transaction in respect of Market Channels | |
| Total Number | 1307 |
| Wholesale Traders (%) | 80.6 |
| Marketing Cooperatives (%) | 19.4 |
| Average Sales transaction per household | 7.34 |
| Average transaction size (Quintal) | |
| Farm gate | 14.9 |
| Wholesale traders | 12.9 |
| Marketing Cooperatives | 24.0 |
| Local Markets | 3.3 |

Source: Authors, 2007

The average farm-road distance is found to be 3.7 kilometer in the study area. In addition, the average distance to the nearest local city is about 22 kilometer. Concerning total sales transaction made during the study period, about 1491 transactions have been made by the sample households, which means an average of 7.3 sales transaction per household. In terms of specific markets farmers sold their produce, the report shows that about 88 percent of the sales transaction were undertaken at farm gate while the remaining 12 percent were done in the local markets. Sales transaction made by farmers with respect to the channels they used is also reported. It is shown that about 80 percent of the transactions made at farm-gate channeled through wholesale private traders while the rest 20 percent through marketing cooperatives. The result also reports the average quantity sold per transaction in respect of markets and types of channels. To this end, the average transaction size per quintal is higher for those who sold at farm gate compared with the size in local markets. Note also that the transaction size is bigger for those who use the marketing cooperatives than wholesale private traders.

## 4. Empirical results and discussions

Based on the above analytical framework and using econometric techniques, empirical results are obtained. Important parameters that relate transaction costs, marketing methods and crop income are discussed in lieu of the theoretical foundation. Before presenting the empirical results factors considered in both the marketing method model and the crop income equation are discussed below. The variables used in the empirical analysis and their theoretical expectation are summarized below in Table 4.

**Table 4: Factors Considered in the Marketing Method Equation**

| Variables Name | Description of Variable | Expected Sign |
|---|---|---|
| AGE | Age of the head of the household (Years) | + |
| EDUC | Education level of the household head | + |
| LAND | Farm land allocated to banana production(hectare) | + |
| RAD | Radio ownership (1=Yes) | + |
| TEL | Telephone ownership(1=Yes) | + |
| MOB | Mobile phone ownership(1=Yes) | + |
| INFO | Farmer has price information(1=yes) | + |
| BYC | Bicycle ownership(1=yes) | + |
| DIST | Distance of farm to main road in Kilometers | - |
| COOP | Farmer is a member of cooperatives (1=yes) | + |
| Dummy | Farmer is from the integrated region[3] (1=yes) | + |

These transaction costs and household characteristics variables expected to affect farmers' marketing decision and the depth of the marketing method they are using. Age is considered here as older and experienced farmers are likely to have more trading contacts and more market information that have a significant impact on transaction costs related to information and search. Older farmers ,therefore, face lower transaction costs and hence exploit more markets available to them.

In terms of bargaining power, age and experience mean a better bargaining power which is gained through reputation and trust which is obtained from a repeated transaction with similar traders. Better education on the other hand means ability to process market information and making an optimal marketing decision by a household. Education can also be interpreted in terms of bargaining. Educated households have more bargaining power than those who are non-educated or less educated. Households with more year of schooling therefore face lower transaction

[3] An integrated region is defined here as a region where distance of farm-to main road is higher than the average distance, i.e., 3.72 kilometer.

costs particularly related with information and bargaining. Hence lower transaction cost means higher depth of marketing. Land holding size particularly land under banana cultivation is also expected to affect the marketing method used by a given household. This is mainly because of the fact that transaction costs are largely fixed costs that can be spread across more production and large area cultivated (Matungul et al., 2001). At the same time those who have large farm land are those who are relatively wealthy and hence have less liquidity constraint in doing marketing. Therefore, they are likely to have greater depth of marketing method. Ownership of information and communication technology equipments is also likely to reduce transaction costs and in turn increase the depth of marketing methods used by the household. These variables particularly improve access to market price information and reduce transaction costs that would have been incurred in searching such information. Radio, telephone, and mobile ownership are included in the model to see if owning these will really lead to a greater depth of marketing. In addition, as a mere ownership of radio, telephone, or mobile phone may not guarantee access to valuable market information, a variable that measures whether farmers have price information when selling banana is considered. Bicycle ownership is also likely to affect transaction costs that are related to transportation. Farmers in the study area usually use bicycle in selling to local markets and road side. Therefore, those households who have access to bicycle are likely to sell more offering greater marketing depth than those who do not have. Distance of the farm to the main road is expected to negatively affect the depth of marketing by households. This is due to the fact that those households whose farm is near to main road are likely to have more access to the roadside where they sell a ripened banana with a better price for direct consumers who pass through the main road from Arba Minch to Addis Ababa. Those households who are far from the main road incur higher transaction costs associated with transporting to the main road. The other important parameter considered in the model is cooperative membership. In spite of the fact that cooperatives are recent and at their earlier stage of operation, it has been observed that marketing cooperatives are serving in solving several marketing problems. They try to improve the bargaining power of farmers by providing credit and market information. Hence, it is expected that cooperative membership has a positive impact on the depth of marketing by households as households who are members face lower transaction costs particularly related to information, monitoring and enforcement. Apart from the above important variables a regional dummy is considered to see the impact of geographic location on the depth of marketing.

**Table 5: OLS Results from the Marketing Method Equation**

| Variables | Coefficient | Std. Error | t-value |
|---|---|---|---|
| AGE | -0.001 | 0.0035 | -0.322 |
| EDUC | 0.018 | 0.00999 | 1.834* |
| LAND | 0.143 | 0.05919 | 2.416** |
| RAD | -0.118 | 0.09564 | -1.237 |
| TEL | 0.295 | 0.17117 | 1.722* |
| MOB | 0.010 | 0.14419 | 0.067 |
| INFO | 0.187 | 0.08717 | 2.145** |
| BYC | 0.247 | 0.09434 | 3.336*** |
| DIST | -0.012 | 0.01002 | -1.187 |
| COOP | 0.235 | 0.09762 | 2.494** |
| DUMMY | 0.399 | 0.09643 | 4.12*** |
| Constant | 2.679 | 0.22473 | 11.925*** |
| F- Statistic: 5.59*** | | | |
| R2 = 0.27 | | | |

*Note: 1. Dependent Variable: Log of Marketing Method Index (LMMI)*
*2. ***, ** and * shows significant level at 1%, 5% and 10% respectively*
*3. Standard errors and t-values are Heteroskedasticity consistent*

Table 5 above summarizes the OLS result from the marketing method equation. The overall significance of the model as measured by the F-statistic shows that the model fits well from statistical grounds. Transaction cost proxies like telephone ownership, bicycle ownership, and having market price information during transaction significantly and positively influence the depth of marketing. For instance, a coefficient 0.295 of variable TEL confirms that the marketing method index score is estimated to be about 29.5 percent higher for those households with telephone than who do not have keeping all other things constant. Similarly, a 0.187 coefficient in the variable INFO indicates that the depth of marketing method is higher by about 18.7 percent for those households who reported that they have market price information for the market they sell their produce than those who do not have such an important information. Transport ownership has also a significant impact on the depth of marketing method by households. The coefficient 0.247 in the variable BYC suggests that a household who owns a bicycle relatively has a greater marketing method index 24.7 percent higher than those who do not have. Transaction cost related variables like ownership of radio, mobile phone, and distance of farm from the main road have been found insignificant in explaining the marketing method index. Apart from these parameters some household specific and socioeconomic variables which of course indirectly affect the magnitude of transaction costs have been found significant in explaining marketing behavior of smallholders. Among others, being a member of marketing cooperative, being in the integrated areas (relatively well developed areas),

and area cultivated for banana, are worth mentioning. To this end, the coefficient 0.143 for variable LAND confirms that a unit (hectare) increase in the area cultivated for banana leads to a 14.3 percent increase in marketing method index score, all other explanatory variables held constant. By the same token, a coefficient 0.235 for the variable COOP indicates that the marketing method index score is estimated to be about 23.5 percent higher for households who are a member of marketing cooperatives relative to those who do not have such affiliation. Similarly a coefficient 0.399 for the variable DUMMY suggests that households who reside in the integrated or relatively well developed villages have a marketing method index score 39.9 percent higher than relatively for households who live in the isolated or less developed villages.

The significant parameters in general suggest that transaction costs are important in affecting the marketing methods used by banana growing households. It is also evidenced that farmers' organizations play an important role in increasing the depth of marketing by facilitating information flow and improving market access by small-scale farmers.

**Table 6: Factors considered in the Crop Revenue model**

| Variables Name | Coefficients | Expected Sign |
|---|---|---|
| LMMI | Marketing Method Index (log) | + |
| LAND | Farm land allocated to banana production(hectare) | + |
| LAB | Family Labor(Adult Equivalent Scale) | + |
| VISIT | Number of Visit by Extension Agent(per year) | + |
| INPUT | Investment in farm inputs(in Birr) | + |
| COOP | Farmer is a member of cooperatives (1=yes) | + |
| DUMMY | Farmer is from the integrated region (1=yes) | + |

The next question is on the relationship between the income generated from the sale of banana and the marketing method index score. It is expected that a higher marketing method index score leads to a higher income. The hypothesized variables that are considered in the crop income model along with their expected sign are summarized in Table 6.

As explained earlier the main hypothesis to be tested is if greater depth of marketing affects the revenue generated from the sale of banana. For this purpose the log of marketing method index is included in the model. Apart from this main variable, others that are expected to affect the level of income of the household are considered here. Farm land allocated to banana production is considered because of the fact that output is directly related to the area cultivated. Hence, the area cultivated for banana

by each household is expected to have a positive impact on income generated from the sale of output. The amount of family labor is also considered cognizant of the fact that family labor contributes in both production and marketing activities that enhance income of the household. Investment of farm input is also expected to affect farm income as output is directly related to the extent to which farmers invest on production and farm implements. The impact of extension services in affecting farm income is considered by looking at visits by extension agents. This is due to the fact that theoretically, advices and support from extension agents on better production techniques and on how to control pests and diseases has a direct impact on output and in turn on households' income. Cooperative membership as in the marketing method equation is also expected to affect the crop income because of the fact that cooperative members have different supports that enhance production and marketing activities. A regional dummy is used to capture geographic location differences between the integrated and those relatively isolated regions where infrastructure is less developed.

Based on the above argument, equation 2 is estimated using the 2SLS procedure once a Durbin–Wu–Hausman test confirmed that there is endogeneity problem as the error term is correlated with the stochastic variable marketing method index and hence OLS cannot give us a consistent estimate. Davidson & Mackinnon (1993) suggest an augmented regression test (DWH test), which can easily be formed by including the residuals of each endogenous right-hand side variable, as a function of all exogenous variables, in a regression of the original model. The Durbin–Wu–Hausman test conducted as in the following steps:

1) An augmented regression is formed by including the residual of the endogenous right-hand side variable, as a function of all exogenous variables, in a regression of the original model, i.e, first we estimated the marketing method equation using OLS as in above and save the residuals.
2) Then we performed an agumented regeression of the crop revenue equation by including the residual from the first estimate.
3) Finally we tested the significance of the residual parameter in explaning the crop revenue equation. The intution here is that if the residual coefficent is significantly different from zero, then OLS is not consistent and instrumental variable estimation is justifiable. The F-test result has confirmed that the coefficent of the residual is indeed significantly different from zero with F-statistic $F(1, 184) = 8.61$ and $Prob > F = 0.0038$.

Hence, to capture possible correlation with the disturbance term, the stochastic variable was replaced with an instrumental variable i.e. estimated marketing method index predicted from all of the explanatory variables in the block-recursive model. Table 7 below summarizes the results of 2SLS estimation of the revenue equation.

**Table 7: Summary of 2SLS results of the Revenue Equation**

| Variables Name | Coefficient | t-value |
|---|---|---|
| LMMI | 0.468 | 1.994** |
| LAND | 0.584 | 4.521*** |
| LAB | 0.020 | 0.54 |
| VISIT | 0.022 | 0.657 |
| INPUT | 0.003 | 4.641*** |
| COOP | 0.344 | 2.301*** |
| DUMMY | 0.455 | 2.662*** |
| Constant | 6.176 | 8.370*** |

*Note: 1. Dependent Variable: Log of Revenue*

*2. R2=0.40*

*3.***, ** and * shows significant level at 1%, 5% and 10% respectively*

As one can learn from the above table, the results are consistent with the hypothesized relationship. As expected, marketing method index, area cultivated, value of farm input, cooperative membership, and village characteristics dummy positively and significantly influence farm income from the sale of banana.

The result particularly confirmed that greater depth in marketing methods used by households, which is due to lower transaction costs, has a strong and positive impact on the level of income generated from banana sales. Area allocated for banana cultivation (LAND) also indicates that crop income is directly related to the amount of land cultivated. Accordingly, a unit (hectare) increase in the area allocated for banana will lead to a 46.8 percent increase in revenue. This is particularly true in the study area where households have an incentive to convert maize and other food crop lands into banana lands. This can also be manifested by the rise land rental price in the region. Farmer's commitment to invest on farm implements and inputs has also been found significant in explaining revenue generated from the sale of banana. The coefficient 0.003 for the variable INPUT indicates that a unit (Birr) increase for investment on farm input leads to a 0.3 percent rise in the revenue generated.

Similarly, it has been also found that membership in cooperative has a positive and significant impact on the income of banana producers. The coefficient 0.344 for the variable COOP clearly shows that the revenue generated from the sale of banana by households who are members of marketing cooperative is 34.4 percent higher than those who do not have such institutional affiliation. This is particularly true in the study area where cooperative members enjoy strong bargaining power, better access to market information, relatively less problem in enforcing contracts and less cheating in grading and scaling, when selling to cooperatives which in one way or another

reduce transaction costs and enhance the depth of marketing methods and in turn raises the revenue reaped from the business.

The dummy variable that captures the difference between those villages with relatively well developed and those less developed areas in terms of infrastructure distance to provincial cities and main road also shows that there is a significant difference between these groups in the revenue generated from the sale of banana. The empirical result suggests that the revenue of households who reside in the well developed areas is 45.5 percent higher than those who live in the isolated areas. This may be due to the fact that households in the integrated and well developed region relatively incur low transaction costs, and also receive better price due to a relatively strong bargaining power. Visits by extension agents and family labour have been found to be insignificant in explaining farm income.

## 5. Conclusions and policy implications

The main objective of this paper was mainly to see the relationship between transaction costs, the depth of marketing methods, and farm income of banana growing farm households who sell their banana at farm gate for cooperatives and /or regional wholesale traders, and at local markets and road sides to direct consumers. Cognizant of the fact that the depth of marketing is determined by the magnitude of transaction costs a household incur, which in turn determines the level of income generated, an attempt has been made to model marketing method as a function of transaction cost proxies and other household specific characteristics. The level of income generated from the sale of banana has also been formulated as a function of marketing method and other household characteristic variables. Econometric result from such block-recursive model has confirmed that marketing method index score (a measure of the depth of marketing) was indeed determined by transaction costs and other household specific parameters. Specifically, regression analysis based on a Transaction Cost Economics approach shows that the depth of marketing methods is significantly influenced by transaction cost variables, such as ownership of means of transport, access to communication, and access to information. Membership in cooperative as a major institutional factor also influences the depth of marketing methods used. Results from a 2SLS estimation show that the level of income generated from selling banana is determined by the depth of marketing methods, the size of allocated land for banana and value of production and farm inputs and cooperative membership. The implication of the finding is that households with lower transaction costs, sizeable allocated land and adequate investment on farm inputs are expected to generate higher income from banana. Hence, investment in public goods such as roads, telecommunications and appropriate institutions, as well as

farmer support services in terms of input supply and marketing information, expected to enhance farm income by reducing transaction costs and in turn improve the livelihood of the rural poor. Particular focus is needed in supporting local marketing institutions by giving organizational and capacity building as these improve the bargaining power of smallholders and enhancing market integration and access. The existing marketing cooperatives should be strengthened and actively expand their outreach to those areas where smallholders are not a member.

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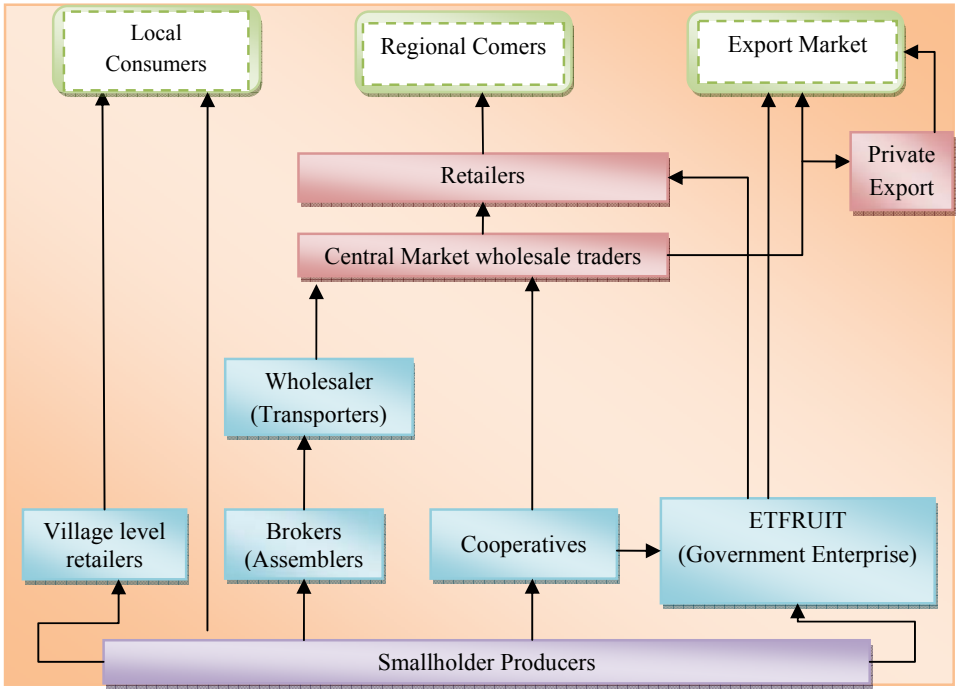
**Annex 1: The Banana Market Chain in the study Area**



# DAIRY MARKETING CHAINS ANALYSIS: THE CASE OF SHASHEMANE-YERGALEM MILK SHED, SOUTHERN ETHIOPIA

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*Abstract*

*This study uses the Heckman two stages estimation procedures to identify factors affecting probability of milk market entry decision and milk volume supplied in Shashemane,-Yergalem milkshed, southern Ethiopia. The result showed that age, family size, education level, experience in dairy production, number of cross bred milking cows owned, distance from milk market center, age squared and annual non-dairy income source are factors determining dairy household milk market participation and milk volume supplied. Milk was the most produced, traded and consumed dairy product in the milkshed whereas butter and cheese were transported from Wolayita and Sidama areas as the areas are deficient in cooking butter and cheese. Dairy producer, producer trader, retailers, semi-wholesalers and dairy producer cooperative, and producers, farmer trader, itinerate traders, semi-wholesaler and retailers were milk and butter market economic agents, respectively. The S-C-P model identified that the market for dairy was competitive. The highest net return/lit for milk market was obtained by dairy producers. The study concludes that education, improved milk cow number, distance from milk market and access to quality financial sources variables should receive a considerable attention from both government and development concerned individuals and institutions in order to improve the sector performance.*

**Key words:** Ethiopia, Dairy cow, Dairy farm, Market Participation, Milkshed, Milk, Butter

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## 1. Introduction

Livestock production is an integral part of Ethiopian agricultural system. The output of the livestock sub-sector (excluding draught power and manure) accounts for about 38% of the agricultural GDP in Ethiopia (valued at 1.4 billion USD in 2000). Milk makes up 20%-25% of this, thus contributing around 350 million USD (FAO, 2004).

In Ethiopia, producers and consumers are spatially separated; most producers are found in the rural areas while consumers or profitable markets are found in urban areas. Most of the milk supply is distributed from producer to consumer through informal marketing channels in both rural and urban areas. Market infrastructures and marketing facilities are not well developed in the country. This, in turn, reduces incentives to participate in economic transactions and results in subsistence rather than market-oriented production systems. Therefore, improving the position of smallholders to actively engage in the dairy market is one of the most important development challenges of the country (Holloway et al., 2002). This seems the case because there were very few researches done on livestock and livestock products marketing. Consequently, dairy product marketing studies become essential to provide vital and valid information on the operation and efficiency of dairy product marketing system for effective research, planning and policy formulation. The objectives of the paper, therefore, are identifying the major butter and milk marketing channels, analyzing dairy marketing costs and margins for major marketing channels and identifying factors affecting dairy supply in the Shashemane-Yergalem milk shed, southern Ethiopia.

