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FOREWORD

The Ethiopian Economic Association (EEA) and its Hawassa Chapter are happy to issue the proceeding of the Seventh Annual Conference on the Southern Nations and Nationalities People Regional State Economic Development which was organized on March 25, 2017 at Lewi Resort Conference Hall. EEA organized this important regional conference as one of its objectives of broadening its activities and coverage at regional level so as to contribute to the economic advancement of regional state through enhancing economic policy formulation capability; the dissemination of economic research findings; promotion of dialogue on critical 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.

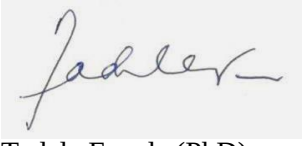
The Annual Regional Conferences that the Association has organized in collaboration with its Hawassa Chapter has created important forums for presenting and discussing development issues that are highly relevant to the Regional Socio-economy. These forums have also provided incentives for researchers to conduct research and present their findings on regular basis. Indeed, the Annual Regional conferences were organized in an interdisciplinary fashion, thereby widening the interactive coverage involving both economists living here in the region and those living outside the region and non- economists who are working and experiences on the region. The Seventh Annual Regional Conference on Southern Nation and Nationalities People Regional State Economic Development has contributed towards a deeper understanding of the regional economy and the complex challenges it faces. It attracted about 130 participants including members of Regional Parliament, higher officials and expertise from Hawassa City Administration, Universities of Hawassa, Wolaita Sodo, Arba Minch, Wolkite and Dilla, NGOs, private sector representative and EEA members in the Southern Region of Ethiopia. The participants of the conference expressed their satisfaction on the organization of the conference and the content of the papers presented. They reflected that the papers largely focused on local issue that can contribute to the development of the region. They also recommended that the issues raised in the discussion are critical that need due attention by policy makers and implementing organs of the region.

In this publication, all papers which were presented at the Seventh Annual Conference reviewed by external reviewers and comments and suggestions including editorial comments were communicated to authors for improvement. Finally, those papers which passed all the review and editorial process published in the Proceeding of the Seventh Annual Conference on the Southern Nation and Nationalities People Regional State Economic Development.

At this juncture, I would like to take this opportunity to express my heartfelt gratitude, on my own behalf and on behalf of the Ethiopian Economic Association, to the many people and organizations that made the conference resounding success. First and foremost, I thank the authors of the papers and the audience whose active participations made the Conference meaningful. The staffs of the Economics Department of the Hawassa University which runs the EEA Hawassa Chapter, participants from Wolaita Sodo, Arba Minch, Wolkite and Dilla Universities and the staff of EEA Secretariat deserve a special recognition for their passion and perseverance in managing the conference from inception to completion. Hawassa University also deserves appreciation for hosting EEA Chapter by providing office and BoFED for its endless support to the organization of the conference.

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 Friedrich Ebert Stiftung of Germany, The African Capacity Building Foundation (ACBF) and the Think Tank Initiative of International Development Research Center (IDRC) of Canada.

Finally, I would like to extend my sincere gratitude to regional government officials who spared their busy schedule and participated in the conference.



Tadele Ferede (PhD)
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Effect of Method of Sowing and Time of Di-Ammonium Phosphate (DAP) Fertilizer Application, on Yield and Yield Components of Tef ((Eragrostictef) Trotter) at Shebedino, Southern Ethiopia

Bekalu Abebe[1] and Tenaw Workayehu[2]

Abstract

Time of DAP application and sowing method vary from farmer to farmer. Therefore, there is a need to determine time of DAP and sowing method recommendations for tef (Eragrostistef (Zucc) Trotter). Accordingly, an experiment was conducted to evaluate the effect of sowing method and time of DAP application on yield and yield components of tef at Shebedino, Southern Ethiopia in 2012 cropping season.DZ-37 tef variety was used as a test crop. A factorial combination of planting method (row planting and broadcasting) and five times of DAP fertilize application (at planting, two, four, six and eight days before planting) was laid out in Randomized Complete Block design (RCBD) with four replications. Row sowing and DAP applied two days before planting had significantly affected days to heading and maturity, plant height , first growth rate, number of tiller and panicle, thousand seed weight, grain, straw and total biomass yields and harvest index. Days to emergence and panicle length were significantly affected by broadcasting and application of fertilizer two days before planting. Row sowing hastened heading and maturity by 1 day and increased growth rate by 23.46% than broadcasting; and DAP applied two days before planting hasten days to heading and maturity by 4 and 5 days, respectively, than DAP applied eight days before planting. Row sowing had 10, 24.8 and 23.8% more panicles, grain and biomass yields respectively, than broadcasting. DAP applied two days before sowing increased panicles, grain and biomass yields by 41.7, 62.1and 59.6% respectively, than DAP applied eight days before sowing. Interaction of row sowing and DAP applied at the time of sowing, had 54.7 and 1.07% more 1000 seed weight and harvest index respectively, than broad casting and DAP applied at the time of sowing. Row sowing was found to be economically acceptable with MRR of 627.7% with 6775.6Birr ha-1more income from grain yield than broadcasting. Row sowing and DAP applied two days before planting had 80.85 Birr ha-1 more additional income from straw than broadcasting. Therefore, row sowing and DAP application two days before planting could be recommended as an economically feasible choice for the study area.

Keywords: sowing method, row seeding, broadcasting, time of fertilizer/DAP application before planting

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1. Introduction

Tef (E*ragrostistef* (Zucc) Trotter) is a small seeded cereal indigenous to Ethiopia and originated in Ethiopia between 4000 and 1000 BC (Tareke and Nigusse, 2008). Currently, tef is grown in almost all regions of Ethiopia; because it is the preferred grain crop for home consumption, market and fetches the highest grain price compared with the other cereals (Zeleke, 2009). Tef is among the major cereal crops in Ethiopia and occupies about 22.6% of the total cereals' land (about 2,731,111.67 hectares), which is more than any other major cereals such as maize (17%), sorghum (15.92%) and wheat (11.89%) (CSA, 2012). Of the total 30 million grain production,14 million tons is contributed by cereals; tef constituted about 16% (34,976,894.64 quintals), next to maize 27.77% (60,694,130.14quintals) during the main cropping season of 20011/12.

In Ethiopia, tef performs well in '*Weinadega'* agro-ecological zones or medium altitude (1700-2400masl). According to Haftamu *et al.* (2009), mean temperature and optimum rainfall for tef during growing season range from 10 to 27ºC and 450 to 550mm, respectively. Tef withstands low moisture conditions and has the ability to tolerate and grow on Vertisols having a drainage problem, which make it a preferred cereal by farmers.

The length of growing period (LGP) ranges from 60 to 180 days within 450 to 550mm rainfall range. Whereas, depending on variety and altitude sometimes it could takes 90 to 130 days for physiological maturity (Haftamu *et al*., 2009).
Ethiopian farmers grow tef for a number of merits; which are mainly attributed to the socioeconomic, cultural and agronomic benefits (Hailu and Seyfu, 2001); although it ranks the lowest in terms of yield from of all cereals grown in Ethiopia. The lower productivity of tef might be due to its confinement to Ethiopia in terms of origin and diversification, which limits the chance of improvement like other cereals of international importance (Kebebew *et al.*, 2001). Other factors contributing to its low in productivity are lodging, method of planting and fertilizer application; the combined effect of those factors result up to 22% reduction in grain and straw yield (Hailu and Seyfu, 2001).Therefore, further improvement of product and productivity of tef is highly needed; as even improved varieties of tef are reported to yield only up to 2.2 t ha-1 on farmers'

field (Hailu and Seyfu, 2001) and the national average yield is 1.17 t ha-1 (CSA 2012).

The most common way of planting tef is by broadcasting the small seed at the rate of 25-30 kg ha-1 (Tareke and Nigusse, 2008). This sowing method results in lodging; which is the main cause for low yield of tef due to high plant density (Tareke, 2009). To minimize the problem of lodging on tef, low seed rate, row planting, late sowing and application of plant growth regulators were used (Fufa *et al.*, 2001).

High rate of nutrient depletion in Ethiopia soil is due to inadequate application of synthetic fertilizer, high biomass removal, erosion, and leaching (Balesh.*et al.*, 2007). The solution for these would be selecting combinations of nutrient source, appropriate rate and timing of fertilizer application; that would optimize fertilizer use efficiency and increases economic return (Grant *et al.*, 2002). Especially, application of nutrients before peak crop nutrient demand is critical; and adequate nutrients early in the growing season are necessary to maximize yield. Mainly, N and P are ensuring good grain or seed fill (Clain Jones, 2011). According to Clain (2011), there are many advantages from early application, like increased nutrient use efficiency and reduced adverse environmental effects. Though there is much advantage from early application, time of fertilizer application before planting is not known; due to limited research work on early application. Therefore, there are controversies regarding appropriate time of DAP fertilizer application before planting. According to my baseline survey some farmers prefer to apply DAP four days before planting, while others prefer to apply three days before planting, the remaining prefers to apply two and one day before planting. This confusion on the right time fertilizer application is not yet solved through research and resulting on loss of fertilizer and reduction in yield.

Majority of the farmers believes for longer time, to higher productivity on tef, broad casting all over the field is necessary. So they faced productivity problem for longer time due to, difficulty to manage weeds and lodging (Jim, 2011).To improve production and productivity of tef planting methods (such as planting in rows rather than broadcasting) and optimum time of fertilizer application

should be considered (ATA, 2012). Hence, this study was initiated with the following objectives:

- To evaluate the effect of sowing method and time of Di-Ammonium Phosphate (DAP) fertilizer application on growth and yield of tef.
- To see the combined effect of sowing method and time of DAP fertilizer application on growth and yield of tef.
- To identify the right sowing method & time DAP fertilizer application in tef production

2. Materials and Methods

2.1 Site Description

This study was conducted at Taremessa Kebele of Shebedino Woreda, in Sidama Zone. The site is located 27 km south of Hawassa and situated at 70 4'N and 440E with an elevation of 1900-2600 masl. The mean annual rainfall varies from 900-1500 mm; with two rainy seasons (bimodal); the belg (short rain from Feb-April) and meher (main season from June- October).The dominant crops growing around the experimental area are enset (*Ensetventricosum*), maize (*Zeamays* L.), tef, different vegetables and Chat (*Catha edulis*). Specifically the study site has an altitude of 1980masl with clay loam textural soil and considered as representative of the Woreda's cool sub humid (Weyna Dega) agro climatic zone (SWRDO, 2013, unpublished).

Based on ten years (2003 to 2012) meteorological data, the average annual rainfall of the study area was 798 mm; with a range of 704.3 mm to 1197.9 mm per year. The total rainfall of the growing year was 922.8 mm with a range of 0.2 to 193.6 mm per month. The total rainfall of the growing season was 590.4 mm with a range of 5.5 to 155.2 mm per month; which are ideal for the production of tef.

The average annual minimum and maximum temperatures are 13.3^{o}C and 27.5^{o}C, respectively. The mean minimum and maximum temperatures of the growing year were 13.5^{o}C and 27.8^{o}C, respectively. The mean minimum and maximum temperatures of the growing season were 14.5^{o}C and 26.3^{o}C, respectively. Generally the Woreda consist of two agro climatic zone, namely

cool sub humid (Weyna Dega (90%)) and cool and humid (Dega (10%)) (SWRDO, 2013) (unpublished).

2.2 Experimental Treatments and design

The experiment consisted of two factors, method of sowing and time of fertilizer application; arranged in randomized complete block design (RCBD). Times of fertilizer (DAP) application was fixed based on the farmers practice in the woreda accordingly(0, 2, 4, 6 and 8 days before planting) and methods of sowing (broad casting and row sowing), were arranged as factorial with four replications.

2.3 Experimental Procedure

Tef variety, DZ-Cr-37 (Tsedeay) released in 1984 was used as a test crop; which is most widely grown variety in the relatively low altitude and moisture prone areas (Truneh *et al.*, 2000).

The experimental field was prepared by using oxen plow and plowed four times, before planting. Plowing started at the end of June and the fourth plowing was done in the middle of August 2012. The experimental plot size was 2m x 2.5m ($5m^2$) and the space between plots was 0.5m; which had 0.2m intra row space.

DAP fertilizer was used at the rate of 100 kg ha-1 as source of N and P; and Urea was applied at the rate of 50 kgha-1; in which 1/3 at planting and 2/3 at stem elongation. The seed rate of tef used was 25 kg/ha for both sowing methods; and all necessary cultural practices were applied.

2.4 Soil Sampling and Analysis

Sixteen random soil samples (0-20 cm depth) from the experimental field were thoroughly mixed to make a composite. The sample was air dried and ground to pass 2 mm sieve and necessary parameters such as soil texture, available P, pH and CEC were determined. For the determination of OC and N 1mm sieve was used. Soil texture was analyzed by Bouyoucos hydrometer method (Day, 1965). Available P was extracted with a sodium bicarbonate solution at pH 8.5

following the procedure described by Olsen *et al.* (1954). The pH of the soil was measured potentiometrically in the 1:2.5 soil: water mixture by using a pH meter and organic carbon was determined following Walkely and Black wet oxidation method (Walkely and Black, 1934). Cation Exchange Capacity (CEC) was determined by Ammonium Acetate method (Jackson, 1973).

2.5 Data Collection

2.5.1 Phenological data

Days to 50% emergence: number of days from sowing up to the date when 50% of the plants emerged in a plot.
Days to 50% heading: number of days from sowing up to the date when the tips of the panicles first emerged from the main shoot, on 50% of the plant in a plot.
Days to 90% maturity: number of days from the date of sowing up to the date when 90% of the crop stands in a plot changed to light yellow color.

2.5.2 Growth data

Plant height (cm):- It was taken at an interval of 20 days; by taking six randomly selected plants and measured from the base of the main stem to the tip of the panicle.

Tillers number (m-2):- to determine the capacity of tillering per 1m2, 10 cm X 20 cm area was demarcated and the number of plants existed in that area were counted. Then recounting was done after at flowering on demarked area; because maximum tillers produced during vegetative phase and senescence occurs at maturity (Lafarge *et al.*, 2004). Finally the difference between the first and second count was converted into $1m^2$.
Panicles per plant: - six plants were randomly taken and the average number of panicles per plant was considered.
Panicle length (cm):- length of the panicle was measured by selecting six plants randomly and measuring from the node (the first panicle branch started) to the tip of the panicle.

2.5.3 Yield and yield components

Total above ground biomass (kg):- was measured after sun-drying for two days.
Straw yield (kg): - was measured by subtracting grain yield per plot from the total above ground biomass.
Grain yield (kg ha-1):- yield from every plot
Thousand seed weight (g): - the seeds were taken from each plot and 1000 seeds counted by hand and then weighted.