## 2. Theoritical and Empirical Review

The total milk production in Ethiopia increased during the 1961-2000 period at an average annual rate of 1.55 percent, though per capita production declined because of the high population growth rate (Mohamed et al, 2004). However, during the last decade production is growing at a higher rate (3.0 percent). The increased coverage of extension services (improved livestock husbandry), increased use of improved inputs (improved breeds and feed), and policy changes promoting dairy production have contributed to faster growth of output. Most of the dairy sector growth in Ethiopia in the 1990s was concentrated in the per-urban and rural production systems. The emergence of private processing industries and marketing units was likely to stimulate producers in the per-urban areas and rural production systems as it offered producers a new market for their milk production (Mohamed et al, 2004).

As is common in other African countries (e.g., Kenya and Uganda), dairy products in Ethiopia were channeled to consumers through both formal and informal dairy marketing systems (Mohammed et.al., 2004). The Formal milk markets were particularly limited to per-urban areas and to Addis Ababa. Unlike the early phases, the formal market appeared to be expanding during the last decade with the private sector entering the dairy processing industry. Recently, private businesses have begun collecting, processing, packing and distributing milk and other dairy products. However, the proportion of total production being marketed through the formal markets remains small (Muriuki and Thorpe, 2001). The informal market involves direct delivery of fresh milk by producers to consumers in the immediate neighborhood and sales to itinerant traders or individuals in nearby towns. In the informal market, milk may pass from producers to consumers directly or it may pass through two or more market agents. The informal system is characterized by no licensing requirement to operate, low cost of operations, high producer price compared to formal market and no regulation of operations. The relative share and growth of the formal and informal market in the 1960-1974, 1974-1991 and 1991-present was different. In all three phases, the informal (traditional) market has remained dominant in Ethiopia (Redda, 2001). The traditional processing and trade of especially traditional soured butter, dominate the Ethiopian dairy sector. Of the total milk produced, only 5 percent is marketed as liquid milk due to underdevelopment of infrastructures in rural areas.

In recent years, promotional efforts have focused on dairy marketing. Milk marketing cooperatives have been established by the SDDP (Smallholders Dairy Development Program) with the support of Finnish International Development Association. These groups buy milk from both members and non-members, process it and sell products to traders and local consumers. The units also process milk into cream, skim milk, sour milk, butter and cottage cheese. The number of these milk cooperatives reached to 32 in total, 2 established by FAO/TCP (Technical Cooperation Programme) and World Food Programme (WFP) while 30 by SDDP (Redda, 2001).

*(i) The descriptive method of data analysis employed S-C-P model for identifying factors that determine competitiveness of dairy market behavior of firms and the success of dairy industry in meeting performance goal. Hakobyan (2004) used S-C-P model to identify factors affecting competitiveness of dairy marketing in Armenia. The S-C-P model examines the causal relationship between market structure, conduct, and performance, and is usually referred to as the structure conduct and performance (S-C-P) model. Thus, this study used S-C-P model to evaluate the efficiency of dairy market in the study area.*

Study conducted by Hollowa et.al (2002) in Ethiopian highland using Probit and Tobit models on data that came from 68 households indicated that the number of cross breed and local breed dairy cows owned, education level of the household head, and the number of extension visits exhibit positive relationship with milk market entry decisions and marketed milk surplus; however, distance from milk market centers exhibited negative relationship with milk market entry decision and marketed surplus. Studies conducted by different scholars on different agricultural commodities marketing based on market concentration ratios, marketing costs, margin and profit analysis indicated that margin and profit received by different marketing actors and level of market efficiency varied with respect to location and size of marketing channel (number and type of intermediaries involved).

Dairy trends and production systems can be greatly influenced by policies. In Kenya, for example, the small-scale specialized dairy production system has witnessed enormous growth within the past years, due to the vast adoption of policies favoring this system (Thorpe et al 2000). Several policies have been suggested for development of the dairy sector of African countries, with each country laying emphasis on different parts of the dairy chain. Most policies sprout from a concept that the dairy sector will realize a great impact if the production and productivity of milk is increased at national level to at least maintain self-sufficiency, thereby reducing imports.

## 3. Methodology

### 3.1 Data and sampling techniques

In this study, both primary and secondary data were used. The primary data were collected using two types of questionnaire, one for dairy producers focusing to identify milk supply determinants and the other for butter and milk traders focusing to identify major marketing channels, marketing cost and margins.

A three stage stratified random sampling procedure was used to select 180 specific farm households for this study. During the first stage, study sites were purposively selected based on milk production potential. Prior to dairy household sampling, an initial complete listing (census) of all the dairy farms was obtained. During the census, breed type (local and cross) and herd sizes were recorded for all households owning dairy farm. The dairy farms were categorized into small, medium and large farm based on the herd size. The technique used to classify dairy farm categories and herd size by Anthony *et al.* (2004) in Hawassa and the surrounding per-urban areas into the three size categories was adopted to categorize cross breed and local breed dairy farms. Accordingly, farms owning 1-5, 6-10 and greater than 10 dairy cows

were classified as small, medium and large farms, respectively. Because the number of large size dairy farm in study areas in general and the number of local medium size dairy farm in Shashemane in particular was very few, `the study did not consider these farms for further data collection. During the second stage, dairy farms were categorized into small (both cross and local small) and medium size (both cross and local medium) farms based on herd size.

**Table 3.1: Sample distribution of the dairy farms**

| Locations | Type and size of dairy farm | | | | Sample size of dairy farm | | | |
|---|---|---|---|---|---|---|---|---|
| | Local small (1-5) cows | Local medium (6-10 cows) | Cross small (>10 cows) | Cross medium (6-10 cows) | Local small | Local medium | Cross small | Cross medium |
| Hawassa | 573 | 300 | 283 | 100 | 34 | 36 | 17 | 12 |
| Shashemane | 431 | - | 166 | 53 | 26 | - | 10 | 6 |
| Yergalem | 179 | 103 | 119 | 46 | 13 | 12 | 8 | 6 |
| Total | 1183 | 403 | 568 | 199 | 73 | 48 | 35 | 24 |

During the third stage, 60% (108) of small and 40% (72) of medium dairy farms were purposively selected. During the same stage, 73 (68% of 108 small sample dairy farm) local small, 35 (32% of 108 sample small dairy farm) cross small, 48 (67% of 72 sample medium dairy farm) local medium, and 24 (33% of 72 sample medium dairy farm) cross medium totaling 180 dairy farm owners from the three milk sheds were randomly selected and distributed across the sample locations using the probability proportional to sample size. Milk and butter traders in the milk shed were recorded during the census.

## 3.2 Method of data analysis

### 3.2.1 Descriptive Methods

**Market concentration ratio:** Used to measure milk market structure whereas marketing margins and profit distribution and producer's share were used to evaluate milk-marketing performance. A market concentration ratio, which refers to the number and the relative size distribution of buyers and sellers, is expressed as:

$$C = \sum_{i=1}^{r} S_i \quad \text{i= 1,2,3,4} \qquad \textbf{(1)}$$

where, $S_i$ is the percentage market share of the $i^{th}$ firm and r is the number of relatively larger firms for which the ratio is going to be calculated.

**Marketing margins:** is always related to final price paid by the end buyer is expressed as a percentage (Mendoza, 1991) is defined as follows:

$$TGMM = \frac{End \text{ buyer price - first seller}}{\text{End buyer price}} x100 \quad \textbf{(2)}$$

where, $TGMM$ is total gross marketing margin. It is useful to introduce the idea of 'producer's participation', 'producer's portion', or 'producer's gross margin (GMMP) which is the portion of the price paid by the consumer that goes to the producer.

The producer's margin is calculated as a difference:

$$GMMp = \frac{End \text{ buyer price - marketing gross margin}}{\text{End buyer price}} \text{X100} \quad \textbf{(3)}$$

where, $GMMp$ is the producer's share of consumer price

### 3.2.2 Econometric method

The study used the Heckman two steps procedures to identify milk market participation and level of participation. The first stage of the Heckman two-stage model a 'participation equation'/ the binary probit equation, attempts to capture factors affecting participation decision. This equation is used to construct a selectivity term known as the 'inverse Mills ratio' (which is added to the second stage 'observation'/ supply equation' that explains factors affecting volume of milk supply.

Specification of the Heckman two-step procedure, which is written in terms of the probability of milk market participation, MMP, and volume of milk marketed, VMM, is:

**The binary probit equation**

$$Y_{1i} = \chi_{1i}\beta_1 + u_{1i} \quad u_{1i} \sim N(0,1) \quad \textbf{(5a)}$$

$$MMP = 1 \text{ if } Y_{1i} > 0 \text{ (5b)}$$
$$MMP = 0 \text{ if } Y_{1i} \leq 0$$

where: $\gamma_{1i}$ is the latent dependent variable which is not observed

$\chi_{1i}$ is vectors that are assumed to affect the probability of sampled dairy household milk market participation

$\beta_1$ is vectors of unknown parameter in participation equation

$u_{1i}$ are residuals that are independently and normally distributed with zero mean and constant variance

**The supply equation**

VMM= $Y_{2i} = \chi_{2i}\beta_2 + u_{2i}$ $u_{2i} \sim N(0, \delta^2)$ **(6)**

$Y_{2i}$ is observed if and only if $MMP = 1$. The variance of $u_{1i}$ is normalized to one because only $MMP$, not $Y_{1i}$ is observed. The error terms, $u_{1i}$ and $u_{2i}$, are assumed to be bivariat, normally distributed with correlation coefficient, $\rho$. $\beta_1$. and $\beta_2$ are the parameter vectors.

$Y_{2i}$, is regressed on the explanatory variables, $X_{2i}$, and the vector of inverse Mills ratios ( $\lambda_i$ ) from the selection equation by ordinary least squares.

where: $\gamma_{2i}$ is the observed dependent variable

$\chi_{2i}$ is factors assumed to affect sell volume

$\beta_2$ is vector of unknown parameter in the supply equation

$u_{2i}$ is residuals in the supply equation that are independently and normally distrusted with zero mean and constant variance.

where, $\lambda_i = \frac{f(\chi\beta)}{1 - F(\chi\beta)}$ **(7)**

$f(\chi\beta)$ is density function and 1-F ( $\chi\beta$ ) is distribution function

Before fitting important variables into the models for analysis, multicoleaniarity problem among continuous and discrete variables was respectively checked by using Variance Inflation Factor (VIF) and Contingency Coefficients (CC) (Gujarati, 2003). VIF shows how the variance of an estimator is inflated by the presence of multicollinearity.

$$VIF = \left(1 - R_j^{\ 2}\ \right)^{-1} \quad \textbf{(9)}$$

where, $R_j^{\ 2}$ is the multiple correlation coefficients between explanatory variables, the larger the value of $R_j^2$ is, the higher the value of VIF ($X_i$) causing higher collinearity in the variable ($X_i$).

$$CC = \sqrt{\frac{\chi^2}{N + \chi^2}} \quad \textbf{(10)}$$

where, CC is contingency coefficient, $\chi^2$ is chi-square test and N is total sample size. If the value of CC is greater than 0.75, the variables are said to be collinear.

**Table 3.2: Description of variables used in the model analysis**

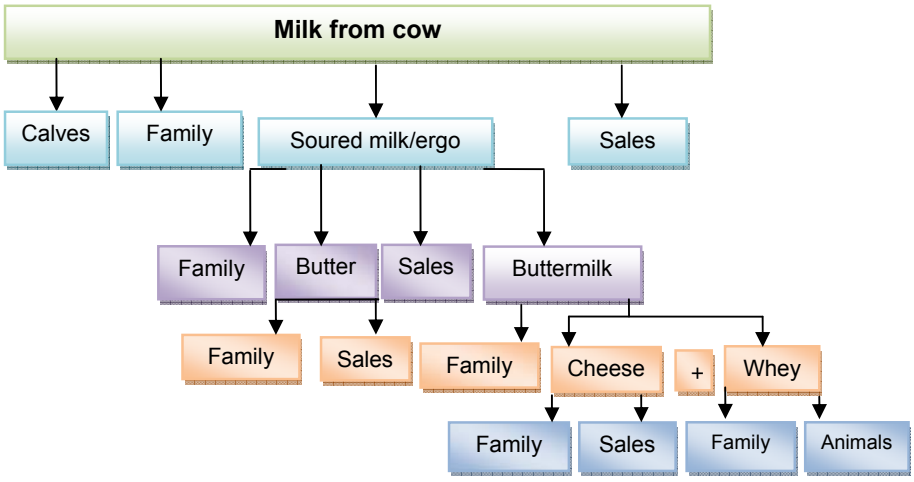
| Variables | Description | Types | Values |
|---|---|---|---|
| MMP | Milk market participation | Dummy | 0=no, 1=yes |
| MMV | Marketed Milk Volume | Continuous | Liter |
| AGE | Age of household head | Continuous | Number of years |
| SMP | Size of Milk Produced | Continuous | Liter |
| FSHH | Family size of household | Continuous | Man equivalent |
| ELHH | Education level of household head | Continuous | Years of schooling |
| EXHH | Experience in dairy production | Continuous | Number of years |
| DNMM | Distance from dairy market | Continuous | Kilometer |
| CB | Cross bred | Continuous | Number of cross breed dairy cow owned |
| LB | Local bred | Continuous | Number of local breed dairy cow owned |
| ACEXT | Access to extension service | Dummy | 0=not visited, 1= visited |
| INFDS | Income from non dairy sources | Continuous | Birr |
| SEX | Sex of the household head | Dummy | 0=female, 1=male |
| ACCR | Access to credit | Dummy | 0=no,1= Yes |
| ACMINF | Access to milk market information | Dummy | 0=no,1= Yes |
| AGESQ | Age of squared of the dairy household | Continuous | Number of Years |

# 4. Result

## Milk production and market supply characteristics

The decision on whether to sell or process whole milk in the study areas was found to depend mainly on distance of the dairy household from nearest milk market, volume of milk produced per household per day and the tradition that the dairy household has been experiencing. Fresh milk, boiled whole milk, soured milk/ergo, soured buttermilk/*arera,* cheese, butter, and whey are the dairy items produced, traded and consumed in the areas (Figure 4.1). Meanwhile, soured milk /ergo and boiled whole milk were the two most important dairy items in terms of volume traded and value in urban areas whereas, soured buttermilk was found to stand first in terms of volume traded and consumed in per-urban and villages.

**Figure 4.1: Milk utilization pattern in the Shahsemane-Yergalem shedMilk market participation by farm type**




The share of milk sold was high among commercial dairy farms mainly due to their larger production base and more market-oriented production objectives.

The share of local breed dairy farms in milk market participation across the sample locations was found to be minimal which is due to limited volume of milk production per household per day mainly due to poor performance of the local breed animal. With respect to sample locations, the milk market share of local dairy farms in

Hawassa, Shashemane and Yergalem was found to be 39.5%, 30% and 10.65%, respectively.

**Table 4.1: Milk market participation share by dairy farm size**

| Farm type | Hawassa | | Shashemane | | Yergalem | |
|---|---|---|---|---|---|---|
| | Total milk yield/day/dairy farm(liter) | % share of milk sold | Total milk yield/day/dairy farm(liter) | % share of milk sold | Total milk yield/day/dairy farm(liter) | % share of milk sold |
| Local small | 79.6 | 32 | 74.9 | 30 | 32.7 | 12.7 |
| Local medium | 127.3 | 47.5 | - | - | 67.1 | 8.6 |
| Cross small | 350 | 72.5 | 115.2 | 66.7 | 141.12 | 72.3 |
| Cross medium | 605 | 80 | 149.4 | 71.2 | 138.6 | 75 |

## Share of dairy in household income

Table 4.2 shows that dairying was found to hold 79.7%, 43.6% and 64% of gross annual income value of Hawassa, Shashemane and Yergalem sampled dairy household, respectively. This shows that dairying has a direct impact on income generation, poverty alleviation and availability of animal protein in the milk shed in particular and in the region in general.

**Table 4.2: Composition of annual income of the sample household by farm type (%)**

| Sources of income | Hawassa (N=99) | Shashemane (N=42) | Yergalem (N=39) |
|---|---|---|---|
| Annual income from dairy | 79.7 | 43.6 | 64 |
| Annual income from crop | 8.1 | 10.22 | 29.3 |
| Annual income from other sources | 12.22 | 46.2 | 6.7 |
| Total | 100 | 100 | 100 |

## Milk marketing channels

Major milk-marketing channels identified to access milk to consumer in milk shed per day were:

I. Producer → consumer (C1);
II. Producer → retailer → consumer(C2);
III. Producer → cooperative → retailers → consumer (C3) and
IV. Producer → cooperative → consumer (C4)
V. Producer → Cooperative → Semi-wholesaler → Retailer → consumer (C5)
VI. Producer → Cooperative → Semi-wholesaler → Consumer (C6)

A considerable milk volume was found to frequently flow from Arsi-Negele peri-urban area (55 km away from Hawassa) and Yergalem urban area (40 km away from Hawassa) to Hawassa through milk semi-wholesaler; however, the frequency and the volume of milk flow from Shashemane urban area to Hawassa (25km from Shashemane) urban area through small scale milk retailers was not substantial and periodic. Milk marketing channel C1 accounts for about 52%, 4.2%, and 14% of total milk marketed in Hawassa, Shashemane and Yergalem, respectively. Channel C1 stands first in Hawassa in terms of importance to distribute milk to consumer and found to accounts for 52% of milk marketed per day in Hawassa.

Channel C2 accounts for 40.4%, 38.2% and 76.6% of total milk marketed in Hawassa, Shahsemane and Yergalem, respectively. It is clear that this channel was found to be more important in Yergalem than elsewhere emphasizing that direct milk sell to consumer is limited due to weak milk demand within micro locality. Channel C3 and C4 were found to account for 5.9% and 2% of total milk marketed in Hawassa; and 47% and 10.67% of total milk marketed per day in Shashemane, respectively. As cooperative of Yergalem did not sell in Yergalem but found to deliver to semi-wholesaler in Hawasssa, it was not considered in channel C4 (producer-cooperative-consumer). Therefore, it was considered in channel C5 and C6 accessing milk for consumer through milk semi-wholesaler

*(ii) Channel C3 accounts for the largest milk volume (47%) in Shashemane due to limited alternative milk sale outlet for the producers particularly during the wet season when supply rises, and fasting period when demand for milk and price as well fall leading to catastrophic circumstances of lacking milk buyers. C5 and C6 refer to proportion of milk in Yergalem that was supplied through dairy cooperative in Yergalem and transported by semi-wholesaler in Hawassa. Milk transported by the semi-wholesaler was accessed to consumer in Hawassa partly through retailer and partly through direct sale of semi-wholesaler to consumer. Both C5 and C6 respectively account for 7.52% and 1.88% of total milk supply in Yergalem.*

### Alternative milk sale outlets

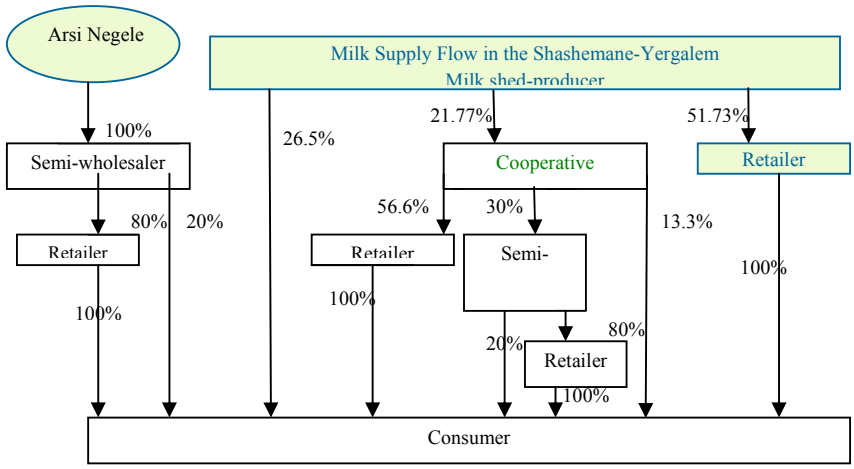
Table 4.3 shows that 10%, 1.5% and 4% of sampled dairy households in Hawassa, Shashemane and Yergalem were respectively found to sell their milk through their own shop. Though milk producers in the study areas have used at least two alternative milk sale outlets, farm gate in Hawassa and delivery to buyers in Shashemane and Yergalem were found to be more important milk sale outlets implying relatively less producer's milk market power.

**Table 4.3 Type of milk market outlets for sample dairy producer households**

| Type of milk marketing sell out let | Sample locations | | |
|---|---|---|---|
| | Hawassa (%) | Shashemane (%) | Yergalem (%) |
| Farm gate | 65.1 | 11.5 | 22 |
| Delivery to buyer | 17 | 50 | 69 |
| Own shop | 10 | 1.5 | 4 |
| Cooperative | 7.9 | 37 | 5 |

Source: Survey result, 2007

**Figure 4.2: Milk Marketing Channels**




Butter marketing channels

Butter collected in rural markets can even be taken by itinerate or semi-whole traders to bigger towns via the public transport system or on foot. Slightly rancid butter still has more market value. Rancid butter is postulated to improve the flavor of edible items. Butter is sold in rural markets and at public butter market in any urban town. Type and quality of butter presented to buyers in these markets, however, show variations. Older butter (locally called *Bisil kibe*) sold in the Addis Ababa market had free fatty acids content.