2.6 Economic Analysis

For economic analysis, a simple partial budget analysis was employed using CIMMYT approach (CIMMT, 1988). For partial budget analysis, the factors with significant effect were considered. Based variability in agronomic management between researcher and farmers, yield was adjusted by subtracting 10 % from average gain yield, which is recommendable for cereals in Ethiopia. Than after, gross yield benefit was obtained by multiplying the adjusted yield by the price of grain (13 birr kg^{-1}). Net benefit was calculated, by subtracting labor cost from gross yield. Finally marginal rate of return (MRR) was obtained, by dividing marginal net benefit to the marginal cost and expressed as percentage (CIMMT, 1988). The mean market price of tef was obtained by assessing the market at harvest (2012 cropping season).

2.7 Data Analysis

The various agronomic data were analyzed using the general linear model (GLM) procedures of the SAS statistical software (SAS Institute, 2000) to evaluate the effect of sowing method and time of fertilizer application and their interaction. Least Significant Difference (LSD) test at $P \leq 0.05$ was used to separate means whenever there were significant differences.

3. Results and Discussion

3.1 Physicochemical Properties of the Experimental Soil

The analytic results indicated that the experimental soil was clay loam textured; having organic carbon content (OC) of 2.54 % (Table 1). The soil had high OC in accordance with Sahlemedhin (1999), who rated OC between 1.74-2.90% as high. The CEC of the soil was 23.87 cmol kg^{-1}, which could be considered as medium (Landon, 1991). According to Olsen *et al*. (1954) P rating (mg kg^{-1}), P content of < 3 is very low, 4 to 7 is low, 8 to 11 is medium, and > 11 is high. Thus, the experimental site of available P content is high. The pH of the soil was 4.98, which is within the range of 4 to 8 suitable for tef production (FAO, 2000).Total N of the soil (0.16 %), is medium; as rated by Havlin *et al*., (1999) who rated total N between 0.15 to 0.25% as medium.

Table 1: - Physio-chemical properties of the experimental soil

Depth (cm)	pH (H_2o)	CEC (cmol kg^{-1})	OC (%)	Total N (%)	Av.P (mg kg^{-1})	Particle size distribution (%)			Texture
						sand	clay	silt	
0-20	4.98	23.87	2.54	0.16	27.4	32	30	38	Clay loam

CEC= Cation Exchange Capacity, OC= Organic Carbon, Av.P= Available phosphorous.

3.2 Crop Phenology

3.2.1 Days to emergence

Days to 50% crop emergence was significantly affected both by method of sowing and time of fertilizer application ($P \leq 0.001$). However, their interaction did not have any significant effect on crop emergence.

Broadcasting shortened days to emergency by 3-days than row sowing (Table 2). The result agrees with the finding of Klosterboer and Turner (2002), who indicated rice in the broadcast emerges earlier than row sowing. The row sown tef was placed relatively deeper than that of broadcasted tef; and the finding was in contrast to the report of Evert *et al.* (2008), who found earlier emergence of

tef on the surface compared to deeper planted tef; because of poor seed to soil contact.

Fertilizer applied eight days before sowing delayed emergency by 2-days than that applied two days before sowing (Table 2). This might be attributed to the high loss of DAP fertilizers from the earlier application before it is used by the plant; especially N, which is highly soluble and may be lost from the soil-plant system by leaching, de-nitrification, volatilization and erosion (Vaughan *et al*., 1990).

Table 2: Effect of method of sowing and time of DAP application on the days to emergence, heading and maturity of tef.

Treatments	50% Emergence	50% Heading	90 % Maturity
Method of sowing			
Broad casting	7b	46a	68a
Row sowing	10a	45b	67b
LSD (5%)	0.24	0.55	0.80
CV (%)	4.32	1.87	1.84
Time of fertilizer application			
At planting	8c	45cd	66cd
2-DBP	8c	44d	65d
4-DBP	9b	46bc	67bc
6-DBP	9b	47b	68ab
8-DBP	10a	48a	70a
LSD (5%)	0.54	1.25	1.80
CV (%)	4.32	1.87	1.84

DBP=Days before Planting, the same letter in a column of each factor shows a non-significant difference at 5% probability level.

3.2.2 Days to heading

Both method of sowing and time of fertilizer application had a significant ($P \leq 0.001$); but interaction did not have a significant effect on days to heading. Row sowed tef was head 1-day earlier than broadcasted (Table 2), which may be due to little weed competition and efficient use of fertilizer than broadcasted one (Mehdi, 2010).

Days to heading was enhanced by 4 days on DAP applied two days before sowing, compared to that of DAP applied eight days before sowing (Table 2). Thus days to heading for application of DAP two days before sowing is smaller; due to minimum loss fertilizer contributes for growth of crop (Brady and Weil, 2002).

3.2.3 Days to maturity

Days to 90% maturity were significantly ($P \leq 0.001$) affected by both sowing method and time of fertilizer application; but their interaction not significant.

Row sowed tef matured 1-day earlier than broadcasted (Table 2).The result is in line with Delesa (2007), who reported rice planted by broadcasting matured later than rows. The possible reason is that, less weed infestation and better use of fertilizer in row planting as compared to broadcast (Farooq *et al*., 2006); specially, P enhanced maturity (Brady and Weil, 2002). Application of fertilizer at planting resulted in 1-day delay and 4-days earlier mature compared to those applied two and eight days before sowing, respectively (Table 2). Thus, applying fertilizer two days before sowing enhanced maturity and this was because of time of application is one of the factor influencing crops phonology and growth (Mugwe *et al.*, 2007).

3.3 Growth Parameters

3.3.1 Plant height

Both sowing method and time of fertilizer application had very high significant ($P \leq 0.001$) effect on plant heights, except the effect of planting method on plant height (ph_1) which was highly significant ($p \leq 0.01$). However interaction effect of time of fertilizer application with planting method did not significantly affect plant height.

Row sowing had batter heights, at all of four measurements (PH_1, PH_2, PH_3 and PH_4) than broadcasting and also contributed for 15, 24, 12 and 3% increments in plant heights, respectively (Table 3). These are due to smaller space among plants in broadcast resulting in higher competition for nutrients; while in row sowing there was wider space and thus relatively less plant competition for

nutrients (Henderson *et al.,* 2000). Also, Caliskan *et al.* (2004), reported taller and more branched plants at the lower plant densities of sesame.

Application of fertilizer two days before sowing had 25% more plant height than DAP applied at sowing on the first measurement. Whereas application of fertilizer two days before sowing had 42, 25.6 and 8.7% higher plant height than that of applied eight days before sowing on PH_2, $PH_3$and PH_4, respectively. The results are in line with the report of Taylor and Francis (2005) and Vaughan *et al*. (1990), who indicated maximum use of N and P with minimum loss resulting in maximum growth in height on lentil and wheat, respectively.

Table 3: Effect of time of DAP application and sowing method on growth of tef.

Treatments	PH_1	PH_2	GR_1	PH_3	GR_2	PH_4	GR_3	PL	PN
Method of sowing									
Broad casting	11.54b	29.80b	0.98b	67.84b	1.89	94.00b	1.32	20.79a	9b
Row sowing	13.56a	39.17a	1.28a	77.30a	1.90	97.32a	1.50	18.51b	10a
LSD (5%)	1.14	3.39	0.23	3.66	0.21	1.58	1.04	2.31	0.34
CV (%)	14.00	15.13	31.30	7.78	17.54	2.54	11.3	5.86	5.54
Time of fertilizer application									
At planting	11.48b	38.16ab	1.32	77.95ab	2.00	97.77ab	2.69	23.75a	11b
2-DBP	15.40a	43.00a	1.38	84.00a	2.05	100.15a	1.34	20.61b	12a
4-DBP	14.60a	35.80ab	1.05	71.50bc	1.78	95.45bc	1.20	18.94bc	10c
6-DBP	11.37b	30.58bc	0.96	66.90cd	1.82	93.75cd	0.82	17.63c	8d
8-DBP	9.89b	24.97c	0.90	62.50d	1.87	91.40d	1.01	17.33c	7e
LSD (5%)	2.58	7.63	0.51	8.24	0.48	3.56	2.33	1.68	0.77
CV (%)	14.00	15.13	31.30	7.78	17.54	2.54	11.3	5.86	5.54

DBP= Days Before Planting, PH = Plant Height (PH_1- was measured 20 days after emergence; PH_2-measured 40 days after emergence; PH_3-measured 60 days after emergence and PH_4- was measured 80 days after emergence),GR= Growth Rate (GR_1-calculated from PH_1& PH_2, GR_2-calculated from PH_2& PH_3, GR_3-calculated from PH_3& PH_4), PL= Panicle Length and PN= Panicle Number. The same letter in a column of each factor shows a non-significant difference at 5% probability level

3.3.2 Growth rate

Sowing method, time of fertilizer application and their interaction were not significant on all growth rates; except method of sowing had significant ($P \leq 0.05$) on the first growth rate. Row sowing had 23% more fast growth than broadcasting on first growth rate (Table 3). The result is in line with the finding of Thakur *et al*. (2004) who reported row sown rice had fast growth than broadcasted. The non significant effect on others growth rate were due to efficient utilization of applied DAP fertilizer at earlier growth stage. Especially N is a constituent of chlorophyll, proteins and nucleic acids, which are essential for plant growth (Rashid *et al*, 2007).

3.3.3 Panicle length

Sowing method and time of fertilizer application significantly ($P \leq 0.001$) affected panicle length, but their interaction was not significant (Appendix Table 5). Broadcasting increased panicle length by 11% more than row sowing (Table 3). Because less tillering on broadcasting due to many plant density (Farooq *et al*., 2006), which contributes to growth of panicle length due to minimum competition for nutrients among tillers. This is in line with Caliskan *et al.* (2004), who reported number of tiller negatively correlated with panicle length on sesame.

Fertilizer applied two days before sowing had 16% more and 13% less panicle length than fertilizer applied eight days earlier sowing and at time of sowing, respectively. This might be due to maximum utilization of nutrients on fertilizer applied two days before sowing and at the time of sowing; because time and rate of fertilizer application has significant effect on both growth and yield (Lloveras *et al*., 2001).

3.3.4 Panicle number

Sowing method and time of fertilizer application significantly ($p \leq 0.001$) affected number of panicles per plant; but their interaction was not significant. Row sown had 10% more panicle numbers than broadcasted (Table 3), because

of better root growth in the case of row planting; which favors the growth (Mugwe *et al.,* 2007) and contributes to panicles per a plant (Blaise *et al.,* 2003).

Application of DAP eight days before sowing and at time of sowing had 42 and 8% less panicle number, respectively, than applied two days before sowing (Table 3). This result is in line with the finding of Genene (2003) who reported time of fertilizer application, particularly those containing N and P affects panicle number of wheat.

3.3.5 Tillers

Sowing method, time of fertilizer application and their interaction significantly ($P<0.001$) affected the number of tillers.

The interaction of row sowing and DAP applied two days before sowing had 5% more tillers than the interaction of row sowing and DAP applied at the time of sowing. Whereas the interaction of broadcasting and DAP applied eight days before sowing has delayed the growth by 83% compared with interaction of row sowing and fertilizer applied at sowing (Table 4). These might be due to the reduction of productive tillers by broadcasting (Delesa, 2007), together with maximum loss of N when DAP was applied eight days earlier to sowing, which could result to less tillering (Lloveras *et al*., 2001). Because N stimulates tillering due to its' effect on cytokinin synthesis (Mengel and Kirkby, 1996)

Table 4:- Interaction effects of time of fertilizer application and sowing method on tef tillering.

Time of fertilizer application	Number of tillers	
	Broad casting	Row sowing
At planting	20.4	43.2
2DBP	26.1	45.6
4DBP	15.0	18.9
6DBP	8.7	14.4
8DBP	7.2	9.3
LSD (5%)	5.21	
CV	17.09	

DBP= Days before Planting, LSD= Least Significant Difference and CV= Coefficient of Variations.

3.4 Yield and yield components

3.4.1 Total biomass

Sowing method and time of fertilizer application significantly ($p \leq 0.001$) affected biomass yield; although their interaction was not significant. Row sowed tef yielded 23.8% more biomass than broadcasted (Table 5), because of better growth in row sowing; due to easy absorption of photo synthetically active radiations (Ahmad *et al*., 2002).

Application of DAP at the time of sowing resulted in 52.5 % more biomass than the treatment with DAP applied eight days prior to sowing. Whereas applying of DAP at the time of sowing 15 % less biomass than DAP applied two days before sowing (Table 5), this might be due to maximum use of applied fertilizer on fertilizer applied two days prior sowing; because efficient utilization of applied fertilizer increased vegetative growth, which resulted for higher biomass production (Wakene 2010).

Table: 5: Effects of time of DAP application and sowing method on yield and yield components of tef.

Treatments	TBM	SY	GY
		Kg ha^{-1}	
Sowing Method			
Broad casting	1092.5b	97.05	995.45
Row sowing	1432.5a	108.5	1324.0
LSD (5%)	97.0	11.6	149.9
CV (%)	19.5	17.4	19.9
Time of fertilizer			
At planting	1525.0ab	110.0ab	1415.0a
2-DBP	1793.8a	117.5a	1676.3ab
4-DBP	1331.3b	101.3ab	1230.0b
6-DBP	937.5c	95.0ab	842.5c
8-DBP	725.0c	90.1b	634.9c
LSD (5%)	359.9	26.1	337.5
CV (%)	19.5	17.4	19.9

DBP= Days before Planting, CV= Coefficient of Variations, TBM = Total Bio Mass, SY = Straw Yield and GY = Grain Yield.

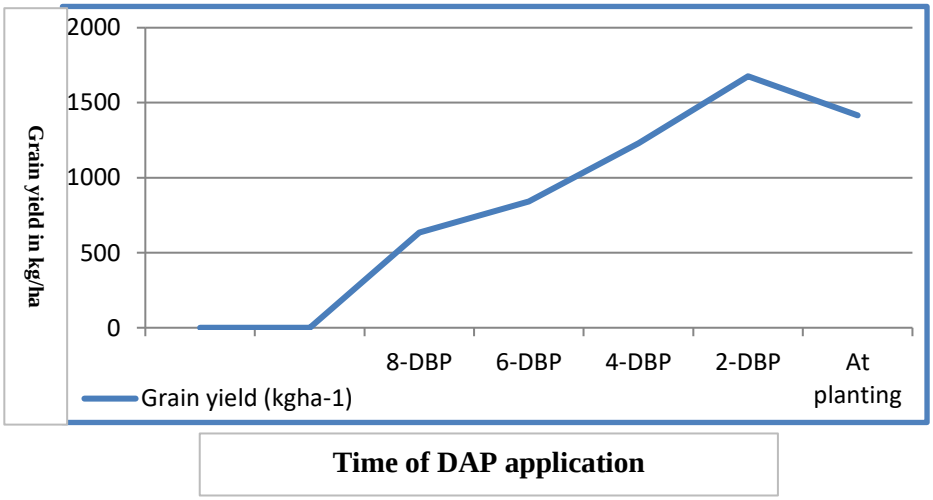
3.4.2 Straw yield

Time of fertilizer application significantly ($p \leq 0.5$) affected biomass yield; although sowing method and interaction of time of fertilizer application and sowing method were not significant.