Butter selling outlets in the milk shed are

- Shops selling butter with honey and/ or cheese;
- Shops selling butter with other consumer items;
- Shops selling butter, honey and other consumer items
- Market place retailers specializing in butter and cheese selling
- Market place retailers specializing in butter selling only

### The major Butter marketing channels

Channel III in Hawassa and Yergalem, and channel IV in Yergalem and Shashemane were identified to be the most vital butter marketing channels in terms of volume and number of intermediaries. Cooking and cosmetic butter are sold either at farm gate or at public market. Itinerate butter traders in the milk shed are found to play the pivotal role in balancing supply of and demand for butter particularly in Hawassa where lucrative market for butter prevails.

**Table 4.4: Major butter-marketing channels**

| Butter marketing channels | Sample locations | | |
|---|---|---|---|
| | Hawassa (%) | Shashemane (%) | Yergalem (%) |
| I. Producer → Retailer → Consumer | 16.4 | 11.5 | 10.24 |
| II. Producer → Producer-trader → Semi-whole seller → Retailer → Consumer | 6 | - | - |
| III. Producer → Itinerate traders → Retailers → Consumer | 72.6 | 31.1 | 42 |
| IV. Producer → Producer trader → Retailer → Consumer | - | 46.2 | 41.7 |
| V. Producer → Consumer | 5 | 11 | 6 |
| **Total** | 100 | 100 | 100 |

## Structure, Conduct and Performance (S-C-P) of Milk Market

### *I. Market structure*

Important butter and milk market actors identified in Shashemane, Yergalem and Hawassa areas during the survey period were: producer, cooperative, and semi-wholesaler, retailer, milk bar, restaurant, kiosks/grocery, and producer, producer trader/village level collector, itinerate trader, semi-wholesaler and retailer, respectively.

**Market Concentration:** According to (Kohl and Uhl, 1985), it is measured by the percentage of milk and butter handled by the largest four upper traders.

**Table 4.5: Concentration Ratio for sampled traders**

| Sample traders | Concentration index for Four Firms (%) | |
|---|---|---|
| | Butter | Fluid milk |
| Hawassa | 37.9 | 62.2 |
| Shashemane | 31.9 | 39.7 |
| Yergalem | 44 | 53.6 |

The survey result highlighted that butter market in Hawassa (37.9%) and Yergalem (44%) is estimated to be weakly oligopolistic (Table 4.5). With regard to milk market, the concentration ratio in Hawassa and Yergalem was identified to be 62.2%, 53.6%, respectively indicating strongly oligopolistic market type from consumer point of view, whereas in Shashemane, it was identified to be weakly oligopolistic type from producer point of view because of outstripping supply of milk.

**Barriers to entry and exit**

The survey result revealed that 90.3% of milk traders were literate and the majority of traders were found to have business experience between one and five years. With regard to working capital, the majority of traders had their own source of working capital. The informal discussion revealed that there were a significant number of milk traders who discontinued their business activities because they ran into debt due to fluctuating demand and competing imported dairy products. .

**Licensing of butter and milk traders**: According to the sampled traders' survey result, average of 96.5% and 74.13% of sampled traders did not have butter and milk trade license, respectively (Table 4.6). Moreover, the enforcement of the law was weak. Thus, trade license and licensing procedures did not create entry and exit barrier. Reputation and relationship with experienced traders and clients parameters are the most credible functional parameter to determine whether milk business firm to be successful or not.

**Table 4.6: Legality of milk and butter traders in the study area (% of traders)**

| Traders | Butter traders | | | Milk traders | | |
|---|---|---|---|---|---|---|
| | Hawassa | Shashemane | Yergalem | Hawassa | Shashemane | Yergalem |
| Licensed | 3.12 | 3 | 5.6 | 37.5 | 6.3 | 21.4 |
| None licensed | 96.88 | 97 | 94.4 | 62.5 | 81.3 | 78.6 |
| No response | 0 | 0 | 0 | 0 | 12.4 | 0 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |

Milk market conduct

*I. Producers' behavior*

**Factors considered by dairy producers in making decision to whom to sell:** The most important factors considered by dairy producers in decision to whom to sell are shown in Table 4.7).

**Table 4.7: Factors considered by milk producers in deciding to whom to sell (%)**

| Variables | Hawassa | Shashemane | Yergalem | average |
|---|---|---|---|---|
| Price | 34.3 | 54 | 89.7 | 59.2 |
| Closeness | 51.4 | 13.5 | 7.6 | 24.2 |
| Secured demand | 14.3 | 32.4 | 2.6 | 16.6 |
| Total | 100 | 100 | 100 | 100 |

Price has the greatest influence (59.2% of the respondent) on the producers' decision to whom to sell followed by consideration of the closeness to demand center for milk (24.16%). Secured demand (16.4%) was found to be the third important factor considered by the sample respondents in the study area during the survey period (January-May, 2007).

## *II. Traders behavior*

**Techniques used by milk buyers to check milk quality:** experienced individual buyers use traditional methods such as spreading milk on hand, tongue testing, smelling and some other techniques to check whether milk is adulterated or not. Whilst, Biftu cooperative and semi-wholesalers had milk-testing equipment such as hydrometer and alcohol, testing kits for water adulteration and bacterial development during their purchase. However, some other traders found to use regular supplier through verbal contractual agreement in order to develop their own supplier quality.

**Milk purchasing strategies:** Albeit, both parties (seller and buyer) bilaterally deal to set milk price, producers have more market power in price setting particularly in Hawassa which is derived from exceeding demand for milk.

Nevertheless, producers at periphery of the town who have limited access to daily milk price information sell their milk through bilateral dealing or it may be decided by buyer. About 27% of milk traders reported that milk market price was set by market whereas about 30.2% of milk traders reported that market price was set by negotiation (annex 2).

The great majority of small traders do not have a telephone for their business. Information seems costlier for smaller traders, where the poor quality of telecommunications means it cannot be circulated from long distance by phone. Due to their mobility, big traders are able to easily conduct a search for markets with better prices before buying or selling. To sum up, the possible outcome of the non-reliable market information system can be broadly summarized as: Wrong decisions occurring due to lack of adequate information;

Delays in making market-related decisions; Decisions made by wrong people /or in wrong places; and Lack of market transparency.

**Table 4.8: source of information for butter and milk traders during purchasing**

| Type of market information sources | Butter trader | | | Milk traders | | |
|---|---|---|---|---|---|---|
| | Hawassa | Shashemane | Yergalem | Hawassa | Shashemane | Yergalem |
| Personal visit | 18.7 | 61.8 | 71.5 | 38.8 | 47.5 | 77.4 |
| Friend/other traders | 61.3 | 21.9 | 23.5 | 12.5 | 15.6 | 14.3 |
| Consumers | 5 | 9.4 | 0 | 38.8 | 34.4 | 7.1 |
| Telephone | 15 | 7 | 5 | 10 | 2.5 | 1.2 |

## Milk market performance

### I. Milk marketing profit

As far as the sample location is concerned, 2.40 birr, 2.24 birr and 2.25 birr/litter of milk was obtained in Hawassa, Shashemane and Yergalem, respectively. About 0.97 birr/litter and 0.07 birr/litter of milk was obtained by cooperative Hawassa and cooperative Shashemane, respectively. The reason for the two cooperative's return/litter of milk was perhaps due to difference in scale economies and purchasing and selling price (annex 1).

### *II. Marketing Costs and Margins*

Price per litter for milk was used for the marketing margin calculations. Margin and cost calculation was carried only for key milk marketing channels.

**Milk marketing margin:** Table 4.9 revealed that the average total milk-marketing margin (TGMM) in Hawassa, Shashemane and Yergalem was found to be 31.6%, 40.9% and 52.3%, respectively. The highest (52.3%) and the lowest (25%) total gross marketing margin (TGMM) was respectively found in Yergalem channel C2 and in Hawassa channel C4.

**Table 4.9: Marketing margin for milk traders**

| Marketing margins (Birr) | Marketing channels | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Hawassa | | | Shashemane | | | Yergalem (%) | |
| | C1 | C2 | C4 | C1 | C2 | C3 | C1 | C2 |
| TGMM | 0 | 38.14 | 25 | 0 | 41.75 | 40 | 0 | 52.3 |
| GMMcop | 0 | - | 25 | 0 | - | 2.5 | 0 | - |
| GMMrt | 0 | 38.18 | - | 0 | 41.75 | 37.5 | 0 | 52.3 |
| GMMp | 100 | 61.86 | 75 | 100 | 58.25 | 60 | 100 | 47.7 |
| NMMcop | 0 | - | 5 | 0 | - | 0.5 | 0 | - |
| NMMrt | 0 | 6.42 | - | 0 | 9.24 | 9.24 | 0 | 6.98 |

## Factors affecting milk supply

### I. Probit Estimation

Out of 13 explanatory variables used in model analysis, number of cross breeding cow owned and distance from milk market are significant at conventional 1% significance level whereas Education, experience and family size are significant at 5% significance level, whilst, age of the household head is significant at 10% significant level. The parameter estimates suggest that the actual milk market entry decision process is postulated to depend on animal asset (number of crossbred milking cow owned), level of formal schooling, distance from the nearest milk demand center, labour force in the dairy household (family size), experience in dairy production and age of house head (Table 5.1).

**Table 4.10: Estimation result of the Binary probit model**

| Variables | Coefficient | t-ratio | Marginal effect |
|---|---|---|---|
| Constant | -0.64 | -1.83 | |
| AGE | 0.20749 | 1.72*** | 0.164 |
| AGESQ | 0.34939 | 0.97 | 0.147 |
| FSHH | 0.16 | 1.65** | 0.101 |
| ELHH | 0.11 | 2.019** | 0.059 |
| EXHH | -0.042 | -2.14** | -0.069 |
| DNMM | -0.0168 | 0.069* | 0.027 |
| CB | 0.6 | 2.41* | 0.102 |
| LB | -0.105 | -0.478 | -0.007 |
| ACEXT | 0.055 | 0.786 | 0.13 |
| SEX | -0.29 | -0.613 | -0.02 |
| ACCR | 0.27 | 0.344 | 0.0025 |
| ACMINFOE | 0.59 | 1.51 | 0.055 |
| INFNDS | -0.156 | -0.702 | -0.009 |

Dependent variable=household market participation (MMP), number of observation (N) = 180, Log likelihood function=-29.74, Restricted log likelihood=-67.480, Chi -squared=75.44, Degree of freedom=139,significance level=0.0000000, *, ** and *** represents significance level at 1%, 5% and 10% probability level, respectively, positive prediction value=90.000%

Focusing to policy relevant variable of the probit model, the positive and significant relationship between education and market participation in Table 4.10 indicates that education improves the dairy household capacity to process production and market related information, which in turn improves bargaining position. The marginal effect also indicates that addition of one-year formal schooling leads the probability of dairy household milk market participation to rise by about 6%.

The positive relationship between number of crossbred milking cows owned and probability of milk market entry decision indicates that as the number of milking cows increases, milk production per dairy household also increases which, in turn, increases percentage share of milk sale volume per day per household. The marginal effect of the variable also confirms that a unit increase in cross bred dairy milking cow leads the probability of dairy household milk market participation to rise by 10.2%. Moreover, this result designates that increasing number of quality crossbred dairy cows is an important policy relevant variable in stimulating the smallholder to market entry and benefit from economic transaction.

On the other hand, the negative association between distance from nearest milk market reveals that the farther is a household from the milk market, the more difficult and costly it would be to get involved in the milk market. The marginal effect also confirms that a one-kilometer increase in milk market distance from the dairy farm owner reduces the probability of participation in milk market by 2.7%. Study conducted by Holloway et.al. (2002) and Gizachew (2005) found consistent result.

However, contrary to prior expectation, experience in dairy production and number of local bred milking cow owned has a strong negative and insignificant correlation with dairy household milk market entry decision, respectively. The reason seems to be these local dairy cattle owners have been integrating their cattle with crop production, thus lacked specialization in milk production which directly hampers both probability and level of milk market participation. Conversely, these households were seemingly participating in dairy derivatives particularly soured buttermilk marketing, but they infrequently sell milk. The marginal effect of the variable also confirms that every one-year experience rise in dairy production causes milk market participation decision to fall by 6.9%.

## II. Supply Equation Estimation

Table 4.11 reports results of the milk supply equation. Age squared, family size and non-dairy source household's financial income are significant at 10% significant level, whereas education level and number of milking cows owned are significant at 1% significant level. These variables are identified to be key precipitators for promoting milk market entry decision of dairy household in the milkshed. Each variable has significant impact on marketable milk surplus.

Focusing on parameter estimates of the model, the coefficient of family size variable confirms that as the dairy household family size increases by one adult equivalent, volume of marketable milk surplus rises by 0.5 litters per day. This is because of the

fact that household members represent labour resources for better management of dairy cows and, hence, are posited to be directly related to engagement in dairy production and marketing activities. Age squared of the dairy household head have non-linear (parabolic) relationship with marketable milk surplus per day. Moreover, the negative sign of the variable indicates that at some stage of earlier period of the dairy household age, the relation was positively linear, as it was shown by positive sign of the coefficient of age variable in probit model estimation, but later on, as the dairy household gets older, the milk sale volume declines, as dairying is the function of active labour force.

Considering the capital forming variable, the model output confirms that addition of one year formal schooling leads to a marketable milk surplus by 0.401 liters per day. In this regard, both marketable milk surplus and entry decision are more responsive to education. However, of capital forming variables, extension visit and experience are non-responsive to marketable milk surplus. Focusing on the animal asset of the parameter estimate, the addition of crossbred milking cow raises daily milk surplus by 4.16 litters; however, the number of local bred milking cow was irresponsive to milk market entry decision and marketable milk surplus indicating clear-cut difference between modern and the traditional production techniques. Contrary to prior expectation, distance to milk market is irresponsive to marketable milk surplus, thus it was not used in supply equation as it was used as selection variable in the probit model in order to increase the efficiency of $\lambda_i$. According to model estimation, non-dairy source financial income has positive contribution to milk surplus per day per household.

**LAMDA(** $\lambda_i$ ): According to the model output, Lambda (Inverse Mills Ratio) or selectivity bias correction factor has positive, but statistically insignificant impact on dairy household marketable milk surplus. This result suggests that there appears to be no unobserved factors that might affect both probability of dairy household market entry decision and marketable milk volume.

**Table 4.11: Supply Equation Model**

| Variables | Coefficients | St.error | t-ratio | Marginal effect |
|---|---|---|---|---|
| Constant | -2.93 | 4.05 | -.722 | |
| AGE | 0.73 | 0.22 | 0.033 | 0.73 |
| AGESQ | -0.13247 | 0.676 | -1.958*** | -0.13 |
| FSHH | 0.509 | 0.27 | 1.85*** | 0.509 |
| ELHH | 0.401 | 0.5 | 0.802* | 0.401 |
| EXHH | 0.0613 | 0.069 | 0.884 | 0.0613 |
| CB | 4.16 | 0.456 | 9.12* | 4.16 |
| LB | 0.61 | 0.77 | 0.799 | 0.61 |
| ACEXT | 0.33 | 0.23 | 1.41 | 0.33 |
| SEX | -1.48 | 1.59 | -0.932 | -1.48 |
| ACCR | -.184 | 2.01 | -.091 | -.184 |
| ACMINFOE | 1.04 | 1.51 | 0.69 | 1.04 |
| INFNDS | 0.0001 | 0.66 | 1.93*** | 0.0001 |
| LMDA | 1.43 | 1.039 | 1.381 | 0.1701 |

Dependent variable=total milk supplied to market, Mean=7.37, number of observation (N) =180), standard deviation=10.29, Model size parameter=13, R-squared=.755966, Adjusted R-squared=73 (prob) =.0000, Log likelihood=-368.1751, Restricted (b=0) =-453.535

# 5. Conclusion and Policy Implications

## 5.1 Conclusion

The maximum likelihood probit model analysis revealed that age of the household, family size, education level, experience in dairy production, distance from milk market and number of cross bred milking cows owned variables were found to exert significant impact on probability of the households' milk market participation. However, the supply equation procedure identified that family size, number of crossbred milking cows owned, education level of the household head, non-dairy source financial income and age squared of the dairy household head as an important factors affecting sale volume of milk. The analysis of competition and the discussion on Structure-Conduct- Performance (SCP) are used as a framework for analyzing the market process. The major economic agents of the milk trade of the milkshed were producers, producer trader, semi-wholesaler, retailers (catering shops, hotels, restaurants, kiosks and supper markets).

The competitive marketing process is determined by market concentration, barriers to entry and assortment of product quality and market information. Entry barriers do not hamper the price formation process in the domestic market. However, having

experience in quality identification and appropriate preservation methods are important factors that determine the success of a firm.

## 5.2 Policy Implication

- As dairy marketing system in the areas was characterized by underdeveloped and inefficient type of market for dairy, government and the sector development concerned entities should strive first to save the dairy sector survival and thus, to improve its performance to meet outstripping domestic dairy demand.
- As it was seen from the models analysis, number of cross bred cows owned has strong positive and significant impact on both probability and level of milk market participation; due attention must be given for integrating cross bred cows to the smallholders dairy sector through promotion of large private investment, which at the end will introduce new technology in the sector.
- As the model analysis result has shown that dairy household milk market participation decision was positively and significantly affected by formal education level of the dairy household head, emphasis should be given to building capacity of the dairy smallholders through short and intermediate practical based training.
- According to model outputs, income from non-dairy source of dairy household was found to affect the sales volume of milk positively. The positively related value of the variable suggests that through improving liquidity, this income makes the household to improve sales volume of milk through expanding dairy production. Therefore, increasing the dimension of access to well functioning formal financial systems and diversified off-farm income sources are critical elements influencing sales volume of milk per day per dairy household.
- As the dairy cooperatives of the study areas were inefficient (below expectation), they must undertake value adding activities to consumers to improve their current position. Otherwise, abandoning them particularly in urban areas is safe.
- There was no linkage between rural dairy producer and urban consumer, which is due to limited milk local zebu. Moreover, as towns and urban expand, dairying is not allowed to keep the neatness of urban and towns by low, which is just now operational. To tackle these combined down pinning effect on dairy sector, rural and per-urban dairying must be stimulated.

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# Appendix

**Annex 1. Milk marketing profit/litter**

| Milk marketing actors | Marketing cost and profit | Milk Marketing Channels | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Hawassa | | | Shashemane | | | Yergalem | |
| | | C1 | C2 | C4 | C1 | C3 | C2 | C1 | C2 |
| Milk producer | Selling price | 3.09 | 3.00 | 3.00 | 2.75 | 2.5 | 2.40 | 2.47 | 2.83 |
| | Production cost | 0.5 | 0.5 | 0.5 | 0.35 | 0.35 | 0.35 | 0.4 | 0.4 |
| | Marketing cost | 0.014 | 0.014 | 0.014 | 0.0104 | 0.0104 | 0.0104 | 0.0141 | 0.0141 |
| | Profit | 2.6 | 2.5 | 2.5 | 2.4 | 2.12 | 2.05 | 2.07 | 2.43 |
| Semi-whole seller | Purchasing price | - | - | - | - | - | - | - | - |
| | Selling price | - | - | - | - | - | - | - | |
| | Marketing cost | - | - | - | - | - | - | - | - |
| | Profit | - | | | - | - | - | - | - |
| Cooperatives | Purchasing price | - | - | 3.00 | - | 2.61 | - | - | - |
| | Selling price | - | - | 4.00 | - | 2.50 | - | - | - |
| | Marketing cost | - | - | 0.03 | - | 0.03 | - | - | - |
| | Profit | - | - | 0.97 | - | 0.07 | - | - | - |
| Retailers | Purchasing price | - | 3.00 | - | - | 2.50 | 2.40 | 2.47 | 2.83 |
| | Selling price | - | 5.00 | - | - | 5.00 | 5.00 | 6.00 | 6.00 |
| | Marketing cost | - | 0.33 | - | - | 0.01 | 0.01 | - | 0.31 |
| | Profit | - | 2.05 | - | - | 2.49 | 2.49 | - | 2.86 |

**Annex 2: Milk and Butter traders purchasing and selling strategies**

| Purchasing and selling price setting strategies | Butter traders | | | Milk traders | | |
|---|---|---|---|---|---|---|
| | Hawassa (%) | Shashemane (%) | Yergalem (%) | Hawassa (%) | Shashemane (%) | Yergalem (%) |
| Negotiation | 78.1 | 65.6 | 88.2 | 37.5 | 40.6 | 12.6 |
| Market | 15.6 | 34.4 | 11.8 | 18.7 | 25 | 37.4 |
| Producer | 6.3 | 0 | 0 | 43.8 | 34.4 | 50 |
| Buyer | 0 | 0 | 0 | 0 | 0 | 5.8 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |

# INSTITUTIONS, SUSTAINABLE LAND USE AND WELFARE: THE CASE OF FOREST AND GRAZING LANDS IN NORTHERN ETHIOPIA

Zenebe Gebreegziabher[1, 2]

*Abstract*

*Land is an essential factor of production for agriculture, forestry as well as other land related activities. Institutions that govern its use determine the sustainability and efficient use of this essential resource. In Ethiopia all land is publicly owned. Such an institutional setting is said to have resulted in major degradation of Ethiopia's land resources and dissipation of the resource rent, as available forest and grazing lands are exploited in a suboptimal fashion. An alternative to current institutional setting is to assign private property institution, but this will lead to welfare costs. In this paper, we examine the welfare effects (from consumer perspective) of change in institutional setting to forest and grazing lands using a unique data set covering 200 cross-section households in Tigrai, Northern Ethiopia. Findings suggest that changing the current institutional setting could indeed be welfare reducing.*

## 1. Introduction

Land is an essential factor of production for agriculture, horticulture, forestry as well as other land related activities. In many developing countries, inefficient use or exploitation of land reduces the amount of resource rent that can be collected, while lowering available future resource rents as land resources degrade over time in suboptimal fashion. Consequently, increasing poverty combined with lack of appropriate institutions governing land use causes peasants to invest too little in land improvements. A cycle of land degradation occurs because, as forests are mined, people turn to grasses, crop residues and livestock dung for fuel, which deteriorates the land further (Pearce and Warford 1993:25).

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Land in Ethiopia is publicly owned.[3] Except for trees that fall in private backyards and farmlands forests/trees and grazing lands remain largely free access resources. Under such an institutional setting or an unrestricted access condition agents would maximize benefits by putting effort to the extent that total cost is equal to total revenue, instead of marginal cost being equal to marginal revenue (van Kooten and Bulte, 2000). Apparently, no agent will have an incentive to delay harvest, as doing so would only enhance the harvest opportunities of others. The outcome is excess depletion and dissipation of the resource rent.[4] It is quite common knowledge that the absence or ineffectiveness of institutions in terms of use regulations of the land resources resulted in severe degradation. Therefore, it would indeed be of public interest to enhance tenure security and alter this situation. An extreme case of this would be enforcing private property institution. An interesting question in here is how would a public policy aiming at altering the status quo affect welfare of private agents? What would be an optimal one or worth doing in terms of addressing the problem?

By and large, there appear to be two opposing and perhaps diverging views as regards to land use/ownership in the country. One favours the status quo, i.e., state stewardship of land, and the other favours private property institution. Though all these policy options are contemplated on the grounds of efficiency and sustainability they are not without welfare costs at individual household level. Therefore, it would be of great interest to empirically examine what the policy of completely enforcing private property institution to forest and grazing/dung resources would mean in terms of welfare of private agents.

Alemu (1999) analyzed perceptions of farmers about the land tenure system prevailing in Ethiopia as well as their willingness to pay for institutionalizing more secured tenure. He found that a large proportion of the sample households are willing to pay for a change in the existing tenure arrangements. Gebeyehu (2000) also investigated at whether type of tenure impact on technical efficiency of farmers, i.e., by considering owner-operators versus tenants. He concluded that type of tenure did not bring about an observable difference in mean technical efficiency across the two groups.

The purpose of the current study is to examine the potential of the policy of assigning an alternative institutional setting, i.e., private property institution, using a unique data set covering 200 cross-section households in Tigrai province, northern Ethiopia. More

[3] Article 40 of the Constitution states: “the right to ownership of rural and urban land is exclusively vested in the state ... and shall not be subject to sale or exchange” (FDRE, 1995).
[4] For details about property rights/institutions, economic dynamics and rent capture see Van Kooten and Bulte 2000.

specifically, in this paper we examine the welfare effects (from consumer perspective) of change in institutional setting to forest and grazing lands. Such a change in institutional setting could be envisaged to counter the dissipation of the resource rent and hence the degradation of agricultural and forest lands. Finally, we draw implications of our findings.

The rest of the paper is organized as follows. The next section describes land use in Tigrai. The theory on institutions and resources degradation is presented in section 3. Then, in section 4, we present the theoretical model of household's maximization problem along with a framework for analyzing/capturing the welfare effects of the change in institutional setting. In section 5, we outline an empirical model, and then section 6 results and discussion. We conclude by drawing some policy/research implications.

## 2. Land use in Tigrai

Tigrai region covers a total of about 50 thousand square km surface/land area (Table 1). Of this total landmass about 25 percent is cultivated or agricultural land. Historically, institutions/property rights to land in Ethiopia were vested in either the *risti* system, the *gulti* system/private land holding, or the church. The *risti*[5] system was the dominant type of land tenure in Tigrai before the 1975 land reform. It was a communal land tenure in which the right to land was not exclusive but shared. Under this system, an individual had usufruct rights to land (*risti* rights) in a given community only if he was able to establish a direct line of descent from the recognized original holder of the land. Nevertheless, the individual's usufruct rights to land were not transferable to others through sale or mortgage, though there was room for temporary lease. Moreover, as the right to land under the *risti* system didn't imply a right to any specific parcel, land redistribution was undertaken periodically to ensure that new entrants/family members were granted access. This implied land fragmentation. In addition, the fact that anybody's land parcels might be reallocated to a distance kinsmen and that no one could sell them for a profit nor leave it to a heir reduced a farmer's incentive to invest in long-term land improvements and, hence, implied land quality deterioration (Hoben, 1995; Hagos et al, 1999). The *gulti* system was characterized by absentee owners (holders), as it was the royal kinsmen/women who had the *gulti* holdings. Initially the *gulti* lands were provided as *maderia*, i.e, for livelihood. However, these were eventually transformed into private holding of the *gultegna* (Jemma, 2004).

[5] As was the case in the rest of Africa (Besley, 1995), *risti* system/ communal land tenure may be regarded as egalitarian in the sense that the distribution was based on the principle of equality, with the land allocated by lottery after being divided into parcels according to quality.

**Table 1: Population size by sex, area and density, Tigrai overall and by zone: 2007**

| Zone | Population ('000) | | | Area $km^2$ | Density (persons/$km^2$) |
|---|---|---|---|---|---|
| | Male | Female | Total | | |
| Tigrai overall | 2,124.8 | 2,189.6 | 4,314.4 | 50,078.64 | 86.1 |
| Western | 183.0 | 174.5 | 357.5 | 12,441.26 | 28.7 |
| Northwestern | 367.6 | 368.3 | 735.9 | 12,267.58 | 60.0 |
| Central | 613.2 | 632.0 | 1,245.2 | 10,353.50 | 120.3 |
| Eastern | 359.7 | 395.9 | 755.6 | 5,705.34 | 132.4 |
| Southern | 496.5 | 508.1 | 1,004.6 | 9,286.52 | 108.4 |
| Mekelle (Metropolitan) | 104.8 | 110.8 | 215.6 | 24.44 | 8819.4 |

Source: CSA (2004) and FDRE PCC (2008)

Forest/shrub and grazing land account for over half of the total land area of the region. Except for trees that fall in private backyards and farmlands, forests/ trees and grazing lands remain largely free access resources. For example, free collection accounted for the dominant part of all household fuel uses in our sample (Table 2). Natural forests and grazing lands were found to be the major sources of freely collected fuels while the private sources constituting a lesser proportion (Table 3). As a result of the free and uncontrolled grazing system that is prevalent in the region, livestock stay outside for most of the day both grazing/browsing and searching for feed. Eventually, the animals leave their manure/dung, which is free for use by any one and there is no defined ownership right to it. For instance, dung collected from rural hinterlands accounts for a significant portion of total household cooking fuel in some towns in Tigrai (Newcombe, 1989). This degrades the land further.

**Table 2: Distribution of sample households by mode/way fuel acquired (in %) (n=200)**

| Mode of acquisition | Fuel type | |
|---|---|---|
| | Fuel wood | Dung |
| Free collection | 85.2 | 72.3 |
| Buying | 11.2 | 0.6 |
| Own source (tree/cattle manure) | 3.6 | 27.1 |
| Total | 100.0 | 100.0 |

**Table 3: Distribution of sample households by source of freely collected fuels by type (in %) n=200**

| Source | Fuel type | |
|---|---|---|
| | Wood | Dung |
| Own farmland/backyard | 15.0 | 33.0 |
| Others' farmland | - | 5.0 |
| Grazing land | 33.0 | 50.5 |
| Forest land | 52.0 | - |
| Total | 100.0 | 88.5[a] |

[a] The remaining are households not using dung at all.

## 3. Institutions[6] and resources degradation: Theory

Renewable natural resources such as forests, grazing lands, fisheries, etc, constitute a significant part of our planet. Rural communities in developing countries depend primarily on these resources for fuel wood, construction material and livestock grazing. These resources are also important sources of livelihood elsewhere in the rest of the world. However, due to unrestricted access by users or in the absence of effective use regulations (rule structures), these resources are subject to over-exploitation on first-come, first-served basis. Alternative theories have been developed to explain the common pool resources problem. Three alternative theories are quite apparent in the literature. The structure of these theories range from a single agent decision framework (e.g., Gordon, 1954) through to game theoretic framework involving strategic interaction among multi agents (e.g., Cheung, 1970; Runge, 1981). One of these theories ascribes the common pool resource problem as 'the free-rider problem'. According to this theory, motivated by narrow self-interest each individual would tend to choose and/or behave independently to utilize the resource at an exploitative level in the expectation that others will do the same, leading to a situation in which all are made worse off. Because part of the cost is born by the entire group involved in using the resource, the social cost of harvesting an additional unit of a common pool resource exceeds the private cost. This is presumed to give individual agents an incentive to enjoy 'free-riding, which finally ends up in overexploitation. Often, a simple prisoner's dilemma game model is used to explain

[6] Institutions are systems of rules/norms that specify certain forms of action as permissible, others as forbidden, and provide for certain penalties and defense when violations occur (Runge, 1984). Through shaping the behavior of people with respect to each other and their belongings, possessions, and property; institutions provide assurance by setting the 'rules of the game'. These rules, hence, affect the welfare of agents through their effect on the rate of resource use and the distribution of returns. By coordinating behavior and reducing uncertainty in the realm of human interaction, they increase the value of a stream of benefits associated with economic activity.

the situation. Therefore, the incentive for free-riding could be avoided through completely defined private property rights to the resources.

For others like Hardin (1968) and Johnson (1972) the problem of common property externality "the tragedy of the commons" can only be resolved through imposition and enforcement of use rules by an external enforcer, the government. Hardin sees 'mutual coercion, mutually agreed upon by the majority of the people affected', and an external authority, the 'custodians', by which restrained access can be enforced as the only viable option. According to this line of theory when a group of people are placed in a setting, where upon all adopting a rule of restrained use of a common pool resource they could mutually benefit, they will not do so in the absence an external enforcer of agreements. Because each agent has an incentive to ignore the social cost of his harvest for fear that other agents will capture the benefits ahead of him.

The third line of theory belongs to the cooperative or conditional cooperative view. Give much importance to what they called 'assurance and uncertainty' in predicating behavior patterns of actors and argue that the institutional rules innovated by the users that help to reduce uncertainty and coordinate expectations are the best solutions to resolve the problem (Runge, 1981). This line of argument emphasizes on the idea that individuals are interdependent because of the non-separable of the cost functions that face them and thus, each individual bases her/his decisions on the expected actions of others. For them, the problem of the common property externality is uncertainty and some kind of institutional solutions that can confirm assurance can easily solve it. Indeed Runge argues that no player has an incentive to defect in a situation where everybody co-operates, it is possible for the players to assure each other that everybody chooses to co-operate and thus reach a stable co-operative Nash equilibrium.

## 4. Theoretical model

### 4.1 Household's maximization problem

Consider the case of a farm household who is assumed to behave as if maximizing a well-behaved utility function defined over the quantities of commodities consumed *q* and environmental and household characteristics *z*, subject to budget constraint *m*. Let the household's utility function be specified as (Sadoulet and de Janvry, 1995):

$$u = u(q, z) \qquad \textbf{(1)}$$

Solving for the Lagrangian function of the household's utility maximization problem in the usual procedure and assuming the second-order conditions are satisfied gives us the ordinary (observed) demand function *q(p,m,z)*. Substituting the demand function derived from this constrained maximization into *u* gives us the indirect utility function:

$$u = v(p, m, z) \qquad \textbf{(2)}$$

Note that $v(\cdot)$ is the maximum utility that the household can reach for given prices *p* and income *m*.

## 4.2 Welfare effects of change in institutional setting

Now consider a change in price of $i^{th}$ good $p_i$ from $p_i^0$ to $p_i^1$ resulting from some public policy. For instance, such a public policy might emanate from the intention to change the existing institutional setting governing forest and grazing lands, e.g., wood and dung, to alter the open access condition and curb the devastation. Specifically, we assume that price of wood and dung change with all other things remaining unchanged. Imagine of a public scheme aimed at enforcing private property institution to forest/wood resources and grazing lands. Three policy alternatives could be envisaged at the disposal of a policy maker: one, completely defining/enforcing private property institution only for wood resources with grazing lands left intact; two, completely defining private property institution only for grazing lands with forest/wood resources left intact; and, three, defining private property institution both on forest/wood resources and grazing lands simultaneously. For tractability of the problem at hand we make the following simplifying assumptions: (i) the cost of completely defining private property rights is zero; (ii) to circumvent the scepticism private property institution might lead to imperfect completion and guarantee that harvests are socially optimal, we assume that the privatization scheme is reasonably fair and does not result in imperfect competition; (iii) buyers and sellers (resource owners) face same equilibrium price; (iv) as wood and dung are no more freely collected, privatization ultimately translates itself into increased prices.[7] Nonetheless, in general, the extent to which prices increase cannot be determined a priori.

[7] There are two reasons that enforcing private property institution ultimately translates itself into increased prices: first is due to marginal user cost. An efficient market would have to consider not only the marginal extraction cost for the resource, but the marginal user cost as well. Hence, agents will take care of the scarcity rent of the resource. Second reason that the value of the resources is greater under the private property institution than under the status quo pertains to the risk averse behavior of agents, i.e., resource owners (Sadoulet and de Janvry 1995).

The mechanism for operationalizing private property institution is that agents are granted an endowment of tradable/transferable permits/deeds to the *in situ* resources, which they control over time. These deeds carefully defined/ specify the boundaries, as boundaries are so important in resolving disputes. Deeds are distributed in lots through lottery method, as experienced in the previous distribution of cultivated land. And that each lot has fair share, both in quality and quantity, of the present natural resource stock. The role of the regulator is confined to choosing the initial allocation of the endowments of permits/deeds and developing the rule governing the game.

Suppose that $(p_i^0, m^0, z)$ and $(p_i^1, m^1, z)$ for i=f,d, as in above are two budgets that measure the prices and incomes that our representative consumer would face under the two (different) policy regimes. It can best be conceived of $(p_i^0, m^0, z)$ as being the status quo and $(p_i^1,w,m^1)$ as being the proposed change. How would, then, such price (policy) change affect the agents' well being? Following Sadoulet and de Janvry, (1995) the welfare change involved in moving from $(p_i^0, m^0, z)$ to $(p_i^1,m^1,z)$ can be expressed as the difference in indirect utility function:

$$\Delta u = v(p_i^1, m^1, z) - v(p_i^0, m^0, z). \qquad \textbf{(3)}$$

The intuition is that if the utility difference in equation (3), as far as our agent is concerned, turns out to be positive the change in institutional setting would be worth doing it and not worth doing it if it turned out to be negative. However, note that utility theory/measure as in equation (3) is purely ordinal and we cannot quantify the utility change. Therefore, we need a convenient monetary measure of changes in our agent's welfare. We considered the equivalent variation (EV) as the motivation in here is to get a reasonable indicator of the likely welfare effects of price (policy) change being examined.[8] More importantly, the equivalent variation (EV) is quite strait away in that it uses current prices as the base and asks what income change at the current price would be equivalent to the proposed change in terms of its impact on utility. Therefore, we specify the equivalent variation EV as follows:

$$EV=e(p^0, u^1, z)-e(p^0, u^0, z)=e(p^0, u^1, z)-m^0, \qquad \textbf{(4)}$$

[8] For a further understanding about alternative welfare measures, CV (compensated variation) and CS (consumers' surplus) see Varian (1992), pp 160-163, Mas-Colell, Whinston and Green (1995), pp 80-91.

where $p^0$ and $m^0$ represent initial prices and income levels and $u^1$ stands for utility level with changed prices.[9] Given initial prices and income, equation (4) could be computed for individual or simultaneous price (policy) changes. Apart from the magnitude the direction of change as implied by the sign of the outcome is also important.

## 5. Empirical model and data

### 5.1 Empirical model

Essentially equation (4) is the relationship that enables us to measure/capture the effects of price (policy) change in some monetary form. Note that the first term in equation (4), $e(p^0,u^1)$ is the income level at which our representative agent achieves exactly utility level $u^1$, at prices $p^0$. And $e(p^0,u^1)- m^0$ is the net change in income that causes our agent to get utility $u^1$, at prices $p^0$. Assuming Cobb-Douglas utility function from the indirect utility function, equations (2), and making use of the expenditure function, we computed the welfare effects using money metric indirect utility function. More specifically, for numerical computation of the welfare changes we used the following money metric indirect utility function:

$$\Delta W = m\frac{\overline{p}_f^{\alpha}\overline{p}_d^{\beta}}{p_f^{1\alpha}p_d^{1\beta}} - m^0 \qquad \textbf{(5)}$$

where *W* stands for welfare and the symbol Δ for change.

Three things appear quite important for the numerical computation of welfare change using equation (5): numerical estimates/values of the substitution elasticities, i.e., α and β parameters; prices, $p^0_i$ and $p^1_i$; and income, *m*. Assuming the utility function associated with wood and dung is of the form $u(q)=q_f^{\alpha}q_d^{\beta}$, where $q_f$ and $q_d$ are quantities of wood and dung consumed by household with $\alpha,\beta \in (0,1)$ and $\alpha+\beta< 1$ and noting that wood and dung are substitutes in cooking, we estimated the substitution elasticities. We considered the variable cooking frequency as a reasonable proxy for the estimation of substitution elasticities. Hence, given initial prices and income, and parameter values, α and β, we can calculate the welfare effects for three different

[9] Note that, alternatively, equation (4) could also be represented as $EV = e(\overline{p}, v(p^1, m)) - e(\overline{p}, v(p^0, m)) = e(\overline{p}, v(p^1, m)) - m^0$, for an arbitrary price vector $\overline{p} >> 0$ and gives the income required to reach the utility level $v(p,m)$ when prices are $\overline{p}$.

scenarios: independent price (policy) change for *i*th good holding the other constant and simultaneous price (policy) change for both goods.

## 5.2 Data and sampling design

The data used in this paper come from a survey of 200 cross-section households conducted in 2000 in Tigrai province, northern Ethiopia. Two-stage sampling was used to select the sample households. First 50 *tabias/kebeles* – the smallest administrative unit in the region – were randomly selected from a total of 600 available *tabias*, and then a random sample of 200 households was selected from these *tabias*. Both quantitative and qualitative data were collected on cooking/baking frequencies of household, household's production (collection) and consumption of various biomass fuel types, and issues regarding household income; demographic characteristics of the household including age, sex and literacy level of the household head and household size. However needles to mention, also obtained from the survey were family resource endowments including total time endowment and labor allocation to various activities, total land holding, land area cultivated, and livestock holdings of household, village level factors including agro-ecological conditions or altitude range and distance traveled (time spent) to collect different fuels. Summary statistics of the variables considered in the analysis has been presented in Appendix Table A1.

Data on cooking/baking frequencies of household was weighted for respective end use share in the total household fuel (EESRC, 1995).

# 6. Results and discussion

At first, empirical estimates of parameters of substitution elasticities between the two goods was obtained using Cobb-Douglas utility function. All the coefficients/parameters turned out to be highly significant, i.e., at 1 percent level. Results have been presented in Table 4. Having estimated parameters $\alpha$=0.5, $\beta$=0.25; and considering $p_f^0$=1.50 (Eth Birr), $p_d^0$=0.25, and $m^0$=140.00 as initial prices and income we analyzed the likely effect(s) of price change, say from $p_i^0$ to $p_i^1$, resulting from change in institutional setting that could be envisaged to alter the open-access conditions of the fuel resources, on the well being of a representative agent/consumer. The respective average values in the dataset were taken as initial prices and income for our representative agent. Effects on agent's well being were analyzed numerically under three alternative scenarios: first, price of dung ($p_d$) changes while wood price is held unchanged; second, price of wood ($p_f$) changes and price of dung held unchanged; and, three, simultaneous change in both prices.

Because the extent to which the change in policy increases prices cannot be determined a priori, we computed the welfare effects of the policy change for alternative price levels. Three different levels of prices, i.e., 25%, 50% and 100% increase in price were considered. Our findings reveal there are private welfare costs involved, be it an independent price (policy) change in *i*th good or simultaneous price (policy) change in both goods. Results show that an independent 25% increase in price of *i*th good would lead to a welfare loss of some one-tenth of agent's income, whereas a simultaneous price increase of similar amount would lead to a welfare loss of two-tenth. We found that a simultaneous 25% increases in prices of wood and dung results in welfare loss equivalent to an independent 50% increase in wood price, with dung price held constant or 100% increase in dung price, with wood price held constant. The details are provided in Table 5.