Application of DAP at the time of sowing and two days before sowing resulted in 18 and 23.3% more straw yield, respectively than the treatment with DAP applied eight days prior to sowing (Table 5). This might be due to maximum use of applied fertilizer, with little loss on applied at the time of sowing and two days prior to sowing; because efficient utilization of applied fertilizer increased vegetative growth, which contribute to higher straw yield (Alam *et al*., 2005).

4.4.3 Grain yield

Sowing method and time of fertilizer application ($P<0.001$) had significant effect on grain yield; but no interaction effect. Row sown increased grain yield by 24.8% over broadcasted (Table 5).This might be uneven seed distribution on broadcasting, which results in excess nutritional competition at certain areas and no competition on other areas of the field and thus less grain yield productivity (Delassa,2007).



Application of DAP two days before sowing increased grain yield by15.6% over DAP applied at the time of sowing, whereas DAP applied eight days before sowing decreased grain by 55.1% compared to application at sowing (Table 5). These could attributed by minimum loss through leaching and volatilization on DAP applied two days before sowing and which resulted in better growth (Erkossa & Teklewold, 2009)

4.4.4 Thousand seed weight

Sowing method, time of fertilizer application and their interaction had significant ($p \leq 0.001$) effect on thousand seed weight. Interaction effect of row sowing and DAP applied two days before sowing had 26.7% more thousand seed weight than interaction of row sowing and DAP applied at sowing. Whereas as the interaction of broad casting and DAP applied eight days prior sowing was weighted 82.4% less compared in weight to row sowed and DAP applied at sowing (Table 6). These might be because of combined effect of row sowing, which enhances efficiently utilization of applied fertilizer (Minale *et al.*, 1999) and appropriate rate of N fertilizer at correct time, which optimizes grain yield and quality (Abdo, 2009).

Table 6: Interaction effects of method of sowing and time of DAP application on thousand seed and harvest index of tef.

	TSW(g)		HI	
Time of fertilizer	**Broadcasting**	**Row sowing**	**Broadcasting**	**Row sowing**
At planting	0.67	1.48	0.92	0.93
2-DBP	1.19	2.02	0.93	0.93
4-DBP	0.44	0.85	0.91	0.92
6-DBP	0.25	0.36	0.88	0.90
8-DBP	0.26	0.32	0.77	0.90
LSD	0.12		0.05	
CV	10.53		4.3	

DBP= Days before Planting, LSD= Least Significant Difference and CV= Coefficient of Variations CV = Coefficient of Variation, TSW = Thousand Seed Weight and HI= Harvest Index

3.4.6 Harvest index

Main effects and their interaction had significant effect on harvest index. Combined effect of row sowing and fertilizer application two days before sowing had 17.2% more harvest index than interaction of broadcasting and application of DAP eight days prior to sowing (Table 4). These might be due to, row sowing had less weed competition and efficient use of applied fertilizer (Thakur *et al*., 2004); and increment vegetative growth by applied N, which in turn increase grain yield by improving cumulative solar radiation intercepted by the crop (Osman *et al*., 2001).

3.5 Association of Grain Yield with Yield and Yield Components

Stepwise multiple linear regressions analyses were carried out using treatment means to determine the effects of method of sowing and time of fertilizer on the grain yield formation. Grain yield considered as dependant, whereas plant height, growth rate, tillers, panicles, panicle length, thousand seed weight, straw yield, total biomass and harvest index were taken as explanatory variables (Table 7).

Grain yield was positively and significant ($P < 0.001$) associated with plant heights taken at four different times, first growth rate, number of tillers and panicle, panicle length and thousand seed weight, r=0.60, 0.69, 0.72, 0.70, 0.51, 0.8,0.6 and 0.81, respectively. Similar correlations were reported in barley by Mekonnen (2005) and Alam *et al.* (2005).On the other hand, grain yield was associated negatively with third growth rate ($r=^{-}0.69^{***}$) and panicle length (0.75^{***}); which was in line with the report of Getachew (2004) on bread wheat.

Table 7: Correlation between yield and yield components of tef

	PH1	PH2	PH3	PH4	GR1	GR2	GR3	PN	PL	GY	SY	TBM
PH1	1.0	0.56***	0.80***	0.82***	0.81 ns	-0.09ns	-0.75***	0.64***	-0.49**	0.60***	0.14***	0.56***
PH2		1.0	0.80***	0.82***	0.82ns	-0.09 ns	-0.75***	0.76***	-0.71***	0.69***	0.30*	0.62***
PH3			1.0	0.94***	0.59***	0.51***	-0.98***	0.83***	-0.69**	0.72***	0.37 *	0.66***
PH4				1.0	0.59***	0.39*	-0.84***	0.81***	-0.68***	0.70***	0.34*	0.22***
GR1					1.0	-0.19 ns	-0.56***	0.49**	-0.49**	0.51***	0.29 ns	0.53***
GR2						1.0	-0.55***	0.29 ns	0.38**	0.21 ns	0.18 ns	0.63 ns
GR3							1.0	-0.79***	0.66***	-0.69***	-0.37*	-0.64***
TN								0.86***	-0.77***	0.80***	0.31*	0.75***
PN								1.0	-0.49	0.60***	0.14ns	0.56***
PL									1.0	-0.75***	-0.22 ns	-0.69***
TSW										0.81***	0.42 ns	0.76***
GY										1.0	0.43 ns	0.97 ns
SY											1.0	0.46 *
TBM											1.0	0.46 *
HI												

ns = not significant, * ** &*** significant at 0.05, 0.01and 0.001 respectively, PH_1, PH_2, PH_3&PH_4= first, second, thread & fourth Plant Height respectively, GR_1, GR_2& $GR_{3=}$ first, second & third growth rates, respectively, TN= Tillers in Number, PL= Panicle Length TBM = Total biomass, GY = Grain Yield, SY = straw yield, TSW = Thousand Seed Weight and HI= Harvest Index.

3.6 Partial Budget Analysis

The return obtained from row planting was above the minimum acceptable marginal rate of return (100%) (CIMMYT, 1988), which is 627.7% and contributes to 6775.6 Birr ha^{-1} more income as compared to broadcasting. The combination of row sowing and fertilizer applied two days prior to sowing had increased straw yield 60% more than broadcasting and application of DAP eight days before sowing (Table 6), which contributed more 80.85 birr ha^{-1}.than broad casted and eight days earlier applied. Thus, in order to obtain benefit from straw and grain, row sowing and fertilizer application two days before sowing could be recommended for farmers in this area.

Table 8: Partial budget analysis of tef as influenced by sowing method.

Treatment	Av.Y (q ha^{-1})	ADTY (q ha^{-1})	GFB (birr ha^{-1})	Total Variable cost (birr ha^{-1})			Net benefit (birr ha^{-1})	MRR (%)
				DFM	Unit labor cost	Total labor cost		
Method of sowing	-	-	-	-	-	-	-	_
Broad casting	19.87	17.88	23,244	90	12 birr	1,080	22,164	_
Row planting	26.58	23.92	31,098.6	180	12 birr	2,160	28,938.6	627.7

Av.Y= Average Yield, ADTY=adjusted yield, GFB= Gross Field Benefit, DFM=Days of Farm Management, MRR=Marginal Rate of Return.

4. Summary and Conclusion

Experiment was conducted in Shebedino, southern Ethiopia to evaluate effects of sowing methods and time of di-ammonium phosphate (DAP) application on yield and yield components of tef. DZ-37 tef variety was used as tef crop and the two treatment factors were time of fertilizer application (8, 6, 4, 2 days before and at the time of planting) and sowing method (broad casting and row sowing). Time of application and method sowing were factorialy arranged using randomized complete block design with four replications.

Soil samples (0-20 cm depth) were collected from experimental field before planting. Analysis of composite soil sample revealed that the soil of the

experimental field was clay loam in texture and slightly acidic (pH=4.98) with 0.16 % total N, 2.54 % organic carbon, 27.4 $mgkg^{-1}$ available phosphorus and 23.87$cmol\ kg^{-1}$ CEC.

Most of the observed parameters; (days to 50% heading and 90% maturity, four interval plant height measurements, first growth rate, tiller and panicle numbers, thousand seed weight, grain, straw and total biomass yields and harvest index) significantly responded to row sowing, fertilizer applied two days prior to sowing and their combination, except days to 50% emergence and panicle length, which were better respond on broad casting.

Broadcasting and DAP application two days before sowing hastened days to emergence by 3 and 2 days, respectively; and row sowing enhanced days to heading and maturity by 1 day. DAP application two days prior to sowing hastened days to heading and maturity by 4 and 5 respectively.

Row sowing increased plant heights taken at four intervals (H_1, H_2, H_3 and H_4) by 15, 24, 12 and 3% more than broadcasting; whereas DAP applied two days before sowing increased 35.8, 42, 26 and 87% the heights as compared to application eight days prior to sowing. Row sowing was hastened the growth by 23% more than broadcasting. Interaction effect of row sowing and DAP applied two days before sowing had 5.3% more tillers than interaction of row sowing and DAP applied at sowing; whereas broadcasting and DAP applied eight days prior sowing delayed the growth by 83.3% compared with row sowing and DAP applied at the time of sowing.

Broadcasting increased panicle length by 10% over row sowing; and DAP applied two days before sowing increased panicle length by 41.7 and 8.3% compared to DAP applied eight days before sowing and application at the time of sowing, respectively.

Row sowing had 10, 24.8 and 23.8% more panicles numbers, grain and biomass yield, respectively than broadcasting. Fertilizer applied two days prior to sowing had 8, 15.6 and 15% more panicles numbers, grain and biomass yield than DAP applied at a time of sowing.

Combined use of row sowing and DAP applied two days before sowing resulted in 82.2 and 17.2 % more thousand seed weight and harvest index, respectively than broadcasting and DAP applied eight days before sowing.

The economic analysis indicated that row sowing had acceptable MRR (627.7%); and 6775.6 Birr ha^{-1}more grain yield income than broadcasting tef. Combination of row sowing and DAP applied two days prior to sowing had additional income from straw (80.85 birr $ha^{-}1$) companied to broadcasting and application of DAP eight days before sowing. Thus, it is possible to recommend that, row sowing and DAP application two days before planting for tef production in the trail area. However, it is advisable to undertake further research across soil type, years and locations to draw sound recommendation on a wider scale.

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Trend, Exit Times and Determinants of Rural Poverty in Case of Southern Nation Nationalities People Region, Ethiopia: Evidence from survey data

Mohammed Beshir[1]

Abstract

This study used a household survey data of 12,768 samples in order to analyze trend, average exit time and determinants of rural poverty in southern nations, nationalities and people region (SNNPR), Ethiopia. Foster, Greer and Thorbeke (FGT) indexes for poverty incidence, depth and severity were equal to 25.61%, 8.09% and 3.69% respectively for the year 2015. Rural poverty incidence in the region reduces by 54.67% for the last 20 years. Average exit time of poverty for all poor households (a measure that accounts for income differential among the poor) was 8.59 years and the time reduces to 7.37 years if we ignore income differences. Logistic regression showed that sex, total number of dependants, education level, presence of out migrant, land holding, use of extension package, number of livestock, saving, off-farm income participation, health status and difference in agro ecologies in which the households live were significant to affect poverty status of households. In order to actuate pace of poverty reduction in the region, access to agricultural input and social participation should favor female headed households. Expansion of qualified social and physical infrastructures such as education, health, financial services should catch the attention of policy makers and development partners. Moreover, enhancing participation in off-farm income activities through overcoming the barriers, intensified use of extension package, controlling of animal diseases and use of modern breeds help to increase and smooth consumption of households. The above variables of interest which are significant in reducing rural poverty should favor more 'Dega', and 'Kola' than 'Weinadega' since the probability of being poor is lower in the latter agro ecology.

Key Words: rural poverty, exit time, logit, SNNPR

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1. Introduction

The World Bank defines poverty as "a pronounced deprivation of wellbeing" (World Bank 2001a). It is related to lack of material income or consumption, low level of education, and health, vulnerability and exposure to risk and voicelessness and powerlessness. Great efforts are continuously exerted by international organizations such as WB, IMF…etc, governments and non-government organizations worldwide to reduce absolute poverty and improve welfare status of many improvised citizens in Africa, Latin America and Asia where the majority of poor live. Countries like China are successful enough to this end since rural head count index reduces from 25% in 1999 to 5% in 2010 (Jayati G. 2010). A number of micro and macro policy reforms and targeted interventions are continuously cited as a source of success.

The measurement and analysis of poverty such as its determinant are crucial for understanding peoples' situations of wellbeing and its causal factors. A credible measurement of poverty is important to bring the living conditions of the poor to the attention of policy makers in designing appropriate interventions and for assessing effectiveness of on-going policies and strategies designed to help the poor (Jonathan Haughton and Shahidur R. Khandker, 2009).

Even though Ethiopia's economy is one of the fastest growing in SSA, the proportion of poor people living in absolute poverty is so high that nearly 29.6% of the population is expending less than the amount required to purchase 2,200KCa per day (MoFED, 2012). The same source also revealed that Southern Nations Nationalities and Peoples' Regional State (SNNPR) is one of the regions with the poverty level which hits near to the country average. For instance, in 1995/96 the regional poverty rate was 55.8 but eventually it declined and reached 29.6% in 2010/11 which is equal to the country's average. The rural and urban poverty incidences of the region for the year 2010/11 equals 30% and 25.8% respectively. These figures indicate that poverty is more of rural than urban phenomenon. In order to combat such high incidences of poverty in rural areas in view of considering very scarce financial resources available to be allocated for the purpose, we have to understand the nature, trend and determinants of poverty.

The effort of Ayalneh B. et al (2005) was one of the pioneer tasks in Ethiopia regarding the determinants of rural poverty taking samples from Alemaya, Hitosa and Merhabete districts. They found that variables such as education level of the household head, household size, per capital income, land holding and number of oxen are the determinants of poverty in the aforementioned districts. Even though their research paved the way for others to address the same in various areas, methodologically they failed to incorporate variables such as marital status, livestock ownership, off farm income participation, saving, health status which have at least theoretically an impact on poverty status of households. Moreover, none of the above districts are from the SNNPR state which makes inference for the region misleading based on this research work.

Tsegaye M. et al (2014) employ a binary logistic regression to analyze the determinants of rural poverty in Gozamn districts of Amhara regional state. Their study was so comprehensive that some of the variables that determine poverty and left out by Ayalneh B. et al (2005) such as livestock ownership, off farm income participation, saving, frequency of visit by extension workers are included in their model and found significant to affect poverty status of households.

Moreover, they calculated average exit time of poverty for all poor households and average poor household to be 4.4 and 4 years respectively. They use real GDP per capita growth rather than real consumption per capita growth in their calculation. But, exit times are more responsive to change in consumption than change in income since in the later case some of the income may find its way to household saving that in turn doesn't affect poverty status directly.