**Table 4: Estimation results (standard error in parenthesis) of substitution elasticities (parameters)/Cobb-Douglas utility function (n=200)**

| Variable | Coefficient [a] |
|---|---|
| Wood | 0.602 (0.027)*** |
| Dung | 0.250 (0.030)*** |
| $R^2$ | 0.974 |
| F-statistic | 2967.27 |
| Prob > F | 0.000 |

[a] *** indicate significance at the 1%.

**Table 5: Welfare effects of price (policy) change for a representative household under alternative scenarios and price levels (for α=0.5, β=0.25)**

| Scenario + Price combination | Income (m) (Eth Birr) | Price (Eth Birr) | | *Δ W* (Eth Birr) |
|---|---|---|---|---|
| | | Dung ($p_d$) | Wood ($p_f$) | |
| Initial ($m^0$,$p_i^0$) | 140.00 | 0.25 | 1.50 | - |
| 25% increase in $p_d$ & $p_f$ held constant | 140.00 | 0.31 | 1.50 | -14.00 |
| 25% increase in $p_f$ & $p_d$ held constant | 140.00 | 0.25 | 1.825 | -14.00 |
| Simultaneous 25% increase in $p_f$ & $p_d$ | 140.00 | 0.31 | 1.825 | -28.00 |
| 50% increase in $p_d$ & $p_f$ held constant | 140.00 | 0.375 | 1.50 | -14.00 |
| 50% increase in $p_f$ & $p_d$ held constant | 140.00 | 0.25 | 2.25 | -28.00 |
| Simultaneous 50% increase in $p_f$ & $p_d$ | 140.00 | 0.375 | 2.25 | -42.00 |
| 100% increase in $p_d$ & $p_f$ held constant | 140.00 | 0.50 | 1.50 | -28.00 |
| 100% increase in $p_f$ & $p_d$ held constant | 140.00 | 0.25 | 3.00 | -42.00 |
| Simultaneous 100% increase in $p_f$ & $p_d$ | 140.00 | 0.50 | 3.00 | -56.00 |

Theoretically speaking open access leads to rent dissipation. This implies that if land is privatized, rent would be captured (maximized), which according to economic

theory is welfare-improving. That is, when price increases, income of the resource owner increases. Hence, the welfare impact of privatization for those who sell fuelwood could be expected to increases. However, the results presented in here represent only the consumer side of the problem.

## 7. Conclusions

In Ethiopia all land is publicly owned, so traditional fuels are collected freely under open access conditions. Such an institutional setting has resulted in major degradation of Ethiopia's land resources and dissipation of the resource rent, as available forest and grazing lands are exploited in a suboptimal fashion. An alternative to current institutional setting is to enforce private property institution. Using dataset from 200 cross-section households in Tigrai province, northern Ethiopia this paper estimated substitution elasticities between two fuel goods wood and dung. We then use these to derive crude estimates of the potential welfare costs of implementing a private property institution.

Considering average values in the dataset as initial prices and income for our representative agent/consumer, we numerically analyzed the effects on our agent's well being of the policy of enforcing private property institution under three alternative scenarios: first, price of dung changes while wood price is held unchanged; second, price of wood changes and price of dung held unchanged; and, three, simultaneous change in both prices. Because we cannot determine a priori the extent to which the change in policy increases prices, we considered three different price levels. Albeit simplifying assumptions, our findings reveal that privatization of the currently public/common pool resources such as forest and grazing lands/dung might indeed be welfare reducing. The findings hold be it an independent price (policy) change in one good or simultaneous price (policy) change in both goods, for different price levels. The loss in well being is some 14.00 to 56.00 Ethiopian Birr, or 10 to 40% of household average monthly incomes. Given the magnitude of the estimated loss, however inconclusive, results might justify the government's reluctance to impose a private property institution on Ethiopia.

However, the analysis considered only the consumer side of the problem and did not consider the producer side. Therefore, further research is needed to include the producer side and evaluate the net effects.

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# Appendix

**Table A1 Summary statistics of variables considered in the analysis (n=200)**

| Variable | Mean | Std Dev | Min | Max |
|---|---|---|---|---|
| Family size | 5 | 2 | 1 | 12 |
| Household income (monthly) (Eth Birr[a]) | 140.012 | 94.227 | 9.958 | 647.083 |
| Number of cattle | 4 | 3 | 0 | 14 |
| Cooking frequency (monthly) | 52.989 | 19.670 | 12.742 | 210.315 |
| Wood price/shadow (Eth Birr) | 1.483 | 7.285 | 0 | 18.376 |
| Dung price/shadow (Eth Birr) | 0.266 | 0.849 | 0 | 3.618 |
| Wood consumption (kg/month) | 117.875 | 86.310 | 0 | 420 |
| Dung consumption (kg/month) | 90.034 | 94.570 | 0 | 628.5 |
| Kerosene consumption (lit/month) | 1.745 | 6.890 | 0.11 | 97.68 |

[a] Birr is Ethiopian currency, currently $1 USD=13.49 Eth Birr

# SPATIAL INTEGRATION OF COFFEE-GROWERS MARKETS IN ETHIOPIA

Tadesse Kuma Worako[1], Zerihun Gudeta Alemu[2] and Gezahegn Ayele Goshu[3]

*Abstract*

*The objective of this study is to evaluate whether the efforts of market deregulation measures by the government of Ethiopia since 1992 has brought any significant linkages among spatially separated producer coffee markets. We employed a Threshold Vector Error Correction (TVEC) procedure. It uses monthly price data for period 1992 to 2006. As results indicate, there exists strong long-run interrelationship between spatially related producer coffee markets. However, regarding the extent of short-term dynamics, out six pairs of producer markets only three pairs (which are located adjacent to each other) show clear short-run price dynamics and integration, while others show weak interrelationship. Transport, information and other transaction costs are found to be major limiting factors for integration of distant producer coffee markets. This implies that it is important for the government to consider policy measures which could reduce transport and transaction costs between local market by improving public infrastructures and services.*

**Keywords:** Coffee, Ethiopia, nonlinearity, spatial price transmission, producer market, threshold vector error correction model

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## 1. Introduction

The issue of spatial market integration[4] lies at the heart of many contemporary debates concerning market liberalization, price policy and parastatals reforms in developing countries. Integration of agricultural commodity and rural and urban food markets is also a precondition for effective reform in formerly centrally planned economies. Without spatial integration of market, price signals will not be transmitted among spatially separated markets, i.e., from surplus to deficit markets or vice versa (Goletti, Ahmed and Farid, 1995; Barrett, 1996; Baulcha, 1997). Market based policies for poverty alleviation and food security could be more effective if markets are integrated. Besides, if markets are integrated, the effect of policy intervention in one market would be transmitted to other markets that it avoids duplication of intervention and, as a result, decreases the fiscal burden on the budget (Baulch, 1997). Knowledge of market integration also allows monitoring of price movements, forecast prices and to identify structural factors responsible for market integration in order to improve marketing infrastructures.

In a competitive market structure, the price difference between any two regions with regard to homogeneous commodities is expected to be equal to the transaction cost at equilibrium level. When the price difference exceeds the transaction cost between the two markets, arbitrage opportunities will be created and profit-seeking traders will exploit such opportunities by transporting commodity from a low-price to a high-price area.

Understanding the importance of market interrelationships, numerous scholars have attempted to develop measures of market integration. Earlier studies on market integration relied on correlation between prices in the pairs (Richardson, 1978); later studies considered the correlation of price differences (e.g. Stigler & Sherwin, 1985); Granger causality by Gupta and Mueller (1982); variance decomposition approach by Delgado (1986); the radial spatial market structure and cointegration by Ravallian (1986); cointegration and error correction approach by Engle and Granger (1987); the parity-bound model (Spiller and Wood, 1988; Baulch, 1997) and Structural model (Palaskas & Harris, 1991; Goletti, Ahmed and Farid, 1995) were developed and used by several researchers.

[4] Spatial market integration refers to the co-movement of prices, and, more generally, to the smooth transmission of price signals and information across spatially separated markets (Goletti, Ahmed and Farid, 1995). Two markets are assumed to be integrated if price change in one leads to an identical price response in the other. According to Barrett (1996), market integration concerns the free flow of goods and information, and thus prices, over form, space and time and it is closely related to the concepts of efficiency.

However, these simple price based regression and cointegration modelling approach have been criticized recently for their ignorance of transaction costs and assumption of instantaneous adjustment for any small deviation from long-run equilibrium (Goodwin and Piggott, 2001; Barret, 1996). As stated by Goodwin and Piggott (2001), the presence of transaction costs, which typically are unobservable to empirical researchers, may lead to a "neutral band" with which prices are not linked to one another. Price equalizing arbitrage activities are triggered only when localized shocks result in price differences which exceed the neutral band. Hence simple modelling approach focused on regression-based tests of market integration may result in misleading inferences when transaction costs are ignored.

Recognizing the importance of transaction cost, Spiller and Wood (1988), Sexton, Kling and Carman (1991), and Baulch (1997) have applied endogenous switching modes which accounts for multiple regimes that may result from transaction costs. In other line of research, several researchers have developed threshold autoregression (TAR) models which take into account transaction cost to evaluate market integration. The simplest class is the univariate TAR model that was developed by Tong (1978). Later Tsay (1989) developed a method to test for threshold effects in autoregressive models. Balke and Fomby (1997) extended the threshold autoregressive models to a cointegration framework, thus combining non-linearity and cointegration. One of the most important statistical issues for these models is testing for the presence of a threshold effect. Balke and Fomby (1997) proposed using the application of the univariate tests of Hansen (1997) and Tsay (1989) using cointegrating residuals from OLS estimate. Lo and Zivot (2001) extended the Balke and Fomby approach to a multivariate threshold cointegration model with a known cointegrating vector, using the tests of Tsay (1989) and multivariate extensions of Hansen (1999). Serra and Goodwin (2002) also extended by introducing Sup-LR test null of $TVECM_1$ against $TVECM_m$.

This study follows specification of Hansen (1999) approach. It also contributes additional values for existing methods for three reasons. Firstly, the earlier studies by Goodwin & Harper (2000), Serra & Goodwin (2003) assumed homogeneity of error variance without testing - which might lead to inferential bias. In this study we extended their approach by testing for the presence of heteroskedasticity in error variances. Secondly, while earlier studies intuitively assumed three regimes, in this study we have tested whether a one, a two- or a three-regime model best fits the data by extending Hansen's (1999) technique which was developed originally for a threshold autoregressive (TAR) models. Thirdly, there is no study we know which analyzed market integration in Ethiopia using similar technique. Those available but applying different techniques could be criticized on methodological grounds (see

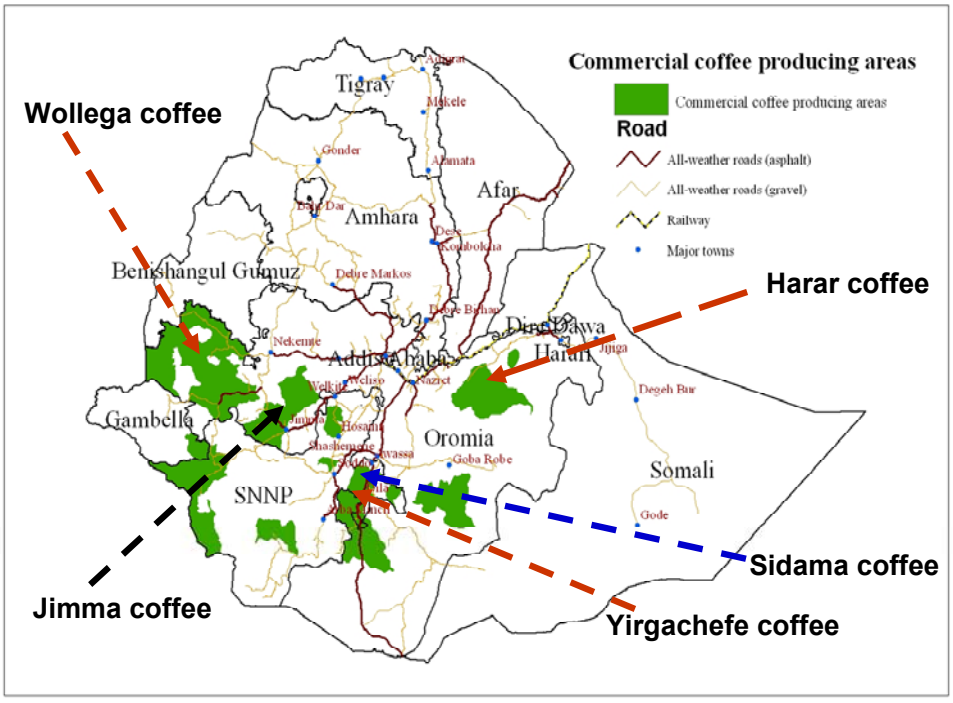
unpublished studies by Amme (1995) and Shibru (1998) and others applying descriptive statistics by Negewo (1993) and IFPRI (2003).

The principal aim of this paper is to evaluate the extent to which six spatially separated producer coffee markets are integrated (see Figure 1). Attempts are also made to measure short-term dynamics for the six producer coffee markets. The rest of the paper is organized as follows. In Section 2, we briefly present the commercial coffee growing areas in Ethiopia. Section 3 provides a description of the methodological approach used in the paper. Section 4 reports estimates of parameters. Finally, section 5 closes the paper with some concluding remarks.

## 2. Commercial coffee growing zones

Regarding the case of Ethiopian coffee industry, commercial coffee is produced in Wollega, Illubabore, Jimma (from south western regions); in Sidamo, Yirgachefe and Borena (from southern regions) and in Harar and Bale (from Eastern and South eastern regions) of the country (see Figure 1).

**Figure 1: Spatial distribution of commercial coffee production areas**



Although there are differences in the quality of the coffees produced in these different regions, they are homogenous and a perfect substitute for one another. Hence, any price increase or decrease due to demand or supply shocks has an effect on all coffee types regardless of their quality differences. In addition, given the current marketing situation, most exported coffee beans are blended (adulterated) and it is almost impossible to observe single origin- or area specific marketing and export. Thus in this study we assume homogeneity of all the Ethiopian coffee. In addition, Yirgachfe and Harar coffee types are considered price leaders due to their superiority in price and quality compared to other coffee types both in the local and export markets.

# 3. Data sources and econometric methods

## 3.1 Data and sources

Monthly price data (Sep. 1981-Oct. 2006) for producer, auction and FOB prices were collected from different sources. Producer price obtained from Central Statistical Agency (CSA) monthly Rural Agricultural Price Survey reports. The auction and FOB prices were obtained from Agricultural Market Promotion Department (AMPD) of Ministry of Agriculture and Rural Development (MoARD) unpublished price reports. All prices are converted in to standard unit (US cents/lb) and currency in order to make comparable with others. All the variables are transformed in to natural logarithms in order to mitigate the fluctuation of individual series and to increase the likelihood of stationarity after first differencing

## 3.2 Econometric methods

### 3.2.1 Statistical properties of variables

Both informal[5] and formal testing methods were applied on individual price series to check for the stationarity of the series. Among the formal tests, the standard ADF test for unit root applied for individual price series on level as follows:

$$P_{jt} = \rho P_{jt-1} + u_t \qquad [1]$$

where $P_{jt}$ and $P_{jt-1}$ denotes the logarithm of the producer price of coffee at time $t$ and $t$-1 respectively, $\rho$ is the coefficient of lagged coffee price and $u_t$ is

[5] The informal tests are tests that provide clues as to whether or not a series is stationary. These include visual inspection (graphical tests) and correlerogram tests were employed.

$i.i.d \sim N(0, \sigma^2)$ error term. If the null hypothesis of unit root is not rejected (i.e. $\rho = 1,$ ) then the time series is non-stationary or vice versa.

Consider a standard cointegration relationship representing an economic equilibrium

$$\begin{bmatrix} 1 & -\alpha_1 \end{bmatrix} \begin{bmatrix} P_{it} \\ P_{jt} \end{bmatrix} = u_t \qquad [2]$$

$$u_t = \rho u_{t-1} + \bar{v_t} \square\square\square$$

where, $P_{it}$ and $P_{jt}$ denotes the logarithm of the producer prices of market $i$ and $j$ at time $t$ and $u_t$ is error term.

In this study statistical properties of price variables as well as cointegration tests are conducted as follows. Firstly, we checked for the stationarity of each price variables by applying Augmented Dickey-Fuller test. This was followed by a test for cointegration or long-run relationships between pairs of price variables representing two spatially separated markets. This is done twice first using the residual based approach as proposed by Engle and Granger and second using the Johansen procedure. In both cases the Law of One Price (LOP) is imposed meaning $\alpha_1$ =1 in equation [2] which gives a cointegrating vector of [1, -1]. The lagged price difference from equation [3] is used to define the threshold variable (i.e., $y_t$ ).

### 3.2.2 Threshold model

Let $y_t$ be a two dimensional *I* (1) time series variable $y_t = (P_{it}, P_{jt})'$. Where $P_{it}$ and $P_{jt}$ are as defined early, the linear form of vector autoregressive ($TVAR_1$) model is given by

$$y_t = \phi_0 + \phi_1 y_{t-1} + \phi_2 y_{t-2} + ... + \phi_k y_{t-k} + \varepsilon_t \qquad [4]$$

where *t = 1,2,3*…T and *k* is the lag length which is assumed unknown. Vector Error Correction representation of equation [4], in other words $TVECM_1$ is given by

$$\Delta y_t = \phi_0 + \hat{\Pi}\phi_{t-1} + \sum_{i=1}^{k-1} \mu_i \Delta y_{t-i} + \psi_t^{(j)} \quad [5]$$

Where, $\hat{\Pi} = \sum_{i=1}^{k} \phi_i - I_2 = \sigma\kappa = \begin{pmatrix} \sigma_1 \\ \sigma_2 \end{pmatrix} (1, o_1, o_2)$, $\kappa = (1, o_1, o_2)$ is a cointegrating vector,

$\sigma = \begin{pmatrix} \sigma_1 \\ \sigma_2 \end{pmatrix}$ is a vector of adjustment coefficients, and $\mu_i = -\sum_{l=i+1}^{k} \phi_i$ .

The three regime threshold vector autoregressive representation of [6] i.e. $TVAR_3$ may be given by

$$y_t = \eta_0^j + \eta_1^j y_{t-1} + \eta_2{}^j y_{t-2} + \ldots + \eta_k^j y_{t-k} + \omega^j{}_t, \quad \text{for}$$
$$\partial_{(j-1)} \le z_{t-d} \le \partial_{(j)} \quad [6]$$

Where t is defined as before; *j=1,2,3*; $-\infty = \partial_{(0)} < \partial_{(1)} < \partial_{(2)} < \partial_{(3)} = \infty$; $\varepsilon^j{}_t \sim IIN(0, \Sigma^j)$, for a three regime $\partial = (\partial_1, \partial_2)$ is threshold value; $z_{t-d}$ and '*d*' are defined as before. The general form of threshold vector error correction representation ( $TVECM_3$ ) of [6] is given by

$$\Delta y_t = \varphi_0^j + \prod^j y_{t-1} + \sum_{i=1}^{k-1} \zeta_i^{(j)} \Delta y_{t-i} + \varepsilon_t^{(j)} \quad \text{for } \partial_{(j-1)} \le z_{t-d} \le \partial_{(j)}$$

[7]

Where $\Pi^j = \sum_{i=1}^{k} \phi_i^j - I_2 = \sigma^j k = \begin{pmatrix} \sigma_1^j \\ \sigma_2^j \end{pmatrix} (1, \alpha_1, \alpha_2)$ and $\zeta_i^{\,j} = -\sum_{l=i+1}^{k} \vartheta_l^{(j)}$ , '*j*' is defined as before.

From [6.11], a $TVECM_2$ could be defined by allowing 'j' to take values j=1, 2 and making $\partial_{(2)} = \infty$.

### 3.2.3 Estimation procedure

An extension to Hansen's (1999) approach was applied to test for linearity using Sup-LR statistics given by [8]. That is, the null hypothesis of $TVECM_1$ against its alternative hypothesis of $TVECM_m$ for $m = 2,3$. After threshold nonlinearity was confirmed, the number of regimes was determined by testing the null hypothesis of $TVECM_2$ against its alternative of $TVECM_3$. To do this, a non-standard test procedure was applied. The authors simulated 2000 Sup-LR statistics ($LR_{1m}$), which were then used to calculate p-values. This was calculated by counting simulated values exceeding actual or computed values as a percentage of the total. See Hansen (1999) for a detailed discussion within a threshold autoregressive (TAR) context.

According to Hansen (1999), the sampling distribution of the simulated Sup-LR, i.e. $LR_{im}$ in [8], depends on whether error variances in $TVECM_i$ are heteroskedastic. This was tested by the regression of squares of residuals from $TVECM_i$ on squares of the variables and the dummies identifying regimes and testing for the joint significance of the variables. Where heteroskedastic error variances were found, the necessary corrections were made (see Hansen (1999) for the method). The Sup-LR was computed using [8] below.

$$LR_{im} = T * (\ln(\left|\hat{\Sigma}\right|) - \ln(\left|\hat{\Sigma}_m(\hat{\gamma}, \hat{d})\right|)) \quad \text{for i = 1,2 and } m = 2,3 \qquad [8]$$

For spatially separated markets, replace $\hat{\gamma}$ by $\hat{\partial}$. Where $LR_{im}$ represents the test statistics, $\hat{\Sigma}$ and $\hat{\Sigma}_m(\hat{\gamma}, \hat{d})$ or $\hat{\Sigma}_m(\hat{\partial}, \hat{d})$ for spatially separated markets) respectively stand for variance covariance matrix of residuals obtained from $TVECM_i$ and $TVECM_m$.

The parameters $\vartheta_0^{(j)}, \Delta^j$, and $\theta_i^j$ in the vertically related markets and $\varphi_0^{(j)}, \sigma^j$, and $\zeta_i^j$ are estimated after a two-dimensional grid search is applied to determine $\gamma$ and $\partial$ by selecting those values of $\gamma$ and $\partial$ which minimize the log determinant of the variance covariance matrix of residuals $\hat{\Sigma}_m(\hat{\gamma}, \hat{d})$ for vertically related markets and $\hat{\Sigma}_m(\hat{\partial}, \hat{d})$. The search was restricted to a minimum of 20 observations in a regime.

# 4. Results and discussions

The analysis of results consists of four sections (i.e., ADF test and linearity test, threshold values and regime switching, estimates of Threshold Vector Error Correction, and responsiveness of one market to shocks in another market).

## 4.1 ADF and linearity test results

As the unit root tests for individual prices under the study indicate that all price series uniformly exhibit I(1) process after first difference (see Appendix table 1), the next step is to test whether the two prices have long-run relationships or not. The test result for Johansen likelihood ratio shows that at 5% level of significance the Johansen test rejects the null hypothesis of zero cointegration (r = 0) for all pairs of producer prices except for Harar and Yirgachefe(see Appendix Table 2). Similarly, the ADF test also rejects the null hypothesis of unit root at 1% level of significance for price differentials. Both results illustrate strong long-term relationship in the spatially separated producer coffee markets.

Once the time series properties of price variables were studied and cointegration confirmed for selected spatial coffee market pairs, then linearity test was conducted using Hansen's (1999) procedure which is also similar to Lo and Zivot (2001). Appendix Table 3 provides the results from linearity test. The hypothesis of linearity tests for six pairs of producer markets – $TVECM_1$ versus $TVECM_2$ and $TVECM_1$ versus $TVECM_3$ were tested. All six pairs of market tests reject the null hypothesis of $TVECM_1$ (i.e., the series is linear) at 1% level of significance, confirming the nonlinearity of all the series. The hypothesis $TVECM_2$ versus $TVECM_3$ is used to decide on the number of regimes, and all pairs reject null of $TVECM_2$, confirming effects that the series exhibits 3 regimes (see Appendix Table 3).

## 4.2 Threshold values and regime switching

Once the threshold effect is confirmed, the next step was to estimate for threshold values. Appendix table 3 shows results from threshold value for lower ($c_1$) and upper ($c_2$) boundaries. These values delineate data series into three regimes and information obtained from three regimes also used to compute regime-switching model. The threshold value directly correspond to transaction costs and presents the amount of price differences need to exceeded in order to trigger adjustment at the upper bound. The price differences have to be at least 5.7% in between Sidama and Yirgachefe producer prices to trigger adjustment. This lower difference may be due to the fact that

the two coffee zones are adjacent to each other. The highest threshold value (18.6%) observed in between Harar and Yirgachefe which may be ascribed to the bunching of transaction costs. This is consistent with earlier finding and might be a reason for lack of long-run cointegration between two markets. These two major coffee zones located about 900 kilometers apart. Similarly, the price difference required to trigger arbitrage between Wollega and Yirgachefe is 13.7%, while for Jimma and Sidama it is 12.5%. These percentage differences may positively associate to the distance and availability of road network connecting the two markets[6].

Regime-switching model is then used to investigate market integration, the persistence of deviations from the long-run equilibrium and timing of switching of observations among the regimes and factors account for switching. In the three-regime model, the persistence occurrence of deviations in the second regime is a condition for market integration. Otherwise if the price differences consistently fall within regimes I and III, it is suggest that the price differences are lower than equilibrium prices or transaction costs are higher than transfer costs. The subsequent section investigates the results from the regime-switching model.

Figures 2 and 3 present the Sidama & Yirgachefe and Jimma & Wollega producer price integration respectively. The results show that in both cases monthly price differences persistently occurred in regime II. The persistent occurrence within the neutral band was stronger in the post-2002 period compared to the pre-2002 period. This perhaps ascribed for the serious price decline in the world coffee price in 2001/02 due to a substantial increase in world coffee production and supply to export market which resulted in a drastic decline in producer price of Ethiopia (e.g., the average produce price dropped from about 85 US cents/lb in 1998 to 35 US cents/lb in 2001/02). However, producer price recovered quickly due to high local consumption and smuggling[7]. These factors indeed serve as a natural price stabilisation mechanism for Ethiopian coffee producers and expected to contribute to the fact that the producer price falls persistently in the neutral or equilibrium band.

[6] See Goodwin and Piggott (2001) for detailed discussion on relation between transaction cost & distance.
[7] Ethiopia on average consumes 48% of its average production and about 15% of production in the south-western and eastern part of the country (i.e. Jimma, Wollega, Illubabore and Harar) is smuggled via Sudan, Djibouti and Somalia. (AMPD, 2006).

**Figure 2: Integration between Sidama and Yirgachefe producer markets**

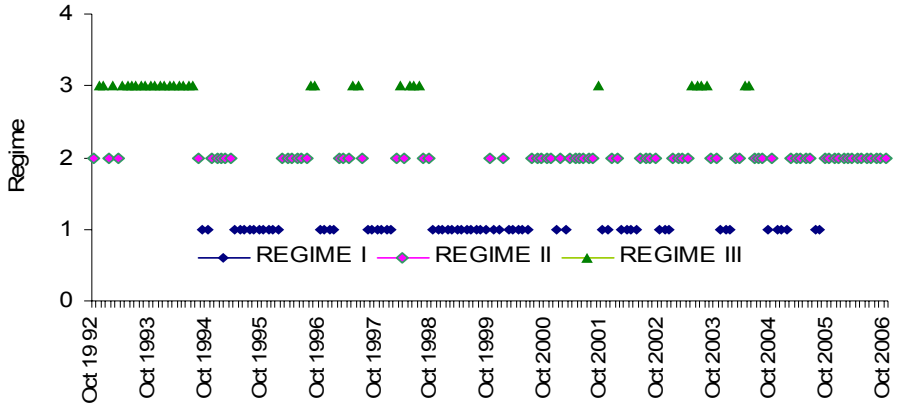
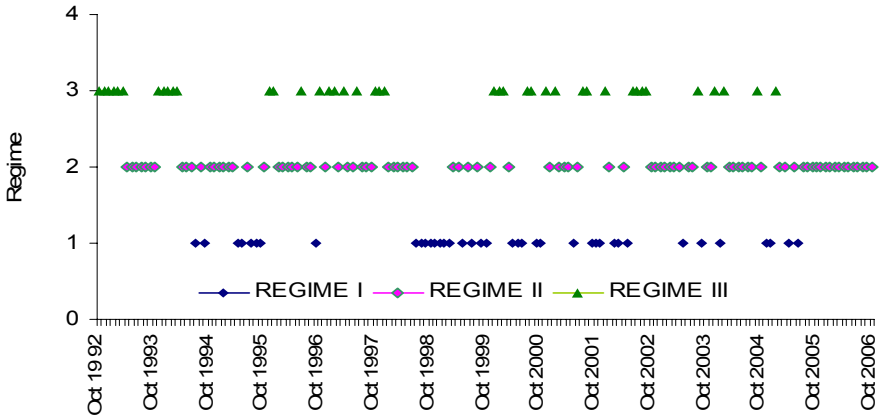



**Figure 3: Integration between Jimma and Wollega producer markets**




In the case of other pairs of producer prices, the results more or less remained similar to those reported earlier.

The average percentage of observation falling in each regime provides more solid evidence regarding relation between markets. Table 1 provides a summary of percentage of observation falling in each regime for period 1992-2006. We sub divided the entire period into two sub-periods (i.e., to 1992-1998 and 1999-2006) based on evidences. During the first period, coffee prices were relatively lucrative due to frosts in Brazil in 1994 and 1997, while in the later period prices dropped to historically low levels, reaching their lowest level in 2001/02 due to an increase in

world production. For the period 1992-1998, of the six pairs of producer coffee markets, it was only in two market pairs that higher percentage of observation (about 50%) fell in the neutral band. In the later period (1998-2006), three market pairs out of six exhibited a larger number observations (42-60%) persistently falling in the neural band - implying integration of three of the six producer market pairs (see Table 2). The simple deduction is that in the later period (1999-2006) the level of integration improved slightly compared to the period immediately after the reform. The three market pairs lacking integration were Jimma and Sidama, Harar and Yirgachefe, and Jimma and Yirgachefe.

**Table 1: Summary of regime switching: % of observation falling into each regime**

| | 1. Sidama & Yirgachefe | | | 2. Jimma & Yirgachefe | | | 3. Wollega & Yirgachefe | | | 4. Harar & Yirgachefe | | | 5. Jimma & Sidama | | | 6. Jimma & Wollega | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RI | RII | RII | RI | RII | RII | RI | RII | RII | RI | RII | RII | RI | RII | RII | RI | RII | RII |
| ar | | | | | | | | | | | | | | | | | | |
| 998 | 31 | 30 | 39 | 24 | 49 | 27 | 12 | 25 | 63 | 29 | 12 | 60 | 18 | 25 | 57 | 17 | 50 | 33 |
| 006 | 38 | 55 | 7 | 49 | 43 | 7 | 20 | 60 | 19 | 51 | 39 | 10 | 55 | 9 | 32 | 26 | 42 | 32 |
| 006 | 34 | 42 | 23 | 37 | 46 | 17 | 16 | 43 | 41 | 40 | 25 | 35 | 37 | 17 | 45 | 21 | 46 | 33 |

**Source:** Author's calculation from TVEC model parameter estimate (2006)

Why did these three producer markets fail to show integration in the post-deregulation period? Although it is inconclusive, there are two expected reasons that may account for the lack of integration between these market pairs. Firstly, the three coffee market pairs are located far apart from each other and price differences between these market pairs are unlikely to be higher than transaction costs. Moreover, current government regulations strictly prohibit the free movement of coffee beans from one production area to another unless the beans have been rejected at the auction market and subsequently released for local consumption. Secondly, Yirgachefe and Harar coffee brands are almost equally respected in the international market due to their high quality, and traders might not have an incentive for arbitrage.

To summarise, almost all price pairs reveal a long-term relationship (cointegration), but in the short run some producer markets lack considerable relationships. This lack of short-run integration between pairs of producer coffee markets may be partly due to their physical separation and resulting high transportation costs.

## 4.3 Threshold vector error correction

The existence of cointegration and nonlinearity alone says nothing about the short-run dynamics of the price series. In other words, speed of adjustment to deviation from long-run equilibrium, responses to changes in spatially related market prices and direction of causality are essential when it comes to evaluating short-run dynamics. Information on such features can be generated from an estimation of error correction models. Table 2 reports the coefficients of lagged price changes on its own variable that captures the short-run dynamics and adjustment coefficients ($u_{t-1}$) to deviation from long-run equilibrium.

As the short-run dynamic relationship between Sidama and Yirgachefe producer market prices indicates (table 1, no. 1), producer price of Sidama has shown response to lagged price change in Yirgachefe producer price at regime I. However, neither Sidama nor Yirgachefe prices is exogenous or price leader. This may be attributed to the fact that both are premium coffees and located in the same production areas that they have close price information exchange and are equally respected brands in the world coffee market. They also have access to relatively better road networks and communication services. The estimated adjustment coefficients of Sidama to changes in Yirgachefe price faster in regime I (44%) and regime III (33%) and which is consistent with theory but producer price of Yirgachefe shows unexpectedly faster adjustment in the neutral band which is inconsistent with theory.

The estimated adjustment coefficients for Jimma and Yirgachefe producer market prices in the outer regimes (regimes I and III) are found to be insignificant, as well as Jimma producer price lack short-run dynamics for lagged price change. This perhaps indicates a weak short-run and long-run relationship between the two pairs of market prices which may be because these two coffee zones are situated far apart (about 700 km) and produce coffee brands which have considerable differences in quality.

As depicted in table 2, no. 3, neither Wollega nor Yirgachefe is a price leader (i.e., they exhibit bidirectional causality). The adjustment coefficients for deviation from long-run equilibrium are faster and more significant in the outer regimes (regimes I and III). Indeed, the two brands (Wollega and Yirgachefe) are high-premium coffees that compete in terms of price on the international market. Wollega producer price has shown response for change in its lagged price at the regime I.

**Table 2: Threshold vector error correction (TVEC) model parameter estimates**

| Producer price pairs | Dependent Variable | Variables | TVEC model | | |
|---|---|---|---|---|---|
| | | | Regime I | Regime II | Regime III |
| 1. Sidama & Yirgachefe | $dPS$ | $dPS_{t-1}$ | 0.009 (0.096) | -0.124 (0.109) | -0.043(0.154) |
| | | $dPY_{t-1}$ | -0.35(0.148)** | -0.140(0.109) | 0.033(0.138) |
| | | $\varepsilon_{t-1}$ | -0.44(0.060)* | -0.24(0.130)*** | **-0.33(0.140)**** |
| | $dPY$ | $dPS_{t-1}$ | -0.023(0.087) | -0.013(0.098) | 0.057(0.139) |
| | | $dPY_{t-1}$ | 0.129(0.133) | -0.019(0.099) | -0.081(0.125) |
| | | $\varepsilon_{t-1}$ | 0.370(0.05)* | 0.440(0.120)* | **0.370(0.131)**** |
| 2. Jimma & Yirgachefe | $dPJ$ | $dPJ_{t-1}$ | -0.085 (0.082) | -0.202(0.104) | -0.073(0.144) |
| | | $dPY_{t-1}$ | 0.091(0.130) | 0.046(0.160) | -0.280(0.230) |
| | | $\varepsilon_{t-1}$ | -0.520(0.070) | -0.560 (0.800) | -0.740(0.180) |
| | $dPY$ | $dPJ_{t-1}$ | -0.102(0.64) | -0.143(0.08)*** | 0.005(0.112) |
| | | $dPY_{t-1}$ | 0.220(0.100)** | -0.010(0.124) | -0.536(0.178)* |
| | | $\varepsilon_{t-1}$ | 0.25(0.05)* | 0.140 (0.140) | 0.040(0.142) |
| 3. Wollega & Yirgachefe | $dPW$ | $dPW_{t-1}$ | -0.41(0.117)** | 0.044(0.099) | -0.21(0.102) |
| | | $dPY_{t-1}$ | 0.137(0.178) | 0.009(0.10)* | -0.061(0.980) |
| | | $\varepsilon_{t-1}$ | -0.400(0.060)* | -0.310(0.080)* | **-0.310(0.090)*** |
| | $dPY$ | $dPW_{t-1}$ | -0.36(0.122)* | -0.001(0.103) | -0.166(0.106) |
| | | $dPY_{t-1}$ | 0.112(0.186) | 0.254(0.105)** | -0.204(0.102) |
| | | $\varepsilon_{t-1}$ | 0.060(0.340)* | 0.370(0.080)* | **0.270(0.090)*** |
| 4. Jimma & Sidama | $dPJ$ | $dPJ_{t-1}$ | -0.06(0.089) | -0.031(0.112) | 0.23(0.185) |
| | | $dPS_{t-1}$ | -0.228(0.128) | -0.026(0.141) | -0.527(0.259) |
| | | $\varepsilon_{t-1}$ | -0.680 (0.11)* | -0.91(0.310)* | **-0.90(0.160)*** |
| | $dPS$ | $dPJ_{t-1}$ | -0.14(0.084)*** | -0.062(0.107) | 0.280(0.175) |
| | | $dPS_{t-1}$ | 0.018(0.121) | -0.005(0.134) | -0.48(0.245)*** |
| | | $\varepsilon_{t-1}$ | 0.10(0.28)** | -0.03(0.29) | 0.002(0.163) |
| 5. Jimma & Wollega | $dPJ$ | $dPJ_{t-1}$ | -0.189(0.133) | -0.194(0.113)*** | 0.081(0.086) |
| | | $dPW_{t-1}$ | -0.170(0.167) | 0.278(0.167)*** | -0.158(0.110) |
| | | $\varepsilon_{t-1}$ | -0.590(0.090)* | -0.780(0.140)* | **-0.540(0.120)*** |
| | $dPW$ | $dPJ_{t-1}$ | -0.372(0.124) | -0.240(0.106)*** | -0.004(0.080) |
| | | $dPW_{t-1}$ | 0.039(0.156) | 0.223(0.156) | -0.295(0.103)* |
| | | $\varepsilon_{t-1}$ | 0.420(0.080)* | 0.180(0.130) | 0.150(0.120) |

Note: - Single, double and triple asterisks indicate statistical significance at 1, 5 and 10 percent respectively
- Harar and Yirgachefe prices pairs lack long-run relation and are excluded.

Regarding Jimma and Sidama producer price relation (Table 2, no.4), the short run dynamics remained weak for both cases. Produce price of Sidama found price leader while Jimma price follower. This is consistent with prior expectation. The speed of adjustment of the Jimma producer price to deviation from its long-run equilibrium is much faster in regime III (90%) as expected. In other words, Jimma producer price adjust 90% deviation in price from Sidama within a month.

The Jimma and Wollega coffee zones are located in the south-western part of the country and are adjacent to each other. The trader's movement and information flow is expected to be high, which might account for the more rapid adjustment of the Jimma producer market price to deviation from its long-run equilibrium (column 1, no. 6). The adjustment coefficients from long-run equilibrium are faster and significant at regime I and II (59% and 54% respectively). The producer price of Wollega is found the price leader. This is consistent with prior expectations due to substantial superiority in quality of Wollega coffee compared to Jimma.

In general, two of the producer price pairs (Nos. 1 and 3) show a bidirectional flow of price signal changes, while two of the pairs (Nos. 4 and 5) indicate unidirectional causality, i.e. leader market to follower market. Unidirectional effect entails the dominance of one price, while bidirectional response entails one market being able to affect another at a particular time and vice versa. In most of the cases, lagged price changes effect on its own variable remained weak which entails lack of short-run dynamics. The speed of adjustment for deviation from the long-run equilibrium varies significantly between pairs of prices. For instance, in most cases, the Jimma producer price has recorded much more rapid adjustment to deviation from the long-run equilibrium compared to any other prices. In general, prices exhibit more dynamic relationships today, although they are affected by high transaction costs between regions to conduct effective arbitrage.

## 4.4 Impulse response of producer coffee markets

The dynamic interrelationship between two spatially interrelated markets is best explained by evaluating the response of one market to positive and negative shocks in the corresponding market. In this section, the results of the impulse response function for selected pairs of spatial markets are reported. With regard to the nonlinear impulse response function (IRF), the approach of Porter (1995) is adopted. According to Potter, responses are defined on the basis of actual data $(z_t, z_{t-1}, ...)$ while a shock $(v)$ is defined as follows:

$$I_{t+k}\ (v, Z_t, Z_{t-1}, \ldots) = E[Z_{t-k} | Z_t = z_{t+}v, Z_{t-1} = z_{t-1}, \ldots] - E[Z_{t-k} | Z_t = z_t, Z_{t-1} = z_{t\ldots1}, \ldots]. \quad [8]$$

Appendix Figures 1 and 2 present the response of Sidama producer price to one-half standard deviation positive and negative shocks in the Yirgachefe[8] producer price. Both positive and negative shocks evoked almost similar responses and eventually led to price convergence to equilibrium after about seven months. In both cases, Sidama price was equally responsive to shocks in the Yirgachefe price. This may be due to the close interrelationship between these two coffee prices and the proximity in location between the regions. This result is also similar to earlier findings.

Similarly, the response of Jimma producer price to one-half standard deviation positive and negative shocks in the Wollega[9] producer price had an approximately equal effect (in opposite directions) and finally both converged to long-term equilibrium after 6 months. As the results in both cases indicate, the time of adjustment was the same when positive and negative shocks were introduced. However, the time of adjustment seems to have been longer for market pairs located far apart. For instance, Wollega producer price took 11-12 months to fully adjust to one-half standard deviation shocks in Harar produce price, which perhaps indicates that the distance between two markets plays an important role in the dynamic interrelationship among prices. Although all prices eventually converged to long-term equilibrium, the time taken for this to happen was too long for the situation to be considered an ideal competitive market.