A study by Nega A. (2015) in Gulomekeda Woreda of Tigray regional state found that family size, dependants, educational level of the head, off farm income and livestock ownership as a significant determinates of poverty.

A detail study about the determinants of rural poverty however should look on inclusion of variables that indicate household's demographic characteristics such as sex, age, marital status, dependency ratio, migration (McKernan and RatCliffe, 2005), location of a household to market, road..etc (Bigsten and

Shimeles, 2008), household's asset holding such as land, livestock, oxen (Quisumbing, 2007) and prior experience of economic shocks like illness with in a household (Neilson et al, 2008).

This paper adds to the existing literatures via inclusion of all categories of the above variables and usage of a large data set collected from rural SNNPR where rare has been done so far to address the determinates of rural poverty in the region by previous researchers. Moreover, poverty analysis for the whole country may not be used by regional planners and policy makers since the country experiences varied socioeconomic, consumption patterns, institutional frameworks…etc. On the other hand, the study of poverty shouldn't gear to a specific locality or districts since policy makers may not exhaustively design interventions to these levels. To this end, this paper using a sample of 12,768 rural households addresses the trend, exit time and determinants of rural poverty at regional level in which variations in institutional frameworks, consumption patterns…etc are relatively minimum and in turn policy inferences comparably more accurate.

This paper has the following objectives:

- Calculating the Foster, Greer and Thorbeke (FGT) indexes of rural poverty in the region for the year 2015 and try to compare the findings with previous figures to observe poverty trends.
- Determining the average exit time from poverty so that it will be possible to gauge the time required to lift the poor from absolute poverty.
- Identifying determinants of poverty in rural SNNPR which in turn help to direct resources on selected causes so as to actuate pace of poverty reduction in the region.

2. Methodology

2.1 Description of the study area

Southern Nations, Nationalities and People's Regional (SNNPR) states is located in South and South-Western part of Ethiopia. The total area of the region is 110,931.9sq KM and accounts nearly 10% of the country's land mass. It has an estimated 18.395 million population and 3.774 million of households (CSA, 2014). On the basis of ethnic and linguistic identities, the region is at present

divided to 14 Zones, 4 special woredas and 1 city administration which in turn contains 3,678 rural and 238 urban kebeles. Rainfalls vary from 400mm to 2200mm and mean annual temperatures swings between 10^0C to 27^0C (BoFED, 2015).

2.2 Sampling design

The survey covered rural and urban areas of the regional state. For the purpose of representative sample selection, the region was divided into two broad categories, i.e., rural and urban areas. Therefore, each category in the region was considered to be a survey domain.

The target population of the study is from 14 zones, and 4 special woredas, and 1 city administration. Multi-stage sampling technique was used for selecting the representative household included in the study. First the region was divided into rural and urban clusters. All 135 woredas in the region excluding woreda towns and 22 reform towns were considered as a rural cluster. From 135 woredas, 30 percent (41woredas)[2] of them were considered as representative sample for rural cluster. These woredas were allocated proportionately into 14 zonal administrative levels and 4 special woredas taking in to account the number of households in each zone and special woreda.

2.3 Sample Size Determination

Sample size of the study was determined using Cochran (1977)

$$n = \frac{z_{\frac{\alpha}{2}}^2 pq}{(\varepsilon)^2}$$

where $z_{\alpha/2}$ = the two − tailed critical value at 99 percent confidence interval (2.91)

p = probability of being poor in the region = 0.3

q = probability of being non − poor in the region = 0.7

ε = margional error between sample and population values of poverty = 0.01

[2] The number of woredas considered in the sample are equal to 30% of the total pool. This percent is the approximate head count index for rural SNNPR in 2010/11.

$$n = \frac{z_{\alpha/2}^2 s^2}{(\varepsilon)^2} = \frac{2.91^2(0.21)}{(0.01)^2} = 17{,}783$$

The determined sample size was proportionately distributed to 41 rural ,26 urban woredas and 1city administration in the region on the basis of their respective household sizes which leaves a sample size of 12,768 rural households to be taken for the survey.

2.3 Methods of measuring poverty and average exit time

2.3.1 Methods of measuring poverty

The first step in the measurement of poverty call for decision regarding the indicator of welfare that should be used. Income or consumption is traditionally used to measure material deprivation. Especially consumption rather than income is viewed as the preferred welfare indicator for the following reasons: consumption better captures the long-run welfare level than current income; it may better reflect households' ability to meet basic needs; it reflects the actual standard of living (welfare); it is better measured than income; income is likely to be understated than consumption expenditure; income is so erratic and seasonal that it may be very difficult for respondents to recall (Jonathan H. and Shahidur R. Khandker, 2009). Consumption includes both goods and services that are purchased, and those that are provided from one's own production (WB, 2005).

In using consumption as an indicator of household's welfare, it has to be adjusted for difference in the calorie requirement of different household members (for age and sex of adult members). Hence, in the present study the family size of each household was converted into adult equivalent using the conventional conversion factor. Then consumption expenditure per adult was calculated by dividing household consumption expenditure by the number of adult equivalents in a household.

Once, the indicator of welfare is decided, the poverty line should be determined so that individuals that expend above and below the poverty line are deemed non-poor and poor respectively. The most widely used method of estimating poverty line is the cost of basic needs method (WB, 2005) because the indicator will be more representative and the threshold will be consistent with real

expenditure across time, space and groups. According to this approach, first the food poverty line is defined by choosing a bundle of food typically consumed by the poor. The quantity of the bundle of food is determined in such a way that the bundle supplies the predetermined level of minimum caloric requirement. It is at least 2,200 KCa intakes per day that will leave an individual not to be poor (MoFED, 2012). The bundle that gives 2,200KCa is valued at local prices and at regional average prices to get a consistent poverty line across the region. Then a specific allowance for the non-food goods and services consistent with the spending of the poor is added to the food poverty line. The formula used for determining the non-food share of poverty line in this study is taken from Ravallion (1994) and presented as follow:

$$S_i = \alpha + \beta log\left(\frac{Yi}{z}\right) + \varepsilon i \qquad \textbf{(1)}$$

Where, S_i denotes the share of food items from the total household's expenditure, $\mathbf{Y_i}$ refers total consumption expenditure per adult equivalent of household *i*, **Z** is the food poverty line, β is regression coefficient, and α is intercept or the food share. I$f\,\hat{\alpha}$ is an estimate of the intercept α, since $log\left(\frac{Yi}{z}\right)$=0 when $\mathbf{Y_i}$=Z, it implies that $\hat{\alpha}$provides an estimate of the food share among households whose total expenditures match the food poverty line. As a result, 1-$\hat{\alpha}$ signifies non-food share.

As suggested by Ravallion and Bidani (1994), the total poverty line (Z^T) is then calculated as

$$Z^T = Z(2 - \hat{\alpha}) \qquad \textbf{(2)}$$

Having set the poverty line, what follow is decision on types of indexes used to measure poverty. Kimalu et al., (2002) pointed out that one poverty measure that has been found manageable in presenting information on the poor in an operationally convenient manner is the FGT (Foster, Greer and Thorbecke) measure developed by Foster et al., (1984). This measure is used to quantify the three well-known elements of poverty: the level, depth and severity (also known, respectively as incidence, inequality and intensity) of poverty.

Mathematically

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{n} \left(\frac{Z^T - Yi}{Z^T}\right)^\alpha \quad \textbf{(3)}$$

Where α takes vales of 0 (poverty incidence), 1 (poverty gap) and 2 (severity of poverty).*N* stands for total sample size and *n* for poor households. Poverty gap and severity are calculated taking poor households not all samples. Poverty indexes are solved using Distributive Analysis/Analysis Distributive (DAD) software which is mainly designed for poverty and inequality analysis. Moreover, the software allows survey data to be weighted easily in case of oversampling of small populations and under sampling of large populations which are identified as common problems related to collection of survey data (WB, 2005).

2.3.2 Method of measuring average exit time

The average time that takes for the poor households to exit poverty is increasingly becoming popular these days for policy issues more than the proportion of the poor households. This is due to the fact that the objective of poverty reduction in a nation will only be successful provided that the economy of the nation grows continuously and at the same time the poor groups of rural households are taken in to account by policy makers. Hence, the concept of average time needed to exit poverty is central to lift majority of the poor households from poverty. An appealing and more useful indicator for policy discussions may be the average exit time amongst the poor than the average exit time of all sample households because otherwise policy makers might conclude (based on the later) that poverty can be quickly eliminated, neglecting to remember that many people are already non-poor (Tsegaye et al, 2014).

As provided by Morduch (1998), for the i^{th} household below poverty line, the expected time needed to exit poverty (t_g^i) if consumption per capita grows at a positive rate g per year is:

$$t_g^i = \frac{\ln(Z^T) - \ln(Y_i)}{\mathrm{g}} \quad \textbf{(4)}$$

Once we get a value for real income per capita growth, we will multiply it by average propensity to consume to get the real consumption per capita growth (*g).*

It is possible to estimate the average exit time of the average poor household by taking the average per capita consumption (μ_ρ)of the poor households per year as shown below although this measure is insensitive to the distribution of consumption/income below the poverty line.

$$t_g^{avg} = \frac{\ln(Z^T) - \ln(\mu_\rho)}{\mathrm{g}} \qquad \textbf{(5)}$$

This measure of exit time for the average poor doesn't take in to account consumption differentials among the poor. Finally, the average exit time across the poor households (T^g) is t_g^i averaged over the entire poor households. Mathematically

$$T^g = \frac{1}{n}\sum_{i=1}^{n} \frac{\ln(Z^T) - \ln(Y_i)}{\mathrm{g}} \qquad \textbf{(6)}$$

Where *n* is household whose consumption per adult equivalent falls below the poverty line.

2.3.3 Determinants of poverty: Econometrics model specification

The analysis of determinant of poverty uses a binary logistic regression. Logistic regression is used to analyze relationships between a dichotomous dependent variable and independent variables of any form. Logistic regression combines the independent variables to estimate the probability that a particular event will occur, in this case the probability of the household falling below the poverty line or not.

The logistic regression equation restricts the predicted values of the dependent variable to lie in the interval between zero and one.
In most applications the logit and probit models are quite similar, the main difference being that the logistic distribution has slightly flatter tails. That is to say, the conditional probability *Pi* approaches zero or one at a slower rate in logit than in probit. Therefore, there is no compelling reason to choose one over

the other. In practice many researchers choose the logit model because of its comparative mathematical simplicity (Gujarati, 2004).

The probabilistic distributive function (PDF) of a household falling below the poverty line, P(Yi=1) is given by

$$P(Y_i = 1) = \frac{e^{Yi}}{1+e^{Yi}} \quad \textbf{(7)}$$

To proceed further, we need the probability of the household not falling below the poverty line *i.e.* $P(Y_i = 0)$ and it is given by 1- $(P(Y_i = 1))$.

$$P(Y_i = 0) = \frac{1}{1+e^{Yi}} \quad \textbf{(8)}$$

When the ratio of equation 7 to 8 is calculated (the probability of an event occurring to the probability of non-occurring) , we get the odds ratio

$$\frac{P(Yi=1)}{P(Yi=0)} = \frac{\frac{e^{Yi}}{1+e^{Yi}}}{\frac{1}{1+e^{Yi}}} = e^{Yi} \quad \textbf{(9)}$$

The logit equation can be obtained via taking the natural log of equation 9.

$$\ln\left(e^{Yi}\right) = Y_i = B_i X_i \quad \textbf{(10)}$$

Where B_i and X_i are set of parameters and explanatory variables respectively. Moreover, the above equation is a fully linear function of X_i.

2.4 Explanatory variables within the model: Explanation, variable representation and expected signs

A total of 16 variable of which 5 household characteristic variables (sex of the household head, age squared of the household head, total dependency, marital status and presence of migration), 4 variables that signify asset holdings (education of the head, landholding in Ha, livestock measured in tropical livestock units and number of oxen), 4 variables that shows household's access to services or infrastructure (time to market, savings, use of extension package and participation in off-farm income activity), 2 variables to show village characteristics (agro ecologies of Dega, Weinadega and Kola[3] where kola is used as a base) and 1 variable (prevalence of illness within the family) to signify the impact of shocks on poverty.

In the following table, we have presented the description of the explanatory variables, the type of the variable (dummy or continuous) and the expected impact a specific variable has on poverty status of the household, which took value 0 and 1 if the household is non-poor and poor respectively.

[3] Dega refers highlands, Weinadega for plateau and moderate highlands and Kola for lowlands.

Table 1: Description of explanatory variables

Sr. No	Variable description	Variable representation in the model	Variable type	Values if the variable is dummy	Expected sign
1	*Sex of the household head*	*Dsex*	Dummy	0= male, 1= female	Negative
2	*Age squared of the household head*	*agesq*	Continuous		Negative/positive
3	*Marital status of the household head*	*dmarstat*	Dummy	0=single, 1= married, divorced and widowed	Positive
4	*Total number of dependants with in a household*	*totdep*	Continuous		Positive
5	*Presence of out migrants*	*Dmmig*	Dummy	0= if there is no out migrant, 1=if there is out migrant	Negative/positive
6	*Educational level of the household head*	*edulevel*	Continuous		Negative
7	*Cultivated Land holding in Hectare*	*Land*	Continuous		Negative
8	*Number of oxen*	*Oxen*	Continuous		Negative
9	*Number of livestock owned in TLU*	*Tlu*	Continuous		Negative
10	*Use of Extension package*	*dexpa*	Dummy	0= non-users, 1= users	Negative
11	*Involvement in off-farm income generating activities*	*dofffarm*	Dummy	0= non-participant, 1= Participant	Negative
12	*Time to access the nearest market in minutes*	*martime*	Continuous		Positive
13	*Saving*	*dsaving*	Dummy	0= non-savers, 1= savers	Negative
14	Agro-ecological zones (Dega, Weinadega, and Kola)	*Dega, Dwodega*	Dummy	1= dega, 2=weinadega & 3= kola where kola is base regressand	Negative
15	*Health status*	*dheal*	Dummy	0= no ill member, 1= ill member	Positive

3. Results and Discussion

3.1 Poverty Line

The use of cost of basic needs (CBN) approach to calculate the cost of minimum threshold calorie requirement of 2,200KCa per day per adult (food poverty line) in rural SNNPR end up with Br 2,002.56. The non-food poverty line was equal to Br. 821.05. The sum of food and non-food poverty lines finally gives us Br. 2,823.61 as a total poverty line in the rural SNNPR.

3.2 Poverty Indexes

Once the poverty lines are calculated, it is possible to provide appropriate summaries of rural poverty in the form of head count, depth and severity of poverty. In the following table, the indexes for rural and urban SNNPR (using separate poverty lines) is shown to facilitate comparisons between the two areas.

Table 2: Poverty incidence, depth and severity in SNNPR, 2015

Location	Poverty Incidence	Poverty depth	poverty severity
Urban	0.1802	0.0525	0.0231
Rural	0.2561	0.0809	0.0369
Region	0.2195	0.0691	0.0317

Source: Own Calculation from SNNPR BoFED survey, 2015

As the figures vividly reveal, the rural SNNPR is hit by higher incidence, depth and severity of poverty as compared to the urban. The result is consistent with the finding of CSA (2011). The proportions of rural population below poverty line is 25.61 percent where as the value is 18.02 percent in urban area.

The poverty gap reflects the total deficit of all the poor households relative to the poverty line. It is, therefore, a much more powerful measure than the head count ratio because it takes into account the distribution of the poor below the poverty line (Ayalneh B., 2005). The poverty gap index of the rural is 8.09 percent. The meaning is that if the region could mobilize resources equal to the 8.09 percent of the poverty line from every household and distributes the resource to the poor in the amount needed so as to bring each household up to the poverty line, then poverty could be eliminated. The severity of poverty in rural SNNPR is 3.69 percent.

3.3 Trends of poverty in the region over time and space

The central statistical agency (CSA) of the country used to undertake household income, consumption and expenditure (HICE) survey. Accordingly, a four round surveys of HICE (1995/96, 1999/2000, 2004/05, 2010/11) are available to look on trends of rural poverty in the region. Coudouel et al (2004) underlined that to obtain robust poverty comparisons over time; one has to use survey with similar sampling frames and methods, and similar definition of income/consumption as an indicator of welfare.

The recent survey by Bureau of Finance and Economic Development (BoFED) of SNNPR follows the footsteps the CSA approach to select samples and calculate indexes. Moreover, both institutions used consumption expenditure per capita as an indicator of welfare. Hence, it is possible to compare trends of poverty over time using the recent survey by BoFED and a number of surveys by CSA. Doing so provide insights about the stability of poverty characteristics and the relevance of various policies, including the use of targeting devices.

The results for head count poverty of the region in the years 1995/96, 1999/2000, 2004/05 and 2010/11 are taken from CSA. Compared to the 1995/96 and 2010/11, the current result for rural poverty head count index has decreased by 54.67 percent and 14.63 percent respectively. The 2015 urban poverty head count index has declined by 60.74 percent and 29.88 percent compared to 1995/96 and 2010/11 results respectively. Through the region is successful enough to reduce aggregate poverty by 60.66% since 1995/96, most of the reduction is registered for urban households than rural households.

Since depth and severity of poverty index figures aren't available from previous surveys for the region, direct comparison of the same across time isn't undertaken. But, historically the region's rural head count index mostly hit around the country's average (MoFED, 2012). If we extend this fact for depth and severity of poverty, rural SNNPR depth and severity indexes for the year 2015 are 1.13 and 15.31 percent higher than the country's rural average found in 2010/11.

Table 3: Trends of aggregate, rural and urban poverty in the region

Type of Index	Poverty indices over time					Change (%)	
	1995/ 1996	1999/ 2000	2004/ 2005	2010/ 2011	2015	2015to 1995/96	2015 to 2010/11
Regional							
Head count index	0.558	0.509	0.382	0.296	0.2195	-60.66	-25.85
Poverty gap index	-	-	-	-	0.0691	-	-
Poverty severity index	-	-	-	-	0.0317	-	-
Rural							
Head count index	0.565	0.517	0.382	0.300	0.2561	-54.67	-14.63
Poverty gap index	-	-	-	-	0.0809	-	-
Poverty severity index	-	-	-	-	0.0369	-	-
Urban							
Head count index	0.459	0.402	0.383	0.257	0.1802	-60.74	-29.88
Poverty gap index	-	-	-	-	0.0525	-	-
Poverty severity index	-	-	-	-	0.0231	-	-

Source: MoFED, 2012 and Own Computation from SNNPR BoFED survey, 2015

3.4 Average exit time from poverty

The estimation of average exit time from poverty requires an assumption to be made on the future growth of consumption per capita. I started the task through calculating the average real GDP per capita growth of the country (a proxy to the region) in the last 5 years. It is equal to 7.8% (NBE, 2015) and the researcher assumed this average growth to hold in the coming years. Second, the real consumption per capita growth should be obtained from the real GDP per capita growth since change in poverty status are highly apparent due to change in the former not the latter. This requires calculating the marginal propensity to consume for the poor and from the survey it is equals to 0.65 which leaves the real consumption per capita growth to be 5.07% (i.e 0.65*7.8%). It is this figure which is used in Equations 5 and 6 to estimate poverty exit times.

Table 4: Average exit times from poverty

Poverty measures	Value
Average exit time of poverty for all poor households *(estimation using equation 6)*	8.59 Years
Exit time of poverty for the average poor household *(estimation using equation 5)*	7.37 Years
Additional years to the average exit time due to inequality among the poor *(1-2)*	1.22 Years

Source: Own computation from SNNPR BoFED survey, 2015

The average exit time of poverty which accounts for income inequality among the poor in the region is equal to 8.59 years where as the exit time reduces to 7.37 years if we ignore income differentials among the poor. The difference between the two values (1.22 years) is the additional exit time required due to consumption expenditure inequality among the poor.

Tsegaye et al (2014) found the average exit time of poverty for all poor households and exit time of poverty for the average poor household 4.4 and 4 years respectively for rural households of Gozzamn district of East Gojam zone (one of the district in Amhara region). They used the real GDP per capita growth (which is usually higher than the average consumption per capital growth) to calculate exit times. This in turn can reduce the time required to exit from poverty. Moreover, variations in consumption pattern in the two regions may account for the difference in exit times.

3.5 Descriptive statistics for sample households

3.5.1 Descriptive statistics (Continuous variables)

As depicted in Table 3, mean age of non-poor households is greater than poor households which in turn elicit the positive role of experience accumulated through life on poverty reduction among rural households. The elders have more skill and knowledge regarding the type of crop to be grown, exact sequence of crop-rotation, controlling diseases…etc. As stipulated by economic theory, the average number of dependants for non-poor households is lower than poor households in our case study and the difference is significant at 1% level of significance. The average number of dependants per household in the region (3.26) is higher than the country average of 2.57. The region is the third largest next to Oromia and Ethiopian Somali in terms of fertility (CSA and ORC macro, 2006) which potentially leads to large of dependants in a family.

As predicted by economic theory, the mean land holding of non-poor households (1.223 ha) is greater than poor households (1.02 ha) which underlines the negative relationship of more land and probability of being poor. Ownership of more land encourages the use of modern inputs and practice of diversification that boosts production and reduces risk of hunger due to crop failure. Though the region has the largest potentially cultivable land of the country, average holdings per household (1.172 ha) is lower than rural Ethiopia's average of 1.77 ha (CSA & WB, 2013). This situation implies the room for increasing production in the region not only by agricultural intensification but also extensification.

The mean tropical livestock ownership of non-poor households is greater by 0.249 units than the poor households. Large number of livestock improves the household's income via sale of them and reduces vulnerability to poverty at times of crop failure. The same line of inequality between non-poor and poor households regarding number of oxen owned.

In contrary to the theory, it takes longer time for non-poor households than poor households to access market though the difference is small (4.05 minutes) and statistically different at 5% level of significance. If markets are available in the nearby area, farmers may engage in selling their agricultural productions at lower prices in time of harvest to finance other food and non-food items. This in turn will leave the household to struggle the rest of the season with meager production or purchase of food items initially sold at higher prices. Such practices may not be frequent if markets are located in distant areas.

The mean consumption expenditure per adult of non-poor households is more than three and half folds compared to non-poor households and the difference between the two mean expenditures is statistically significant at 1%.

Table 5: Sample Characteristics of Households (continuous variables)

Variable	Non-poor Households (N=9,550)		Poor Households (N=3,218)		Mean difference	t-value	Total Sample (N=12,768)	
	Mean	Standard Deviation	Mean	Standard Deviation			Mean	Standard Deviation
Age	43.91	13.151	42.591	12.030	1.319	5.02***	43.577	12.890
Total Dependants	3.057	1.925	3.920	1.916	-0.863	-22.01***	3.275	1.959
Educational Level	2.851	3.827	2.280	3.072	0.571	7.67***	2.707	3.660
land holding in Ha	1.223	1.070	1.020	0.984	0.203	9.51***	1.172	1.053
Number of Oxen	0.738	0.977	0.697	0.932	0.041	2.06**	0.728	0.966
Minutes to get market	60.590	99.424	56.538	78.216	4.052	2.1**	59.569	94.542
Tropical Livestock Units (TLU)	3.113	3.959	2.864	3.729	0.249	3.13***	3.05	3.903
Consumption Expenditure per Adult equivalent (ETB)	7,083.888	6,306.444	1,935.361	590.676	5,148.527	46.24***	5,786.272	5,901.86

Source: Own calculation from SNNPR BoFED survey, 2015 ****,** and* significant at 1%, 5% and 10% respectively*

3.5.2 Descriptive statistics for discrete variables

From the total sample households, 17.64% of them are headed by females where as the significant portions of the sample (82.36%) have male heads. Though the numbers of female heads are small, more than half of the poor households (50.25) are those headed by females. In terms of marital status, only 4.5% of the respondents are single heads and relatively they contribute a similar percentage of pool of poor households. The sample households witnessed low participation on off-farm income activity (21.51%). Moreover, 42.36% of the total poor are those who participate on off-farm income activity.

Table 6: Sample characteristics of poor and non-poor households (discrete variables)

Dummy	Category	Frequency	Percent	Number of poor households	Percentage from the total poor households
Sex	Male	10516	82.36	1601	49.75
	Female	2252	17.64	1617	50.25
Marital Status	Single	574	4.50	143	4.44
	Married, divorced, widowed	12194	95.50	3075	95.56
Participation in off-farm income activity	Participant	2746	21.51	1363	42.36
	Non-participant	10022	78.49	1855	57.64
Saving	Savers	7480	58.58	1742	54.13
	Non-savers	5288	41.42	1476	45.87
Health status	Absence of illness	4107	32.17	957	29.74
	Presence of illness	8661	67.83	2261	70.26
Extension package	Users	9792	76.69	2365	73.49
	Non-users	2976	23.31	853	26.51
Agro-climatic zone	Weinadega	7,552	59.15	1797	55.84
	Dega	1,803	14.12	450	13.99
	Kola	3,413	26.73	971	30.17

Source: SNNPR's BoFED Survey, 2015

More than half of the sample households, (58.58%) practice saving in formal financial institutions such as microfinance institutions and banks. Even though 54.13% of the poor are savers, their contribution to the total poor is lower than their part in total sample (58.58%) which signals positive role of saving on poverty reduction. In terms of health status, 67.83% of the respondents experience illness in the last three months and the positive relationship between illness and poverty is vivid since 70.26% of the poor are from those households who encountered health problems. The use of extension package in the region becomes common in recent years since 76.69% of the total respondents used to practice it. The users of extension package accounts 73.49% of the total poor. Though these households composes the majority of the poor, their contribution to the total poor (73.49%) is lower than their share from the total sample (76.69%) that entails a negative relationship between use of extension package and probability of being poor. Agro-climatically, most of the respondents are from Weinadega (59.15%) followed by Kola (26.73%) and Dega (14.12%).

3.6 Econometrics Analysis for determinants of rural poverty in the region

As depicted in Table 6, thirteen variables out of sixteen are found significant to affect the probability of being poor either positively or negatively and each of them are separately discussed as follow:

Sex of Household Head

Sex of the household head is statistically significant in determining the households' status of poverty. The result of the regression analysis shows that the coefficient is negative and statistically significant at 5 percent level of significance. Female household heads are more likely to fall into poverty by 4.6 percent than the male counterparts, citrus paribus. In most cases female headed households lack labor, social participation, access to agricultural inputs and education which accentuate poverty. Studies by McKernan and Ratcliffe (2005) and Naifeh (1998) found that female household heads are less likely to exit from poverty than male counterparts.

Total Dependency

It is found that as the number of dependent increases by one person, the probability to fall into poverty increases by 4.5 percent. This is because as the number of dependants increase, the same income will be shared among more number of families which reduces the individual's share of income and in turn consumption of both food and non-food items. This result is in conformity with Ayalneh et al (2005), Maru (2004), Getaneh (1999) and Nega (2015).

Education level of head of the household

Education was measured based on the level of grade the household head has completed. The coefficient for education of the household head is negative and significant at 1 percent level of significance. As educational level of the household head increases by one grade level, the probability of households falling into poverty reduces by 1.3 percent. In rural areas schooling enhances the understanding and utilization of modern agricultural technologies and facilitates entry into productive and profitable farm and non-farm activities, as a result of which households will be in a better position to escape poverty.

Studies by Quisumbing (2007) and Neilson et al. (2008) found that the educational attainment of the household head has a positive relationship with the probability of never being poor or more-educated households have a smaller chance of falling into poverty. Moreover, research works by Tsegaye et al (2014), Ayalneh et al (2005) and Metalign (2005) also found that the probability of being poor reduces with more levels of education in selected Ethiopian rural areas.

Table 7: Logistic and Marginal effects for analysis of determinates of rural poverty in the Region

Explanatory Variables	Coefficients (β)	Standard Error	Marginal effects (δy/δx)	Standard Error	P>I ZI
Dsex	0.274	0.071	0.046	0.011	0.0000**
Agesq	0.000	0.000	0.0001	0.000	0.0000***
Dmarstat	0.130	0.104	0.024	0.020	0.2280
Totdep	0.252	0.011	0.045	0.002	0.0000***
Dmmig	-0.358	0.066	-0.060	0.010	0.0000***
Edulevel	-0.073	0.007	-0.013	0.001	0.0000***
Land	-0.286	0.027	-0.051	0.005	0.0000***
Oxen	-0.026	0.025	-0.005	0.004	0.3050
Tlu	-0.026	0.007	-0.005	0.001	0.0000***
Dexpa	-0.636	0.056	-0.126	0.012	0.0000***
Dofffarm	-0.245	0.096	-0.041	0.015	0.0070***
Martime	-0.001	0.000	0.0002	0.000	0.0020***
Dsaving	-0.284	0.044	-0.051	0.008	0.0000***
Ddega	-0.040	0.050	-0.007	0.009	0.4230
Dwodega	-0.133	0.070	-0.023	0.012	0.0510*
Dheal	0.186	0.046	0.033	0.008	0.0000***

Number of observations	12,768	Hosmer-Lemeshow test for goodness of fit	
LR chi2(16)	993.52	Hosmer-Lemeshow chi2 (8): 14.70	
Prob > chi2	0.0000	Prob > chi2 = 0.0652	
Log likelihood Pseudo	-6629.7329	VIF test for multicolinearity	
Pseudo R2	0.0689	Mean VIF = 1.11	

**** and ** significant at 1% and 5% respectively*

Presence of out-migrant

The result of the regression analysis shows the coefficient for migration is negative and significant at 1 percent level of significance. Keeping other variables constant, the probability to fall in to poverty reduces by 6 percent for households with migrated family member than households having no migrated family member. Like that of many less developing countries' rural areas, the

migrants from the region may be initially surplus in which their marginal contribution to production is near to zero. In such a case, migration may not reduce rural production and then income. On the other hand, migrant's remittance may add to the consumption level of receipts.