## 5. Conclusion and policy implication

The primary objective of this study is to measure whether the deregulation of the Ethiopian coffee industry since 1992 has improved long and short-run price relationship and price transmission between spatially related markets. The study evaluated spatial integration between six selected pairs of producer coffee markets. The study also criticises previous studies on the topic done for Ethiopia on methodological grounds and extends the technique of Hansen (1999), which was originally developed within a threshold autoregressive (TAR) context to test for the presence of threshold effect, to handle heteroskedasticity in the error variances and to decide on the number of regimes that best characterises the responses. The method applied in this study tackles specification and thus inferential biases that previous studies in the field have overlooked. Most of the earlier studies that made

[8] Yirgachefe in this study considered as reference market due to its reputation in both local and export markets for its superior quality.
[9] Wollega coffee is chosen because of its better quality and reputation compared to Jimma.

use of the TVEC model merely assumed constant error variance without validating their assumptions and commonly fitted a TVEC model$_3$, ignoring the possibility of fitting other alternative TVEC models.

Salient findings from the evaluation are: Firstly, all market pairs confirm a strong long-term relationship in that spatial price pairs converge to their long-run equilibrium even if they exhibit divergence in the short run. Secondly, short-run dynamics are more important to policy than long-run dynamics. Accordingly, the results of regime switching reveal integration of three of the six producer market pairs. This implies that producer market pairs lack noticeable cointegration. In general, as indicated above, spatial price integration between producer coffee markets is limited. Strong spatial coffee market integration is still lacking after two and a half decades of market reform. This lack of short-run integration between pairs of producer prices of coffee markets may be due partly to physical separation and high transport costs. This is evidenced by the fact that adjacent coffee markets, for instance Sidama and Yirgachefe and Jimma and Wollega, are highly responsive to price shocks in one another, while coffee markets located far apart (e.g. Jimma and Yirgachefe, Harar and Yirgachefe, and Jimma and Sidama) lack integration and are less responsive to shocks in their corresponding markets. Hence, Ethiopian coffee markets are related in the long run, but short-term integration is largely absent between producer markets located far apart.

Thirdly, the results of nonlinear impulse response convey some interesting findings. Firstly, after a small drift in the initial period, all converge to equilibrium. Secondly, the number of months required to normalise the effect of shocks ranges from 6 to 12 months for spatial pairs, implying a weak dynamic nature of producer coffee market in Ethiopia. Lastly, our analysis confirms the significance of threshold effects and suggests considering the effect of transaction cost in market integration analysis significantly influence spatial price linkages.

The policy implication of this finding are: liberalization of markets is an important beginning measure but by itself not a element of success. We need second-generation policy measures which could level playing filed for all market participants. Among others, high transportation, information and other transaction costs still remain the major limiting factors for producer market integration. Besides, producers lack strong grass root level institution which could minimize marketing costs and improve information on price, quality, and other services.

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## Appendices

**Table 1: ADF test statistics for the stationarity of produce prices**

| | Producer price of … | At level/first difference | Lag length[10] | ADF statistics | DW | P-value |
|---|---|---|---|---|---|---|
| 1 | Sidama coffee | Level | 0 | -3.069** | 2.151 | 0.0309 |
| | | First diff. | 0 | -14.990* | 1.979 | 0.0000 |
| 2 | Jimma coffee | Level | 0 | -4.089* | 2.256 | 0.0013 |
| | | First diff. | 2 | -11.356* | 2.0384 | 0.0000 |
| 3 | Wollega coffee | Level | 0 | -2.788*** | 2.2676 | 0.0622 |
| | | First diff. | 0 | -15.452* | 2.0358 | 0.0000 |
| 4 | Harar coffee | Level | 1 | -2.779** | 2.0168 | 0.0637 |
| | | First diff. | 0 | -18.569* | 2.0146 | 0.0000 |
| 5 | Yirgachefe coffee | Level | 0 | -2.795*** | 1.9119 | 0.0611 |
| | | First diff. | 0 | -12.8298* | 1.9973 | 0.0000 |
| 6 | Average producer prices | Level | 0 | -1.9860 | 2.2325 | 0.2925 |
| | | First diff. | 0 | -14.8286* | 2.0106 | 0.0000 |

Single, double and triple asterisks indicate statistical significance at 1, 5 and 10 percents respectively

**Table 2: ADF and Johansen test results (spatial price transmission)**

| | Producer market price pairs | Test | Test statistics |
|---|---|---|---|
| 1 | Sidama and Yirgachefe | Max eigenvalue test r = 0 | 23.58** |
| | | Trace test r = 0 | 27.93** |
| | | Max eigenvalue and trace test: r = 1 | 4.35 |
| | | ADF test price differential | -4.90* |
| 2 | Jimma and Yirgachefe | Max eigenvalue test r = 0 | 26.34** |
| | | Trace test r = 0 | 32.04** |
| | | Max eigenvalue and trace test: r = 1 | 5.70 |
| | | ADF test price differential | -5.52* |
| 3 | Wollega and Yirgachefe | Max eigenvalue test r = 0 | 29.25** |
| | | Trace test r = 0 | 32.47** |
| | | Max eigenvalue and trace test: r = 1 | 3.21 |
| | | ADF test price differential | -5.05* |
| 4 | Harar and Yirgachefe | Max eigenvalue test r = 0 | 14.91 |
| | | Trace test r = 0 | 20.55 |
| | | Max eigenvalue and trace test: r = 1 | 5.64 |
| | | ADF test price differential | -4.19* |
| 5 | Jimma and Sidama | Max eigenvalue test r = 0 | 47.58** |
| | | Trace test r = 0 | 53.97** |
| | | Max eigenvalue and trace test: r = 1 | 6.39 |
| | | ADF test price differential | -8.22* |
| 6 | Jimma and Wollega | Max eigenvalue test r = 0 | 47.50** |
| | | Trace test r = 0 | 52.25** |
| | | Max eigenvalue and trace test: r = 1 | 4.75 |
| | | ADF test price differential | -8.02* |

Single, double and triple asterisks indicate statistical significance at 1, 5 and 10 percents respectively

[10] Eviews 5.2 automatically selects the optimum lag lengths, which minimizes the AIC and SIC for model selection.

**Table 3: Test for linearity and number of regimes**

| Producer market pairs | Hypothesis | Likelihood ratio | Bootstrap p-value | | Threshold value | |
|---|---|---|---|---|---|---|
| | | | Homos kedastic | Hetros kedastic | Lower band $\varepsilon_{t-1} \leq c_1$ | Upper band $\varepsilon_{t-1} \succ c_2$ |
| 1. Sidama & Yirgachefe | LR12 | 49.97 | 0.0000 | 0.0000 | -0.1614 | 0.1037 |
| | LR13 | 217.32 | 0.0000 | 0.0000 | | |
| | LR23 | 88.12 | 0.0000 | 0.0000 | | |
| 2. Jimma & Yirgachefe | LR12 | 47.41 | 0.0000 | 0.0000 | -0.1687 | 0.0232 |
| | LR13 | 238.13 | 0.0000 | 0.0000 | | |
| | LR23 | 190.73 | 0.0000 | 0.0000 | | |
| 3. Wollega & Yirgachefe | LR12 | 58.57 | 0.0000 | 0.0000 | -0.0404 | -0.1765 |
| | LR13 | 239.34 | 0.0000 | 0.0000 | | |
| | LR23 | 180.77 | 0.0000 | 0.0000 | | |
| 4. Harar & Yirgachefe | LR12 | 135.15 | 0.0000 | 0.0000 | 0.0966 | 0.2828 |
| | LR13 | 221.80 | 0.0000 | 0.0000 | | |
| | LR23 | 86.63 | 0.0000 | 0.0000 | | |
| 5. Jimma & Sidama | LR12 | | 0.0000 | 0.0000 | -0.0326 | 0.1571 |
| | LR13 | 265.84 | 0.0000 | 0.0000 | | |
| | LR23 | 157.25 | 0.0000 | 0.0000 | | |
| 6. Jimma & Wollega | LR12 | 81.49 | 0.0000 | 0.0000 | -0.2884 | -0.1493 |
| | LR13 | 279.94 | 0.0000 | 0.0000 | | |
| | LR23 | 110.04 | 0.0000 | 0.0000 | | |

Source: Compiled from TVEC model$_3$ estimation result

**Figure 1: Response of Sidama producer market to positive shocks in Yirgachefe producer market**

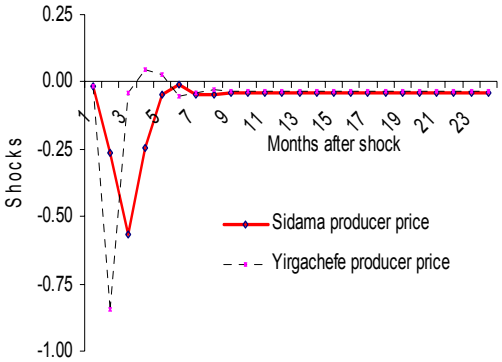
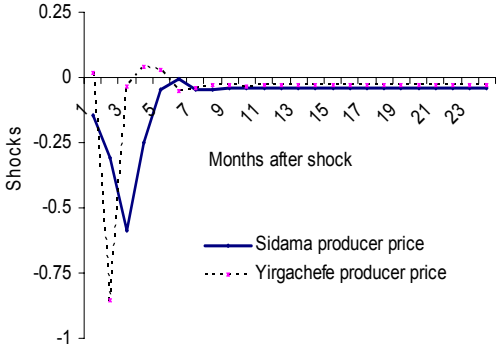



**Figure 2: Response of Sidama producer market to negative shocks in Yirgachefe producer market**



# ADOPTION AND CONTINUED USE OF IMPROVED MAIZE SEEDS IN CENTRAL ETHIOPIA

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*Abstract*

*The literature on agricultural technology has very little to say concerning the continued use of an agricultural technology. This paper analyses the factors that explain the adoption and continued use of improved maize seeds in one of the high potential maize growing areas in central Ethiopia. Using bivariate probit with sample selection model we show that adoption of improved maize varieties is strongly influenced by adult equivalent, total land owned, access to credit from formal sources, involvement of the household head in off-farm activities, experience in hiring farm labor, and cooperative membership; whereas the decision to continuously use the seeds is determined by the proportion of farm area allocated to maize, literacy of the household head, involvement of a family member in an off-farm activity, number of visits by development agents to the household, experience in hiring farm labor, sufficiency of land owned to sustain the household, and continued use of fertilizer. Accordingly, appropriate strategic interventions that consider such factors are required so that improved seeds are adopted and continuously used to increase farm yields and help fighting food insecurity.*

**Keywords:** Adoption, continued use, improved maize seeds

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## 1. Introduction

It is believed that an effective way to increase agricultural productivity is broad-based adoption of new farming technologies (Minten and Barrett, 2008). The substantial improvement in productivity of cereal crops in the mid 1990's following extensive promotion of improved technologies by SG 2000 in Ethiopia supports this hypothesis. For instance in Bako area of central Ethiopia the average productivity of maize has increased from 1.6 tons to more than 5.4 tons per hectare during 1993-1996 (SG2000, 2002). However, in recent years, maize productivity has either remained constant or has shown a declining trend. The productivity of maize, the main crop in the area, declined by about 14% in 2007 (from 2.8 tons/ hectare in 2006 to 2.4 tons/hectare in 2007), after stagnating for the previous three consecutive years. This decline in maize productivity could be explained partly by the withdrawal of farmers from using new agricultural technologies. The use of improved seed declined from 74.3 tons in 2006 to 63.9 tons in 2007, amounting to a 14% fall in seed use (DOARD, 2008).

Adoption of improved technologies will not improve food security and reduce poverty if barriers to their continued use are not overcome (Oladele, 2005). Rogers (2003) reported two types of technology discontinuance; i.e., replacement discontinuance where farmers disadopt the existing technology in order to adopt a superior one and disenchantment discontinuance where a decision to disadopt a technology, with or without replacement, is due to dissatisfaction about its performance.

Problems of discontinuance are evident within Ethiopia. In a study undertaken by Tenkir et al., 2004, it was indicated that about 40% of those who tried new inputs interrupted using them. Regarding specific technologies, the disadoption rate was 7.6% for maize seeds and 14% for chemical fertilizers (Tenkir et al., 2004). But, this study has stopped short of explaining the reasons for discontinuance.

The adoption and continued use of new technologies are central to agricultural growth and poverty reduction efforts. However existing studies on agricultural technologies have been mainly concerned with factors influencing adoption of new technologies (Feder et al., 1985; Sunding and Zilberman, 2001). The few studies that have investigated reasons why farmers continue or discontinue employing technologies include Carletto et al. 1999; Neill and Lee, 2001; Oladele, 2005; Aklilu and Graaf, 2007; and An, 2008. These studies show that farm assets, institutional factors and market conditions explain the decision to adopt new technologies. However, those studies say little about problems of discontinued adoption in rural Africa, where structural and institutional constraints are likely to adversely affect poor

farmers' ability to continue using already adopted technologies in general and improved maize seeds in particular.

This paper studies adoption and continued use of improved maize seed technology in the Bako area of central Ethiopia. It explains why some farmers continue using improved maize seed while some decide otherwise. Insights generated by this study are expected to help in designing appropriate policy instruments to sustain the adoption of agricultural technologies. It contributes to the adoption and diffusion literature since it focuses on the continued use of a technology that is already adopted.

## 2. The study area

The study is conducted in Bako Tibe district, located in the central part of Ethiopia, located about 250 km west of the capital, Addis Ababa. The district has mean annual temperature of 20.4° C and mean annual rainfall of 1217mm, the main rainy season extending from May to September. Elevation ranges from 1500 to 2000 meters a.s.l.

The area is known for maize production though there are crops like sorghum, *tef*[8] (*Eragrostis abyssinica*), niger-seed and pepper. Based on the Ethiopian agricultural enumeration survey, in Bako Tibe, the maize cultivated area accounts for about 50% of the total cropped area (which was 22640 hectares) and 60% of the land under cereal crops (CSA, 2003). Farmers in the area produce maize for consumption as well as for selling. Improved maize cultivars introduced by Bako Agricultural Research Center (BARK) and SG2000 have been in use in the district

## 3. Methodology

### 3.1. Source of data

The main source of data for this study is a survey conducted on a sample of farmers from Bako area in April 2008. Secondary data on yield, use of improved seed and the institutional environment were obtained from agricultural development offices and the research center in the district. A two-stage sampling technique was used to select the sample. In the first stage, a total of 15 *kebeles*[9] were selected purposively out of 28. In the second stage, sample households were selected using systematic random sampling. A sample of 120 households was drawn from the 15 *kebeles* in proportion

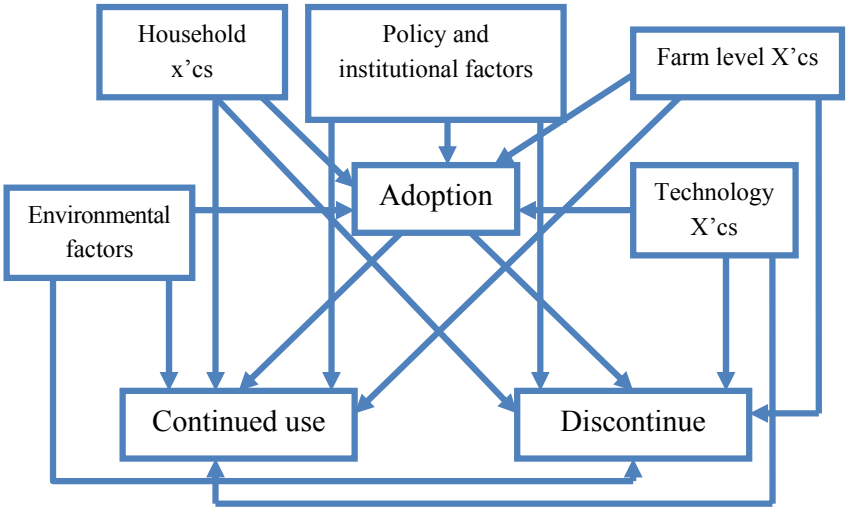
[8] *Tef* is an endemic crop to Ethiopia. It is the most important staple food crop that is used to prepare *enjera* – the commonest component of Ethiopian dish.
[9] *Kebele* is the smallest administration unit in Ethiopia

to the population size in each *kebele*. This sample size is within orders of magnitude of sample sizes in previous, similar studies conducted in the area and elsewhere (Negatu and Parikh, 1999).

## 3.2 Analytical model

The adoption of a technology and its continued use are interdependent decisions affected by an overlapping set of factors. The decision to adopt improved maize seed can be simply hypothesized to be influenced by total land size, access to credit, access to extension and the like. Since adoption occurs before continuation or discontinuation of a technology, variables that are assumed to be stable overtime are included in the adoption equation (Niell and Lee, 2001). Continued use can also be influenced by these factors but to a different extent. Continued use of improved maize is expected to be influenced by, among others, the area that can be allocated to maize, access to extension on complementary technologies, use of complementary technologies, and indebtedness. The sketch below shows a simple representation of the complexity of the decision making process.

**Figure 1: Conceptual Framework**




This intricacy is confounded by the fact that the farmers who adopt technologies are those who want to do so and some of the factors that influence continued use might be due to the use of the technology itself. These phenomena generate modeling problems related to self selection and endogeneity (see Doss, 2006 for a detailed discussion).

Accordingly the analytical framework we are using is different from the conventional single equation estimation. The decisions of adoption and continued use of improved maize seeds are related as those who continue to use the technology are those who have adopted it first.

We can specify the two decisions, adoption and continued use, independently of each other using probit or logit models. However, such specification would provide inefficient estimates of the parameters of continued use model since it ignores the potential correlation between the unobservables (captured by the error terms) of the two decisions, because the decision to use continuously is contingent on the decision to adopt. This can be fully addressed by a bivariate probit with sample selection model (Neill and Lee, 2001; Wooldridge, 2002; Greene, 2008). This model is similar to Heckman's selection model except we have probit model both in the selection (adoption) and outcome (continued use) models.

Adoption of improved maize seeds or any technology will be an optimal choice if the expected net marginal benefit of adoption exceeds zero (Saha et al., 1994). The household decides to continue using improved maize seeds in a particular year only if this use creates a utility gain (Carletto et al., 1999). However, this utility gain is not observable. What we observe is the choice to adopt or not and the choice to use continuously or otherwise.

The unobservable perceived utility '$y_j^*$' depends on vector of explanatory variables '**x**', and the binary outcome $y_j = 1$ arises when the latent $y_j^* > 0$. In this case, we observe $y_2$ (continued use) if and only if $y_1$(adoption) = 1. The first probit equation is therefore fully observed and we have censored sample for the second equation. This censoring of observations in the continued use equation implies the importance of self selection at the adoption decision making level. The standard model for the latent variables specifies a linear model with additive errors, as

$$y_1^* = \mathrm{x}_1'\beta_1 + \varepsilon_1, \quad y_1 = 1 \ if \ y_1^* > 0,0 \ \text{otherwise}, \tag{1}$$

$$y_2^* = \mathrm{x}_2'\beta_2 + \varepsilon_2, \quad y_2 = 1 \ if \ y_2^* > 0 \ \text{and} \ if \ y_1^* > 0,0 \ \text{otherwise}, \tag{2}$$

where x and $\beta$ are vectors of explanatory variables and coefficients to be estimated, respectively. Estimation by maximum likelihood is straightforward given the additional assumption that the correlated errors are joint normally distributed and homoskedastic (Cameron and Trivedi, 2005, pp. 548), with

$$E\left[\varepsilon_1 \mid \mathrm{x}_1, \mathrm{x}_2\right] = \mathrm{E}\left[\varepsilon_2 \mid \mathrm{x}_1, \mathrm{x}_2\right] = 0 \quad (3)$$

$$\mathrm{Var}\left[\varepsilon_1 \mid \mathrm{x}_1, \mathrm{x}_2\right] = \mathrm{Var}\left[\varepsilon_2 \mid \mathrm{x}_1, \mathrm{x}_2\right] = 1 \quad (4)$$

$$\mathrm{Cov}\left[\varepsilon_1, \varepsilon_2 \mid \mathrm{x}_1, \mathrm{x}_2\right] = \rho\,. \quad (5)$$

Accordingly, there are three types of observations in the sample with the following probabilities.

$$y_1 = 0: \qquad prob(y_1 = 0) = \Phi(\text{-}x_1\beta_1), \quad (6)$$

$$y_1 = 1, y_2 = 0: prob(y_1 = 1, y_2 = 0) = \Phi(x_1\beta_1) - \Phi_2(x_1\beta_1, x_2\beta_2, \rho), \quad (7)$$

$$y_1 = 1, y_2 = 1: prob(y_1 = 1, y_2 = 1) = \Phi_2(x_1\beta_1, x_2\beta_2, \rho), \quad (8)$$

where $\Phi$ is the univariate normal distribution, and $\Phi_2$ is the bivariate normal distribution. And the log-likelihood function to be maximized is based on these probabilities and can be specified as:

$$\begin{aligned} \ln L = \sum_{i}^{N} \{ & y_{i1} y_{i2} \ln \Phi_2(x_1\beta_1, x_2\beta_2; \rho) \\ & + \mathrm{y}_{i1}(1 - \mathrm{y}_{i2}) \ln[\Phi(x_1\beta_1) - \Phi_2(x_1\beta_1, x_2\beta_2; \rho)] \\ & + (1 - \mathrm{y}_{i1}) \ln \Phi(\text{-}x_1\beta_1)\}, \quad i = \text{number of observations.} \end{aligned} \quad (9)$$

The model parameters are estimated by maximizing this log likelihood function with respect to the parameters.

Overlapping set of variables related to household, farm and institutional characteristics has been included in the models. In this study, an adopter is a farming household that has used improved maize seed at least once over the last six years. An adopter is a continuous user only if he or she uses improved maize seed continuously once he/she has adopted improved seeds. Adult equivalent[10], total land size owned, number of plots owned and access to formal credit sources (dummy) appear only in the adoption decision model. Similarly, number of male and female

[10] The conversion factors used are adapted from Storck et al., 1999.

family members, proportion of land allocated to maize, access to irrigation facilities (dummy) on own plots, indebtedness to formal credit sources (dummy), money saving (dummy), number of visits by development agent (DA), awareness of all other components of the maize technology package (dummy) and continuous use of fertilizer (dummy) appear only in the decision to continuously use model.

The variables that appear in both models are literacy of household head (dummy) fertility (dummy) and infertility (dummy) of main plot owned, sufficiency of land owned (dummy), and livestock wealth in tropical livestock units (TLU)[11], involvement of the household head in off-farm activities (dummy), involvement of another family member (dummy), experience in hiring farm labor, distance from DA's office, distance from nearest town market, and membership in a primary cooperative.

The model is specified based on the assumption that continued use of a given technology is likely to be impacted by many of the same factors that influence adoption (Wendland and Sills, 2008). These factors characterize the household, the farm assets endowment and institutional and policy environments that are external to the household.

Human capital endowments, usually captured by family size and composition and education are the main factors influencing the decisions of households. Family size and composition influence such decisions from both the labor supply and consumption demand angles. Availability of labor within the household, as measured in number of adult household members, or male and female family members, has also been controlled in the model. In the study area most households depend on household labor for farm activities, partly because labor markets are not sufficiently developed. In addition it is apparent that the application of improved seeds requires more labor. Consequently, availability of labor can increase the probability of continued use of the technology.

Education increases the ability of farmers to obtain, process, and use information relevant to the technology leading to greater use of new technologies (Wozniak, 1997). Human capital assets of the household head affect the profitability of modern technology as they reflect productive unobservable characteristics of the decision maker, such as farming skills and entrepreneurship (Carletto et al., 1999).

Access to farm assets such as land, or livestock, is also expected to enhance continued use of modern technologies. Sain and Martinez (1999) argued that the larger the farm size the less binding is the financial and land constraints faced by a

[11] The conversion factors used are adapted from Jahnke et al., 1982.

farmer. Ownership of livestock promotes adoption and continued use of improved maize seed since it generates income to finance the inputs associated with the technology and reduces the risks that may arise from crop failure (Nega and Sanders, 2006).

Institutional factors and policy variables that include the extent of competitiveness of credit and labor markets, access to extension, and access to land make up the other set of determinants of adoption and continued use. Extension provides farmers with information on availability and properties of the new technology and technical skills for using it (Wozniak, 1997). Improved seed varieties are unaffordable to poor peasants since they require using complementary inputs like fertilizer whose price is rising from time to time. Access to credit, by helping farmers to finance the acquisition of improved seed and fertilizer could enhance adoption and continued use of an agricultural technology.

The effect of access to sufficient land is expected to be positive on both technology adoption and continuation. Farmers who do not own sufficient land may not be able to capture the full returns from investments in new technology, and thus, will be less willing to use new technology. This is either because they must share the increased product with a landlord or because they might not have the minimal size of land for economically competitive maize production. Inadequate infrastructure like roads and lack of seed are other external factors affecting technology adoption and continued use. Households living near major towns have good access to both physical infrastructure and seed supplies hence are expected to be using previously adopted technologies.

## 4. Results and discussion

### 4.1 Descriptive statistics

The data shows that only 7.5% of the sample households have never adopted improved maize varieties. About 63% of the sample households have been using the improved seeds once they adopted them, whereas the remaining 37% have not been doing so. Accordingly, adoption rate of maize seed in the study area is more than 92% while discontinuance is about 37% (Tables 1).

Those households which discontinued using the improved seed were asked to state the reasons why they could not continue using the improved maize seed. Most farmers (61.5%) identified high price of seed and fertilizer as reasons for discontinuance. Since prices of seed and fertilizer are the major cost components of production, a rise in input cost, (such as lack of credit, unavailability of input, etc. ),

may render farm activities unprofitable; this is in line with the disenchantment theory of disadoption (Rogers, 2003). Another major factor that farmers mentioned as a constraint is lack of credit. Partly because of defaulting problems, farmers have found it increasingly difficult to get credit from official sources.

Farmers obtain improved seed from different sources. Cooperatives are the major sources of improved maize seed. More than eighty percent of the sampled household reported that they obtain seed from the nearby primary cooperatives. This implies the importance of membership and/or access to the cooperatives. Accordingly, about 81% of sample households are members of cooperatives, while this number rises to 93% for adopters who continue to use improved maize seed. On the contrary, only 33.3% of non-adopters are members of cooperatives (table 2). There is also a large informal sector market for maize seeds as supplies from the formal sector cannot satisfy existing demand. There is also an interesting difference between adopters and non-adopters in terms of distance to nearest town markets measured in walking hours. The adopters are relatively closer to town markets (0.61 hour) as compared to non-adopters (0.70 hour) (Table 1).

The summaries in Tables 1 and 2 further show that households that have adopted improved maize seeds are better off in terms of livestock wealth, average land holding as compared to non-adopters. Non-adopters allocate on average a higher proportion of their land to maize as compared to adopters in general but a lower proportion as compared to those adopters who are using the improved seeds continuously. In terms of access to the developments agents (the major source of extension services), adopters have better access as it takes shorter for them to reach for the DA (Table 1).

Comparing continuous users with those who discontinue, it is evident that the latter have more female family members and are located far from the DA and town markets (Table1). Again, more than half of those who discontinue are illiterate, most of them have never hired farm labor, and a third of them are not members of cooperatives (Table 2).

## 4.2 Estimation results

The bivariate probit with selection model was found to be valid as the likelihood ratio test of independent equations strongly rejects the null hypothesis that the random terms of the adoption and continued use equations are not correlated. This implies that ignoring the selection into approved status would render the estimates of a univariate probit equation for continued use of improved maize seeds equation biased

and inconsistent. The estimation results show that adult equivalent, total land owned, access to credit from formal sources, involvement of the household head in off-farm activities, experience in hiring farm labor, and cooperative membership positively and significantly influence the decision to adopt improved maize varieties. Only literacy of the household head was found to affect the decision to adopt negatively. At the second stage, proportion of farm area allocated to maize, literacy of the household head, involvement of a family member in an off-farm activity, number of DA's visits to the household, experience in hiring farm labor, sufficiency of land owned to sustain the household, and continued use of fertilizer were found to be positively and significantly influencing the continued use of improved maize varieties. The only factor that negatively and significantly influences continued use of improved maize seeds is the number of female family members (Table 3). The variables are discussed under each of the equations below.

**Adoption of improved maize seeds**

Adult equivalent was found to be significantly and positively influencing the likelihood of improved maize adoption. This implies that increase in family size positively influences, through increases in the availability of labor and/or the consumption requirements, the decision to adopt improved maize varieties. The size of farmland owned by the household is also positively associated with the decision of using improved maize varieties, as land is the most important and scarcest resource in this part of the country.

Households headed by literates are relatively less likely to adopt improved maize varieties in the study area. This is against the conventional expectation but can be related to the fact that the relatively more educated household heads are youngsters and land ownership among the youth is minimal. It was similarly reported in Ethiopia that education influences timing of adoption but not whether to adopt an agricultural innovation (Weir and Knight, 2000).

Access to credit from formal sources was found to be positively and significantly influencing the decision to adopt improved maize varieties. This is expected as farming households rarely have sufficient means to buy the improved maize seeds and other associated components, magnifying the importance of cash credits that can be used to purchase the technologies to be adopted. Credit access has mostly been reported to have a similar result in earlier research (See Pattanayak et al., 2003 for a summary). Access to credit by itself is not enough, however, and should be provided in such a way that clients will be able to repay in time without staying indebted for long and thus ending up abandoning the livelihood improving technologies.

Related to access to cash through credit is involvement of the household head or any other family member in off-farm economic activities. The participation of the household head in off-farm income generating activities increases the likelihood that the household adopts improved maize varieties. Similarly, households with experience in hiring labor are more likely to adopt improved maize varieties than those who have not been in hiring labor. Ouma et al (2002) have reported a positive influence of labor hiring on the adoption of maize seed and fertilizer in Embu, Kenya.
Being member of a cooperative positively influences, as expected, the decision to adopt improved maize varieties. This is related to the access to inputs and information that cooperatives create for members, as discussed above.

**Continued use of improved maize seeds**

Number of female family members was found to be negatively influencing the continued use of improved maize varieties, once they have been adopted. This is apparently related to the labor supply implications of more female family members in the household. Improved maize production obviously requires more labour than the traditional production which typically involves sowing with broadcasting and less application of inputs.

The proportion of farmland allocated to maize influences the decision to use improved maize varieties continuously. The relative share of maize shows the importance attached to the crop, hence the decision to continuously produce it.
Despite the fact that household heads that are relatively educated are less likely to adopt the improved maize varieties, they were found to be more likely to continue using the variety if they adopt it once. Engagement of a family member in an off-farm activity also influences positively the decision to use improved maize varieties continuously. This can be associated with the possibility that cash is being generated from off-farm activities that can be used in purchasing required inputs to continue growing improved maize varieties.

The access to extension has been widely reported to positively influence adoption and continued use of agricultural technologies (Feder and Umali, 1993; Knowler and Bradshaw, 2007). Similarly, the frequency of visits by development agents of the bureaus of agriculture was found to be significantly influencing the decision to use improved maize varieties. The development agents have a number of services they render to the community that includes, *inter alia*, advices on crop management, crop pest control, and availability of agricultural inputs. Extension services would inform and build the capacity of farmers, increasing their knowledge and reducing their uncertainties in making decisions.

Experience in labor hiring was also found to be important in positively influencing the decision to continue growing improved maize. Like in the adoption case, the access to the labor market encourages the continued use of improved seeds. Households that believe their land holding is enough to sustain the family were found to be more likely to continually use improved maize. This highlights the importance of land ownership for the continuing use of agricultural technologies.

Continuous use of fertilizer positively and strongly influences the continued use of improved maize varieties. This clearly shows that adopting another component of the improved technology package increases the chance that households use the essential component of the package for long.

## 5. Conclusions and policy implications

In developing countries like Ethiopia, widespread adoption of yield-enhancing agricultural technologies is one way to alleviate poverty and to ensure food security. However, adoption is not sufficient to meet this national aspiration. In addition it must be ensured that farmers use the technology in a sustainable manner.

This study represents one step toward understanding the process of post-adoption behavior of farm households,, implying that technology adoption requires close follow up and monitoring to ensure that households continue using it, and usingI it appropriately. The paper provides insights into the key factors associated with adoption and continuous use of improved maize seeds, and the results reveal that human capital, asset endowment, institutional and policy variables all affect these interrelated decisions of farmers.

The econometric results have implied the importance of family size – both as a supplier of labor and as a consumer of maize, involvement of the household head in off-farm activities – as a source of income that can be invested on improved maize technologies, and that of the experience of hiring labor as an indicator of the exposure to the labour market in influencing the adoption decisions of households. Size of total farmland owned and membership to cooperatives were also found to be important. The importance of land in Ethiopian agriculture in general and in the study area can not be overemphasized. Similarly, the empowerment that cooperatives bring about for the farming households in terms of creating access to market and information is vitally important.

One time trial or use of an agricultural technology can hardly change livelihoods implying the need to use technologies on a continuous basis. Proportion of land

allocated to maize and the perception that the land owned is sufficient to sustain livelihoods are found to be important factors in determining continuous use of improved maize. Likewise, literacy of the household head, engagement of a family member in off-farm activities, and household's access to the labor market were also important in positively influencing the continuous use of improved maize seeds once adopted.

Using complementary technologies – in this case fertilizer, and access to extension service sources also increase the likelihood that improved maize seeds are used continuously. Targeted capacity building activities that enable female family members to contribute in the production and marketing of maize might possibly play an important role in making maize "women's crop', and thus the continuous use of improved seeds.

Appropriate strategic interventions that consider such factors are required so that improved maize seeds are adopted and continuously used to increase farm yields and help fighting food insecurity. Government Extension systems need to address the specific factors which affect the decision to use a technology continuously. However, the current extension system in Ethiopia has its own problems including top-bottom approach for the dissemination of knowledge, capacity limitations (e.g. only 50% of required human resources is met), lack of specialists, and overlapping and incongruent responsibilities of DAs. An effective and efficient extension system may render an innovation sustainable and useful for economically and spatially disadvantaged groups, thus, contributing towards alleviating poverty and reducing inequality among rural communities.

Therefore, how to break the vicious circle of poverty through effective promotion of agricultural knowledge and innovation system on a sustainable basis is an important question for policy-makers in poor countries.

The extension system needs to be pluralistic, demand-driven and participatory. To improve input availability and affordability, targeted and time-bound subsidies may be considered. Credit constraints could be ameliorated by writing off huge debt incurred by poor farmers, and credit subsidies could be considered as an option. Problems of location disadvantages could be addressed by constructing more feeder roads and by expanding communication networks.

Agenda for future research includes a dynamic analysis of the adoption and continued use of a technology. In other words, further research is required, using panel data for proper analysis, to extend and demonstrate the dynamic processes that influence farmers' decisions to adopt a technology and use it continuously.

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**Annex Table 1: Continuous descriptors of sample households**

| Variable | Adopter | | | | | | Non-Adopter | |
|---|---|---|---|---|---|---|---|---|
| | Continued use | | Discontinue | | All adopter | | | |
| | Mean | St.dev. | Mean | Mean | Mean | St.dev. | Mean | St.dev. |
| Male family members | 4.04 | 1.76 | 2.70 | 1.27 | 3.55 | 1.72 | 2.00 | 1.32 |
| Female family members | 3.61 | 1.71 | 3.39 | 2.00 | 3.53 | 1.82 | 1.89 | 1.36 |
| Adult equivalent | 6.07 | 2.14 | 4.82 | 2.08 | 5.60 | 2.20 | 3.19 | 1.52 |
| Total livestock unit | 5.27 | 4.20 | 2.91 | 2.60 | 4.39 | 3.85 | 1.59 | 2.26 |
| Total land owned (ha) | 4.83 | 2.95 | 2.87 | 1.86 | 4.10 | 2.76 | 1.85 | 1.42 |
| Proportion of farmland allocated to maize | 1.35 | 2,15 | 0.56 | 0.64 | 0.26 | 0.36 | 1.05 | 1.78 |
| Number of plots owned | 3.00 | 1.59 | 2.59 | 1.45 | 2.85 | 1.55 | 2.44 | 1.94 |
| Number of visits by the DA | 4.16 | 8.17 | 1.10 | 2.19 | 3.02 | 6.76 | - | - |
| Distance from DA office (hours) | 0.37 | 0.42 | 0.66 | 0.74 | 0.48 | 0.57 | 0.50 | 0.54 |
| Distance from nearest town market (hours) | 0.55 | 0.46 | 0.70 | 0.66 | 0.61 | 0.54 | 0.70 | 0.66 |
| | 70 | | 41 | | 111 | | 9 | |

**Table 2: Discrete descriptors of sample households**

| Variables | Levels | Frequency | | | |
|---|---|---|---|---|---|
| | | Adopters | | | Non-adopters |
| | | Continued user | Discontinued user | Total | |
| Main plot fertility | Very fertile | 5 | 4 | 9 | 2 |
| | Fertile | 32 | 10 | 42 | 2 |
| | Infertile | 33 | 27 | 60 | 5 |
| Literacy of the household head | Literate | 50 | 20 | 70 | 6 |
| | Illiterate | 20 | 21 | 41 | 3 |
| Has irrigation on own plots | Yes | 26 | 3 | 29 | 2 |
| | No | 44 | 38 | 82 | 7 |
| Received credit from formal sources | Yes | 19 | 12 | 31 | 0 |
| | No | 51 | 29 | 80 | 9 |
| Indebted to lenders | Yes | 24 | 19 | 43 | 1 |
| | No | 46 | 22 | 68 | 8 |
| Saves money | Yes | 20 | 11 | 31 | 0 |
| | No | 50 | 30 | 80 | 9 |
| Off farm activities - head | Yes | 22 | 10 | 32 | 4 |
| | No | 48 | 31 | 79 | 5 |
| Off farm activities - family member | Yes | 17 | 8 | 25 | 2 |
| | No | 53 | 33 | 86 | 7 |
| Aware of all technology components | Yes | 59 | 30 | 89 | 3 |
| | No | 11 | 11 | 22 | 6 |
| Experience in hiring labor | Yes | 54 | 15 | 69 | 1 |
| | No | 16 | 26 | 42 | 8 |
| Member of a cooperatives | Yes | 65 | 29 | 94 | 3 |
| | No | 5 | 12 | 17 | 6 |
| Farm land owned is sufficient | Yes | 20 | 11 | 31 | 4 |
| | No | 50 | 30 | 80 | 5 |

**Table 3: Bivariate probit with selection model estimation results**

| **Continued use of improved maize (Outcome equation)** | | |
|---|---|---|
| **Variable** | **Coeff** | **Robust St. error** |
| Male family | 0.125 | 0.110 |
| Female family | -0.203$^{++}$ | 0.096 |
| Tropical livestock units | -0.043 | 0.052 |
| Proportion of farmland allocated to maize | 0.243$^{+}$ | 0.136 |
| Main plot - very fertile (dummy) | 0.055 | 0.599 |
| Main plot – infertile (dummy) | -0.324 | 0.310 |
| Literate household head (dummy) | 0.618$^{+++}$ | 0.238 |
| Indebted to lenders (dummy) | -0.215 | 0.172 |
| Saves money (dummy) | 0.196 | 0.182 |
| Off-farm activity – head (dummy) | 0.154 | 0.212 |
| Off-farm activity – family member (dummy) | 0.455$^{++}$ | 0.207 |
| Aware of all technology components (dummy) | -0.294 | 0.283 |
| Number of visits by the DA | 0.034$^{++}$ | 0.017 |
| Experience in hiring labour (dummy) | 0.613$^{+++}$ | 0.175 |
| Distance from nearest town market (hours) | 0.185 | 0.290 |
| Member of a cooperative (dummy) | -0.228 | 0.279 |
| Land owned - sufficient (dummy) | 0.779$^{+++}$ | 0.267 |
| Uses fertilizer continuously (dummy) | 1.998$^{+++}$ | 0.404 |
| Has irrigation on own plots (dummy) | 0.329 | 0.317 |

**Table 3 Continued**

| **Improved maize adoption (Selection equation)** | | |
|---|---|---|
| **Variable** | **Coeff** | **Robust St. error** |
| Adult equivalent | 0.633$^{+++}$ | 0.232 |
| Tropical livestock units | 0.258 | 0.172 |
| Total land owned (ha) | 0.401$^{++}$ | 0.197 |
| Main plot - very fertile (dummy) | -0.056 | 0.472 |
| Main plot – infertile (dummy) | -0.043 | 0.339 |
| Literate household head (dummy) | -1.140$^{++}$ | 0.555 |
| Received credit from formal sources (dummy) | 1.686$^{+}$ | 0.897 |
| Off-farm activity – head (dummy) | 1.309$^{+}$ | 0.730 |
| Off-farm activity – family member (dummy) | -0.775 | 0.598 |
| Distance from DA office (hours) | -0.051 | 0.563 |
| Experience in hiring labor (dummy) | 0.948$^{++}$ | 0.415 |
| Distance from nearest town market (hours) | 0.095 | 0.703 |
| Member of a cooperative (dummy) | 0.662$^{++}$ | 0.335 |
| Land owned - sufficient (dummy) | -0.501 | 0.475 |
| Number of plots owned | -0.194 | 0.215 |
| /athrho | -14.285 | 1.254 |
| Rho | -1.000 | 0.000 |
| Wald test of independent equations ($\rho = 0$): $chi^2(1) = 129.79$ prob > $chi^2 = 0.0000$ | | |

+++, ++, and + significant at 1%, 5%, and 10% levels of statistical error respectively.

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