Land holding by a household in Hectare

Given that the vast majority of the region's population lives in rural areas and agriculture is the dominant means of livelihood, land size is expected to play a significant role in determining the status of poverty. The result of this study shows that the coefficient for size of cultivable land the household owns is negative and statistically significant at 1 percent level of significance. An increment of land holding by one hectare reduces the probability of falling in to poverty by 5.1 percent. As land size increases, it creates an opportunity to diversify production which helps to reduce risks of crop failure, increases yield and household income. Getaneh (1999), Tsegaye et al (2014), Maru (2004) and Nega (2015) arrived at a similar impact of land holding on poverty.

Livestock Ownership in TLU

Ownership of livestock was measured in terms of tropical livestock unit (TLU). The coefficient for the ownership of livestock is negative and significant at 1 percent level of significance. The result indicates that as livestock ownership in TLU increases by one unit, the probability to fall into poverty decreases by 0.5 percent. Livestock ownership plays several roles such as source of food and income for household. Hence, it helps reduce poverty. The result is in conformity with studies by Hilina (2005), Semere (2008), Tsegaye et al (2014) and Nega (2015).

Utilization of agricultural extension packages

The result of the regression analysis shows that the coefficient is negative at 1 percent level of significance. The proper utilization of fertilizer and improved seeds as per the recommendation of extension workers reduces the probability of the household to fall in to poverty by 12.6 percent than the non users. Utilization of improved agricultural inputs increases crop productivity and in turn increased income from the same amount of land and labor use.

Participation in off-farm income activities

Keeping other variables constant, those households who participate in off-farm income activities reduces the probability of being poor by 4.1 percent than non-participants. Income from other activities will be a plus to the existing agricultural income which in turn increases consumption of the household. Moreover, this income may be used to smoothen consumption at times of agricultural crop failurities which is a frequent phenomenon in the region due to erratic nature of the rain in the country as a whole. The result is in conformity with finding by Tsegaye et al (2014).

Time to Access Market

Proximity of rural areas to the market was hypothesized to provide rural people with better access to market and thereby contribute in lowering household's chance of falling into poverty. Contrary to the expectation, the coefficient for the variable found to be negative and statistically significant at 1 percent level of significance. As time to access market increases by one minute, the probability of the household to fall into poverty reduces by 0.02 percent. Though potential explanation is given on page 13 about this finding, it may require further research since the result contradicts from prior expectations.

Saving

Results of logistic regression in this study reveals that the coefficient for saving is negative and statistically significant at 1 percent level of significance. This means, compared to non-savers, savers can reduce the probability of falling in to poverty by 5.1 percent. Lack of sufficient capital is one of the major bottlenecks that constrain the rural people from engaging in productive activities. Saving creates capital for investment and also helps to smooth out consumption in times of shock. Hence, it contributes positively to escape from poverty. The result is in conformity with the study by Metalign (2005).

Agro ecology

It is found that as compared to those households living in Kola agro ecology, those living in Weinadega can reduce the probability of falling in to poverty by 2.3 percent. The result is significant at 5%. On the other hand, there is no significant difference in terms of reducing the probability of being poor between households living in Dega and Kola since the coefficient is insignificant. High

amount of rainfall in the country's highlands (Dega) causes massive soil erosion which leads agricultural practice less rewarding. The lowland of the country (Kola) though the land is fertile, lack of rainfall and wide spread presence of fatal diseases such as malaria are main constraints to boost up agricultural production. Moreover, due to their topography both agro ecologies (Dega and Kola) have lower access of social and physical infrastructures such as schools, hospitals, roads…etc.

Health Status

The regression result indicates that the coefficient for health status is positive and statistically significant at 1 percent level of precision. The presence of ill member in the family tends to increase the probability of a household to fall into poverty by 3.3 percent. This could be due to the fact that presence of illness in the family reduces the productive time of the family and drains substantial amount of money for treatment and thus pushing the household into poverty via leaving meager income for consumption. Dercon et al (2005) got a result that death and illness of family member reduces real consumption. Moreover, Neilson et al (2008) found that a smaller chance of escaping from poverty for those heads that experience illness in a family.

Policy Implication

Through the region is successful enough to reduce aggregate poverty by 60.66% since 1995/96, most of the reduction is registered for urban households than rural households. The effort of reducing poverty in rural areas should be a priority because of not only relatively lower pace of reduction of poverty but also higher incidence of poverty in rural than urban areas.

Therefore, there should be multi-dimensional interventions by government and non-governmental organizations especially targeting the following demographic, social and economic variables that significantly determine poverty in the region.

One of the variables that significantly affect poverty is sex of the household head. The probability of falling in to poverty is higher among female households as compared to the male counterpart. This call for governmental and NGOs efforts to bias in favor of families with female household heads as far as

provision of credit and training, transfer payments, livestock, agricultural inputs and tools concerned.

The implementation of family planning will calm down the growth of population and in turn dependants (since the two variables are highly positively correlated) in short run. To this end, the implementation of the current population policy in full scale is important. The long run solution should eye on educating and providing job opportunities for women. Doing so will increase the cost of rearing children that in turn reduce the demand for them (Todaro, 2011). The government may also look on raising pension payments to reduce dependants since children in LDCs are mainly born as a safeguard at old ages. But this solution should be weigh vis-à-vis its high command on budgets and nil impact on gross domestic product.

Education creates an opportunity to get formal sector employment, healthily children…etc. But there is a debate about the level of education that should be given so that it better hits poverty. But, if we are working with more capital constraints to deliver all levels of education desired by the society, it is better to opt for primary and adult education since they maximize the net return from societal point of view (Todaro, 2011). Interventions targeting to reduce direct and indirect costs of education and increasing accessibility of this service call for determined participation of not only government but also communities and NGOs.

Increase in land holding of households significantly reduces the probability of being poor. Though there is room for extensification in the region, it is impossible to expand the amount of land one owns unlimitedly since it is fixed. The possible and feasible solution to increase agricultural production is via intensification. Intensification requires the supply and implementation of agricultural packages like fertilizer, selected seed, pesticides, insecticides and irrigation. This has to be accompanied by agricultural supporting policies like rural transport, credit, extension service, storage and marketing facilities.

The amount of livestock in TLU found significant to reduce poverty. Hence, the expansion of rural animal health centers, implementation of better management system, securing reliable water source for the livestock (Yisehak et al, 2013)

and rearing of high yielding breeds (Metalign, 2005) should catch the attention of policy makers and non-governmental organizations so that the return from the sub-sector will improve.

The expansion of microfinance institutions should be further intensified to explore those who can save. Moreover, different saving programs and awards have to be implemented to encourage more saving in addition to the great task left to aware the people about the role of savings not only for the savers but also the country as a whole. Job creation shouldn't be neglected if there is a desire to lift up savings substantially via from increased income.

No variable is more powerful to reduce poverty than the use of agricultural packages. Extension workers can add to productivity via avoiding blanket recommendations in use of modern inputs. Provision of both short and long term trainings and improving incentives for extension workers to increase their determination to work with farmers in remote areas should catch the attention of various stakeholders who work to combat poverty in the region.

Efforts should be intensified to increase accessibility and quality of hospitals, health posts, centers and pre and post natal services. The use of traditional medicine is common in the region and it in turn reduces the number of visits of formal health centers. The usage of traditional medicine should be backed by scientific researches and licenses should be given on the basis of the quality of traditional medicine vendors.

The effort of poverty reduction in the region also requires targeting in the form of agro ecologies. Those variables of interest which are highly effective in reducing poverty should favor more Dega and Kola than Weinadega since the probability of being poor is lower in the latter.

Last but not least, low improvements in poverty gap and severity in the region will be improved if the poorest of the poor are appropriately identified and included under productive safety net programs (PSNP) to get direct cash transfers.

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The Impact of Self Help Group on Household Food Security
(Case of TDA's Self Help Group)

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Abstract

This study assessed the contribution of Self Help Group (SHG) program participation of households to the food security in intervention areas of Wolaita zone. It made use of survey data of 79 non Self Help Group (SHG) and 346 Self Help Group (SHG) households. In order to measure the multi-dimensional food security index, this study used the FGT type of index and is to be 38 percent equally for both SHG and non SHG households. To identify factors affecting participation in SHG and food insecurity level of households; we used endogenous switching regression model. Thus, results from the findings showed that the likelihood of participation in SHG is about 83 percent and is significantly influenced by number of livestock in TLU and income. Results of the endogenous switching regression also showed that food insecurity is affected by sex, education and age of house head, land holding of the household, shock experienced by household and the place of residence – being living in Kindo Koyisha. Analysis of SHG contribution indicates that participation in SHG program reduces food insecurity, however, households who decides not to participate in SHG tend to have benefits above the average whether they participate or they do not, but they are better off by participating than not participating in SHG. Moreover, it is evident from the results that the impact of adaptation on food insecurity is larger for the non SHG households. Finally, it was recommended that the SHG intervention should be scaled up directing its efforts to female headed and/or young non SHG households and to the neediest areas like Offa.

Key words: Wolaita Zone, Food insecurity, SHG households, Non SHG households, FGT

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1. Introduction

Ethiopia is among the world poorest country. Considerable number of the population lives in extreme poverty. According to the government reports some 29 percent of the population still live below poverty line (MoFED, 2015). The country also suffers from frequent droughts and floods that result in significant loss of harvest and livestock. These hazards put 10 to 15 per cent of the population at risk of food insecurity or malnutrition, leaving them in need of emergency food aid (Courtenay Cabot Venton, et al., 2013).

In its development agenda, the government of Ethiopia has taken community-based organizations (CBO) as a tool to straggle poverty. The Growth and Transformation Plan's (GTP) commitment to expanding democracy and good governance, and promoting grass roots participation in the implementation and success of the Plan is premised on CBO support to enable grass roots participation and empowerment of individuals who otherwise would not have any voice (Development Assistance Group Ethiopia, 2014). Self Help Group (SHG) approach is among the CBOs that recently introduce to Ethiopia to intensify the indigenous self-help groups such as Idir and Iquib.

SHGs are mutual assistance organizations (groups of 15 to 20 people chosen from the poorest section of the community) through which individuals undertake collective action in order to improve their own lives. Collective action implies that individuals share their time, labor, money, or other assets with the group. SHGs typically involve members in group governance and leadership, and aim primarily to improve individual member welfare. Members of self-help groups receive individual benefits from participation, but groups may also produce positive social externalities (Professor Leigh Anderson, 2014).

In line with this, the Wolaita Kale - Hiwot Church - Tezepeza Development Association (WKHC-TDA) has been undertaking a SHP program taking food security as project foci in Offa and Kindo Koyisha districts from 2011 to 2014. This program was aimed at contributing towards food security and livelihood improvement of food insecure poor households in Offa and Kindo Koysha districts by the end of June 2014. At the end of the project period, WKHC-TDA has established 163 SHGs with 2,388 members in the project area. This study is

therefore focused on exploring the impact of this SHG program on food security of households in the project area.

2. Justification of the study

SHG has been emerged in Ethiopia since 2002 (Courtenay Cabot Venton , et al., 2013). It has being become popular as well as familiar to the poor in view of the varied benefits receivable from SHG services by the poor. Self Help Groups (SHGs) have turned out to be the familiar means of development process converging all development programs.

Asset accumulation of SHG members is considered to play an important role in building social capital. In situations where social capital is accumulated, SHG households diversify their income, pool resources to help those in need and initiate change in their communities. As a result, food intake is more frequent for SHG households and diets are more nutritious. These households are sending their children to school and now paying for private education and healthcare. Their asset base is growing and gives them the resilience to cope with bad times without their having to sell off assets at reduced prices (stress sales). Both women and men are being empowered to engage in issues that affect them and become drivers for change in their communities (Courtenay Cabot Venton, et al., 2013).

Considering these benefits of SHGs in food security and livelihood development of the poor, the WKHC-TDA has invested above ETB 15 million Tear Fund funded food security and livelihood development program in Offa and Kindo Koyisha districts from 2011 to 2014. Despite this big investment, though few studies focused on cost benefit analysis of Self-Help Groups have been conducted by the funding organization (Tear Fund), there has not been a single study reported which has focused exclusively on the impact of SHGs on the weaker sections of the society in the project area.

Hence, this study is to generate information and analyze to what extent these Self-Help Groups have been able to create sustainable impact on the economic lives of the weaker sections of the society mainly in terms of their food security.

Objective of the study

The general objective of the study is to look in to the impact of the Self-Help Groups on food security of the weaker sections of the society. Specifically:
To assess factors that affect the likelihood of households to be included in SHGs
To look in to factors affect the food security SHG households and Non SHG households
To compare the food security status of SHG households and Non SHG households

3. Theoretical and Conceptual framework

3.1 The Concept of SHG

There are several definitions of self-help groups. In line with this study SHG can be taken as a development model which recognizes that poverty is not only a material deprivation, but it is also continuous process of disempowerment that includes denial of choice, rights and opportunities, displacement, discrimination and oppression (Facilitator for Change Ethiopia, 2012).

The approach is constructed on two basic canons. The first is based on the principle that every single individual is gifted with marvelous potentials so that it is possible to empower the poor to realize their hidden capacities and use it even in the presence of a society that relegates people and make them believe that they are poor and valueless. The second one is even if the poor are powerless, discriminated and voiceless; they can be strong engines of growth when they bring their resources together.

The SHG system has a hierarchical structure. A total of 15-20 individuals who know each other from the same neighborhood, activity or occupation, and on a similar socio-economic level form one SHG and develop their own by-laws. Approximately 8-12 similar SHG living in close proximity establish a Cluster Level Association (CLA), which represents its members to lower levels of local government (Kebele and Woreda) and undertakes numerous other activities. A number of CLAs in a given area form a Federation Level Association (FLA) to represent membership to higher levels of local government (City, Zone, and

Region) besides playing many other roles. The concept of the SHG approach thus refers to a harmonized system.

The basis of the self-help group exists prior to any intervention. The interveners, whether from the NGO, Bank, or Government must have the experience to identify these natural groups which are commonly called "affinity groups". What links together the group members, therefore, is not primarily the need for credit, but a "social capital stock" of relationships built on mutual trust and confidence, on mutual interests of the group members, on a degree of social and economic homogeneity and on the gut feeling of its members that the group offers the best opportunity to realize their latent and often suppressed aspirations to develop economically and socially without creating social tensions locally.

Social capital is a collection of capitals inherent to social relations including trust, norms, and networks, normally associated with confidence in communal institutions, civic engagement, independent economic development and the whole community well-being and contentment. People who engaged in community development activities emphasize on the quality of social relationships and its importance to build solidarity and effective community initiatives (Phillips R. & Pittman H., 2009).

Social capital theory postulates that social capital built through the relationship of people can be used as a resource for different development initiatives among the community. Among the development initiatives that could be induced through SHG Programs is economic empowerment of the weaker section of the society in terms of their level of income, food security, health care, education, housing and the like. This process of empowerment manifests itself in increased self-esteem and decision-making at the family level.

3.2 The Concept of Food Security

Food security refers to the existence of people, at all times, that have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 2002). This definition focuses on the nutritional status of an individual and the risk that adequate status is not realized. Thus, food security is not a goal per se, but a set of conditions that needs to be fulfilled in order to contribute to adequate nutritional status that enables an active and healthy life.

Hence, an individual is taken as food secure when s/he can provide her/him with adequate amounts of acceptable food at all times in a sustainable way, without engaging in socially unacceptable activities, without sacrificing its productive assets and endangering the environment and others' human rights. Therefore, a situation of food insecurity is a basis for hunger and famine development.

The above definition of food security can be further elaborated by looking at the four dimensions of food security, i.e. food availability, food access, utilization and stability (FAO-ESA, 2006). Food availability refers to the availability of a sufficient quantity of quality food, either from domestic production or import, including food aid. In addition, individuals must have access to means for acquisition of appropriate foods. They have to be aligned with legal, political, economic and social arrangements of the community in which individuals live (this includes access to common resources and other traditional rights). The utilization dimension is related to health and non-food factors (e.g. safe and clean water, good sanitation) that are a prerequisite for achieving nutritional security. Finally, the three dimensions of food security have to be stable over time.

The food security dimensions are hierarchically interrelated (Barrett, 2010): food availability is necessary but insufficient to have food access, which is necessary but not sufficient to guarantee adequate food utilization. The same is valid in the feedback loop: adequate utilization enhances human capital that is necessary for achieving access to food. Having constant access is a prerequisite for guaranteeing sustainable food availability. Webb and Rogers (2006) stress the importance of risk as an additional dimension in the food security

framework, with the capability to disrupt and put additional pressure on any of these previously described factors.

Various proxy measures are available for measuring different aspects of food security and the choice of indicator is driven by the measurement objective. Food security indicators are divided in to process indicators that reflect both food supply and access and outcome indicators which serve as proxies for food consumption. It is important to stress that the process indicators reflect some degree of vulnerability to household food insecurity, either through availability of food supplies or access to food.

Food supply-related indicators focus on agricultural production, agro-meteorological data, access to natural resources, market infrastructure and exposure to conflicts or its consequences. Food access indicators measure household strategies and capacity for surviving difficult times of food scarcity, such as coping behaviors and agricultural risk management. There is overlap and interaction between these supply and access indicators. Direct outcome indicators are based on food frequency assessments, and household budget and food consumption surveys. Indirect indicators focus on storage estimates, subsistence potential and nutritional status.

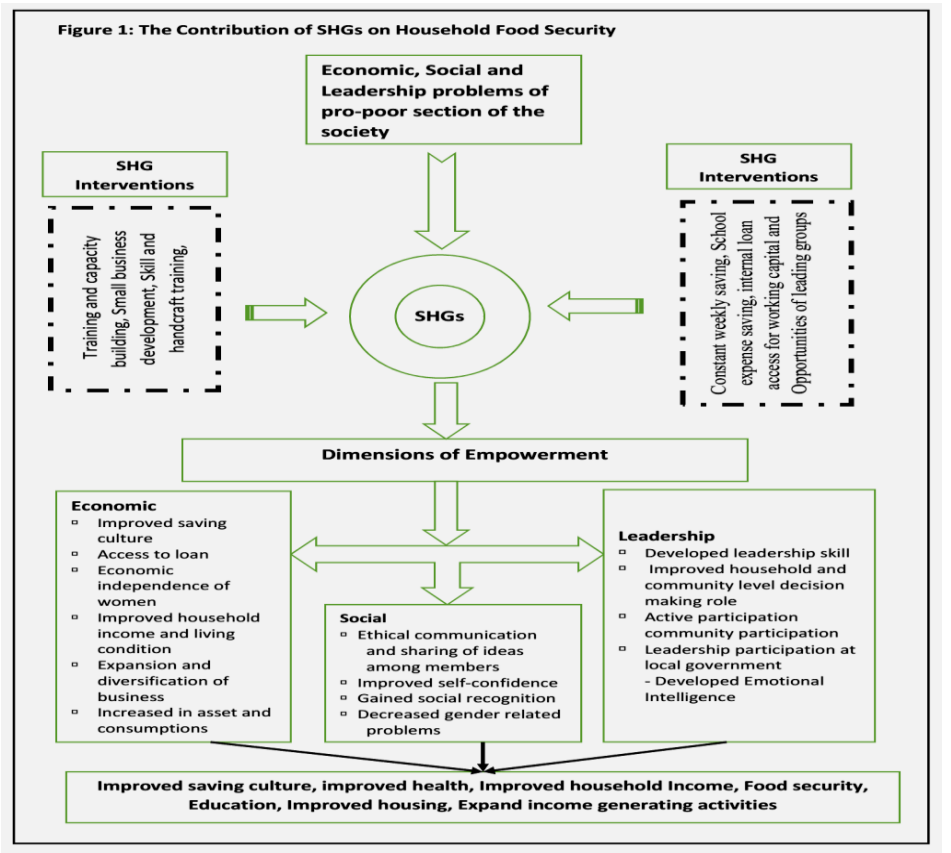
However, from the array of the above food security indicators, it can be difficult to extract a household's overall status of food security. To do so, it may be useful to construct a multidimensional index that incorporates the most important indicators from each dimension of food security. The construction of such an index can be highly subjective, particularly with regard to the weights assigned to each element of the index.

3.3 The Contribution of SHGs on Household Food Security

The wide range of literatures documents the important role of SHGs for the empowerment of the weaker section of the society. The three major contributions of SHGs in empowering poor are (i) personal empowerment like developing a sense of self and individual confidence and capacity, (ii) collective empowerment which is achieved as a result of the cooperative work with group

and (iii) empowerment in close relationships each poor family member experiences with their immediate family members (Rowlands 1998).

Figure 1: Contribution of SHG to Food Security



The contributions of SHG are interrelated with the hierarchical system of the concept and its efforts of empowerment (Figure 1). The hierarchical system of SHG contributes a lot for the empowerment of the poor in order to help them to fight with economic, social, and leadership problems in individual, family, group and community level through building strong mutual relationship among the community.

Among the most significant outcome of the SHGs empowerment is social empowerment. SHG members talk consistently about increased confidence and

skills, the ability to relate better to one another and the sense of support that they feel from one another and gain social recognition.

Consistently, SHG members experience a cycle of 'asset accumulation'. As a result of the social capital that is built at the heart of the program, SHG households are diversifying their income, pooling resources to help those in need and initiating change in their communities. As a result, food intake is more frequent for SHG households (three plus meals per day) and diets are more nutritious. These households are sending their children to school and now paying for private education and healthcare. Their asset base is growing and gives them the resilience to cope with bad times without their having to sell off assets at reduced prices ('stress sales'). Both women and men are being empowered to engage in issues that affect them and become drivers for change in their communities (Courtenay Cabot Venton, et al., 2013).

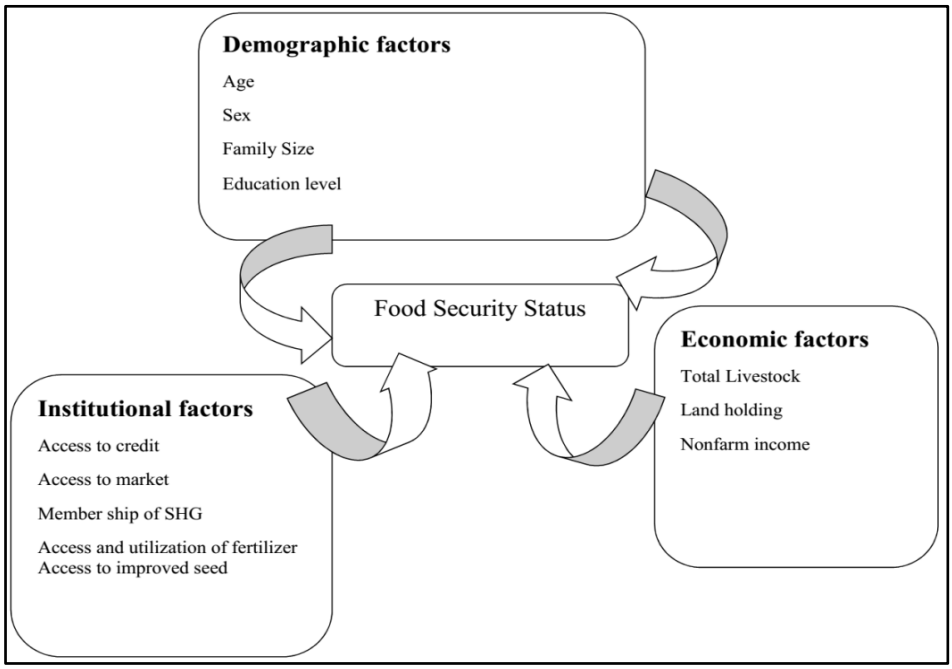
The above discussion on contribution of SHG on food security then pinpoints that SHG don't only directly impact food security but also and hugely driving force of food security. Food security of household can be affected by demographic characteristics of households, socioeconomic status of households and institutional factors available to the households. The following section outlines important factors of food security in the wide literature.

3.4 Determinants of Food Insecurity

Determinants of food security (Figure 2) are categorized into three groups within the framework of the general definition of food security mentioned above, that is, food availability, food access, and utilization. For example, food availability may be constrained by inappropriate agricultural knowledge, technology, policies, inadequate agricultural inputs, family size, etc. On the other hand, access to food and its utilization could be constrained by economic growth, lack of job opportunities, lack of credit, inadequate training, inadequate knowledge, etc. (Hoddinott, 1995). So that, these determinants could be affected by one or more causes like land holding size and fertility of the soil, education level of the household, ownership of cattle (oxen), off farm and nonfarm employment opportunities, personality traits of the household (working habit

and extravagancy), climate changes (rain fall amount), and other factors can determine and cause food insecurity.

Figure 2: Determinants of Food Security



Age of household head (AGEHHH): age is a continuous explanatory variable peculiar to the household head. As age of household increases, it is assumed that farmers could acquire more knowledge and experience. Age, as a proxy, indicates that and pre assume vulnerability and risk conditions of food insecurity is low among aged households. They are more risk averter and the chance of a household to become more food secure increases along an increase in age (Mulugeta, 2002). Thus, it will be hypothesized that age of the household heads and food security are positively correlated.

Sex of household head (SEX): It is a dummy variable taking value of 1 if the household head is male, 0 otherwise. Household head is a person who economically supports or manages the household. In most cases, male-headed household is very common in the study area. As male is directly engaged in crop and livestock production, he contributes more labour. Labor factor plays a great

role in rural areas. Hence, male-headed households are in a better position to pull labor force than the female headed ones. Moreover, with regard to farming experience, it is assumed that males are better than the female farmers. Of course it is difficult to generalize whether a household headed by female is more food insecure than a male-headed household. For instance, Clay et al. (1999) found that households headed by women are not less food secure than those headed by men. Aschalew (2006) reported that sex of the household head has statistically significant negative effect on food insecurity when a household is headed by female. Yilma Muluken (2005) is found statistically insignificant positive relationship between this variable and food insecurity when a household head is male. Contrary to this, some empirical evidences indicated that sex of the household head has significant negative effect on food insecurity when a household head is male (Del Ninno et al., 2001; Ayalneh, 2002). So since sex of the household head is an important determinant of food security, it will be hypothesized that male-headed households are less likely to be food-in secured.

Family size (FAMSIZ): Family size refers to the total number of household members who lived and eat with household head at least for six months. It is an important variable which determines the state of household food security and will be expected to have negative impacts on household food security. An increase in household size implies more mouth to be fed from the limited resources. Large family size has negative relationship with food security. (Mulugeta, 2002; Abebaw, 2003; and Ayalew, 2003). Thus, it will be hypothesized that family size has negative association with food security.

Dependency ratio (DEPRAT): Dependency ratio is obtained by dividing inactive labor force (age less than 15 and above 65) by the active labor force (age between 15 and 65) with in a household (Aschalew, 2006; Guled, 2006). A household with more inactive productive labor force compared to the active age shows a high dependency ratio and it is more likely to be food insecure and vice versa. Therefore, in this study this variable will be hypothesized that dependency ratio and food security are negatively correlated.

Livestock ownership (LIVOWN): It is a continuous variable and measured in TLU. Unlike urban dwellers, the rural households accumulate their wealth in

terms of livestock. They are prominent sources of wealth to farm households. Households with large livestock size are expected to be less vulnerable to food insecurity. Hence, this variable will be hypothesized that possession of large size of livestock (higher value of TLU) increases the likelihood of the household to be food secure (Yilma, 2005; Guled, 2006).

Annual Income (ANINC): Annual income is a continuous variable and it is the amount of total income (measured in Birr) a household has earned in the last twelve months. Income earned from sales of livestock and cash crop (such as, wheat, maize, tomato, onion, etc,). It is obvious that income earned from any source improves the food security status of the household. High-income families are less likely to be food insecure. Yilma Muluken (2005), Abebaw Shimeles (2003) and Ayalneh (2002) found that income variable has significant negative effect on food insecurity. Hence it will be expected that households who have large income, are better in their food security status. Thus it will be hypothesized that total annual income and food insecurity are negatively related.

Use of improved seed (IMRVSEED): Seed is the essential agricultural inputs, which affects production. It is a dummy variable taking value of 1, if the farmers used improved seeds and 0 otherwise. Improved seeds, particularly moisture stress resistant varieties can withstand drought and erratic rain distribution. It increases agricultural productivity by boosting overall production, which in turn contributes to attaining food security at household level. Hence, it will be hypothesized that using improved seeds have positive association with household food security (Tesfaye, 2005).

Cultivated land size: size of cultivated land has influences on food security. As stated in Adem (2006) is cultivated land owned by the household used for production of crops and livestock's that plays great role in determining food security. Hence, it will be assumed that the larger the size of the land, the less the food insecurity of the house hold. Therefore, this variable is hypothesized to affect food security status of household positively.

Off-farm income: this is income from various sources like share cropping, labor work and beekeeping. The importance of off-farm income is not only a guarantee to the sustainable food security on household level, but also to

increase the carrying capacity of the rural region to face the pressure of population growth (Tampubolon, 2009). It will be hypothesized that off-farm income is positively related with household food security.

Frequency of Extension Contact (EXCT): It measures the Frequency of monthly contact with the extension agent. It is represented by exchange visit, participation in demonstration and field day or any other consultation and advice in a month. It is obvious that agricultural extension is the most important source of information for rural household about agricultural technologies. Equivalent studies conducted by Chilot et al. (1996), and Haji (2003) found that extension contact positively affected adoption of new technologies by exposing farmers to new information and technical skills. In this study also agricultural extension contact will be expected to make positive influence on household food security.

Chemical fertilizer uses (CHEMFERT): It is dummy variable taking value 1, if the farmers use chemical fertilizers and 0 otherwise. Use of synthetic fertilizers is a mixed blessing (World Resources Institute, 1992). Fertilizer use has been perceived as improving productivity per unit of area. Households using fertilizer are expected to have better food production capacity than the non-users. Hence, it is hypothesized that the households who use chemical fertilizer are expected to be more food secure than the non-users.

Pest and disease (PD): this is one of the factors affecting production and reducing yield. Hence, it will be expected to have negative linkage with household food security. FSB (2007) indicated that among the major challenges, pests and disease, plays grate role of food security in Ethiopia.

Saving (SAV): Formal savings could provide households a mechanism for accumulating funds during good times and drawing it down quickly during bad times that is more reliable and efficient than informal options (Zeller and Sharma, 2000). In particular, formal savings should better enable households to spend income from an earlier harvest for food purchases during the lean season, when food household stocks have been depleted. Therefore this variable will expect to influence food security positively.

Access to credit (CREDRECIVED): It is dummy variable that takes value 1 if the household takes credit 0 otherwise. Credit serves as a means to boost production and expand income generating activities. Thus, a household who have access to credit does initiate investment in farm and non-farm activities and enhance sustainable food security. Thus, it is hypothesized that households who have access to credit are expected to be food secure (Aschalew, 2006).

Land rented in (LNDRENTEDIN): It is a dummy variable that takes value of 1 if the household rent in land and 0 otherwise. In most cases households rent in additional land for agricultural purposes in terms of fixed cash or sharecropping (Yared, 1999). The arrangement allows an increment in cropped land and production which in turn increases food security. Thus, it will be hypothesized that land renting in has positive correlation with household food security.

Land rented out (LNDRENTOUT): This is a dummy variable that takes value of 1 if household rent out land and 0 other wise. Land rent out is renting own land in terms of fixed cash or sharecropping for agricultural purpose (Yared, 1999). This arrangement is hypothesized to be correlated positively with the household food security.

Access to nearest market (ACCESMART): It is dummy variable that takes value of 1 if the household has market access and 0 otherwise. Closeness to market centers creates access to additional income via off-farm/non-farm employment opportunities, easy access to inputs and transportation. Thus this variable will be expected that household who has access to market has better opportunity to be food secure than the one who doesn't have access. (Tesfaye 2005; Guled, 2006) found a positive association between access to the nearest market center and household food security

Membership to self-help group (MSHG): Membership to SHG represents whether a household is member to self-help group or not. It is a dummy variable with 1 if the household head is member and 0, otherwise. Membership to self-help group increases households' access to services that might be granted by being member. In Ethiopia, cooperatives that have been promoting by bureau of cooperative commission, including traditional cooperatives such as 'equb', 'iddir' and labor sharing culture, guarantee members access to credit and labor

shares (Berhanu, 2007). it would appear that social networks that facilitate sharing of farm equipment and labor as well as membership in community groups are important assets for the poor (Warren, 2002). Therefore, this variable will be expected to positively influence HH food security.

4. Methodology

4.1 Data and Data source

This study has used both primary and secondary data from different sources. Primary data on household socioeconomic features are collected from respondent households in Offa and Kindo Koyisha Woreda. While secondary data on the program intervention and prices related data is collected from TDA and CSA respectively. Moreover, secondary data on conversion factors for Tropical livestock Unit (Source: Tilahun et al., 2004; *EHNRI, 2000), per gram energy calorie supply of different food items (Merrill and Watt, 1955 and Ethiopian Health and Nutrition Research Institute, (2000), conversion factors for adult equivalent (World Bank, 1986) and weights for multidimensional food security index (WFP, 2013).

Sampling technique

A two-stage sampling technique was used to select the sample. At the first stage, a sample of 10 kebeles will be randomly selected from Offa and Kindo Koyisha Woreda, the project intervention areas. At the second stage, sample households are going to be selected using systematic random sampling. A sample of 425 households (79 from non SHG and 346 from SHG) will be drawn from the selected kebeles in proportion to the population size in each kebele.

4.2 Measurement of food security

In order to establish the impacts of a particular intervention on food security, a good measure of food security that captures all the three dimensions – food availability, accessibility and utilization - is obviously needed (Staatz, J. M., et al., 2009). However, in the empirical world finding such measures of food security is difficult and for lack of an obvious measure that encompasses all these aspects, using food security measures capturing at most one dimension of the 3 dimensions is common. But such measures rather capture the

consequences of being food insecure, but not necessarily food security status per se.

An alternative measure is then to use an aggregate measure to obtain a combined measure of the 3 dimensions. To do so, it may be useful to construct a multidimensional index that incorporates the most important indicators from each dimension of food security. However, the construction of such an index can be highly subjective, particularly with regard to the weights assigned to each element of the index. For this study then we applied the multidimensional index approach of measuring food security following Christiaensen and Boisvert (Christiaensen & Boisvert, 2000).

Assume there be m dimensions to food security with X_{ij} the value of the dimension j for person i and Z_j the minimal requirement for dimension j. A person i is then deprived with respect to dimension j if X_{ij} is less than or equal to the threshold Z_j. The level of deprivation associated with each dimension j is:

$$P_j(X_{ij}/Z_j) = \left(1 - \frac{X_{ij}}{Z_j}\right)^{\alpha_j} \text{ for } 0 \leq X_{ij} \leq Z_j \text{ with } \alpha_j \geq 1$$
$$= 0 \text{ for } X_{ij} \geq Z_j$$

Where $P_j(X_{ij}/Z_j)$ is a continuous non increasing convex function of X_{ij}/Z_j with P_j: $(0,\infty) \rightarrow [0,1]$ and $P_j(X_{ij}/Z_j) = 1$ if $X_{ij} = 0$ and $P_j(X_{ij}/Z_j) = 0$ if $X_{ij} \geq Z_j$. If $X_{ij} = 0$, $P_j = 1$; deprivation is at its maximum i.e. nothing to eat now or certain of not enough to eat in the future. At the other extreme, $P_j = 1$ if $X_{ij} \geq Z_j$, a person is not deprived. Thus, a person's food insecurity is not affected by being overfed.
The continuity of P_j ensures that small changes (or measurement errors) in dimension j ca not lead to large changes in deprivation status regarding j. Convexity of P_j also implies that deprivation decreases at a non-increasing rate if a person's attribute j increases. In other words, a person is considered to be deprived for a particular dimension, the larger its relative shortfall. In normalizing by thresholds, deprivation is scale invariant. Since only relative distance of an attribute from its threshold matters, food insecurity can then be measured as:

$$fis_i = \sum_j a_j P_j\left(X_{ij}/Z_j\right)$$

Where $a_j > 0$ and $\Sigma\, a_j = 1$ is the weight or value attached to the shortfall with regard to dimension j.

The index properties differ depending on α. For this particular study we adopt, with some modifications on the indicators and food insecurity line of each component of multidimensional food security, food security weights shortfall weights of WFB developed by Statistics Division Food and Agriculture Organization of the United Nations computed for 169 countries based on the Suite of Indicators presented in the State of Food Insecurity 2013 Report (see Table 1).

To avoid double counting and to meet the transfer axioms, we ignore α=0. For α=1 the food insecurity index becomes head count ratio for those deprived with respect to attribute j and for α=2, food insecurity index becomes the squared coefficient of variation for dimension j which measures the inequality of attribute j among those j deprived.

As in the case of multidimensional poverty index, this measure of individual food insecurity can also be aggregated across n individuals in to a food insecurity index of the population as:

$$FIS_i = \frac{1}{n}\sum_i \sum_j a_j P_j\left(X_{ij}/Z_j\right)$$

Where FIS = 1, everyone has maximal food insecurity, FIS = 0 every one is food secure.

4.3 Food security impact of SHGs

It was evidenced from our literature review above that SHG contributes a lot for the empowerment of the pro poor to help them fight with economic, social, and leadership problems in individual, family, group and community. This empowerment in turn creates improvements in the food security of the poor. When attempting to evaluate the benefit from participating in SHGs, a possible

model then would be endogenous switching regression model for participation in SHGs and its outcome, household food security status.

Consider the following model, which describes behavior of a household with two continuous (food security status) regression equations and a criterion function that determines its regime, participation in SHGs.

Regime 1: $Y_{1i} = \beta_1 X_{1i} + \varepsilon_{1i}$ if $I_i = 1$ ……. **(1)**

Regime 2: $Y_{2i} = \beta_2 X_{2i} + \varepsilon_{2i}$ if $I_i = 0$ ……. **(2)**

$I_i = 1$ if $\gamma Z_i + u_i > 0$

$I_i = 0$ if $\gamma Z_i + u_i \leq 0$

Where Y_{ji} are continuous dependent variables, household food security index in this case; X_{1i} and X_{2i} are vectors of exogenous variables; I_i is selection equation and is 1 if the household participates in SHG and 0 if do not participate; Z_i represents a vector of independent variables in the selection equation; u_i, ε_{1i} and ε_{2i} are error terms; and β_1, β_2, and γ are vectors of parameters.

Now assume that u_i, ε_{1i} and ε_{2i} have a trivariate normal distribution with mean vector zero and covariance matrix Ω given by:

$$\Omega = \begin{bmatrix} \sigma_\mu^2 & \sigma_{1\mu} & \sigma_{2\mu} \\ \sigma_{1\mu} & \sigma_1^2 & . \\ \sigma_{2\mu} & . & \sigma_2^2 \end{bmatrix}$$

Where σ_u^2 is a variance of the error term in the selection equation, and σ_1^2 and σ_2^2 are variances of the error terms in the continuous equations. σ_{1u} is a covariance of u_i and ε_{1i}, and σ_{2u} is a covariance of u_i and ε_{2i}. The covariance between ε_{1i} and ε_{2i} is not defined, as Y_{1i} and Y_{2i} are never observed simultaneously. We can assume that $\sigma_u^2 = 1$ (γ is estimable only up to a scalar factor). The model is identified by construction through nonlinearities. Given the assumption with respect to the distribution of the disturbance terms, the logarithmic likelihood function for the system of (1–2) is:

$$\ln L = \sum_i \left(I_i w_i \left[\ln\{F(\eta_{1i})\} + \ln\left\{\frac{f\left(\frac{\varepsilon_{1i}}{\sigma_1}\right)}{\sigma_1}\right\} \right] + (1 - I_i w_i) \left[\ln\{1 - F(\eta_{2i})\} + \ln\left\{\frac{f\left(\frac{\varepsilon_{2i}}{\sigma_2}\right)}{\sigma_2}\right\} \right] \right)$$

Where F is a cumulative normal distribution function, f is a normal density distribution function, w_i is an optional weight for observation i, and

$$\eta_{ij} = \frac{\gamma Z_i + \frac{\rho_j \varepsilon_{ij}}{\sigma_j}}{\sqrt{1-\sigma_j^2}} \; j = 1.2$$

Where $\rho_1 = \sigma_{1\mu}^2/\sigma_u\sigma_1$ is the correlation coefficient between ε_{1i} and u_i and $\rho_2 = \sigma_{2\mu}^2/\sigma_u\sigma_2$ is the correlation coefficient between ε_{2i} and u_i. To make sure that estimated ρ_1 and ρ_2 are bounded between −1 and 1 and that estimated σ_1 and σ_2 are always positive, the maximum likelihood directly estimates $\ln\sigma_1$, $\ln\sigma_2$, and atanh ρ:

$$\text{Atanh } \rho_j = \frac{1}{2}\ln\left(\frac{1+\sigma_j}{1-\sigma_j}\right)$$

After estimating the model's parameters, the following conditional and unconditional expectations could be calculated:

Unconditional

$E(Y_{1i}|X_{1i}) = X_{1i}\beta_1$

$E(Y_{2i}|X_{2i}) = X_{2i}\beta_2$

Conditional

$E(Y_{1i}|I_i = 1, X_{1i}) = X_{1i}\beta_1 + \sigma_1\rho_1 f(\gamma Z_i)/F(\gamma Z_i)$

$E(Y_{1i}|I_i = 0, X_{1i}) = X_{1i}\beta_1 - \sigma_1\rho_1 f(\gamma Z_i)/\{1 - F(\gamma Z_i)\}$

$E(Y_{2i}|I_i = 1, X_{2i}) = X_{2i}\beta_2 + \sigma_2\rho_2 f(\gamma Z_i)/F(\gamma Z_i)$

$E(Y_{2i}|I_i = 0, X_{2i}) = X_{2i}\beta_2 - \sigma_2\rho_2 f(\gamma Z_i)/\{1 - F(\gamma Z_i)\}$

Of course, Y_{1i} and Y_{2i} cannot both be observed for any single household. This is unfortunate, as the difference between the two is exactly what we wish to discover, that is, we are interested in (a) the difference between the food security index of the SHG participating household compared with their expected food security index without being participated in SHG, and (b) the difference between non participants' food security index and their expected food security index had they participated in SHG. Algebraically, these are:

$Y_{1i} - E(Y_{2i}|I_i = 1)$ the benefit to each SHG participant

$Y_{2i} - E(Y_{1i}|I_i = 0)$ the benefit forgone by non- SHG participant

This can be summarized in the table below as follows:

Sub – Sample	**Decision to Participate**		**Treatment Effects**
	Participate	**Not participate**	
Households that Participated (SHG)	**a**	**c**	TT
Households that did not Participate (Non-SHG)	**d**	**b**	TU
Heterogeneity effects	**BH1**	**BH2**	TH

Observed expected production quantities

$E(Y_{1i}|I_i = 1, X_{1i}) = a$

$E(Y_{2i}|I_i = 0, X_{2i}) = b$

Counterfactual expected production quantities

$E(Y_{1i}|I_i = 0, X_{1i}) = d$

$E(Y_{2i}|I_i = 1, X_{2i}) = c$

Ii = 1 if households participated in SHG; I*i* = 0 if households did not participate; *Y1i*: Food insecurity if the household participated in SHG; *Y2i*: Food insecurity if the household did not participate in SHG;

TT: the effect of the treatment (i.e., Participation) on the treated (i.e., SHG households): the benefit to each SHG participant

TU: the effect of the treatment (i.e., Participation) on the untreated (i.e., Non – SHG households): -1* (the benefit forgone by non- SHG participant)

$TT = Y_{1i} - E(Y_{2i}|I_i = 1)$ - the benefit to each SHG participant where Y_{1i}can be estimated by $E(Y_{1i}|I_i = 1, X_{1i})$

$TU = Y_{2i} - E(Y_{1i}|I_i = 0)$ - the benefit forgone by non- SHG participant where Y_{2i} can be estimated by $E(Y_{2i}|I_i = 0, X_{2i})$

BH1= a – d: the effect of base heterogeneity (like difference in skill) for households that participated

BH2= c – b: the effect of base heterogeneity (like difference in skill) for households that did not participate

TH = (TT - TU), i.e., transitional heterogeneity: to whom is the effect of the participation larger, to SHG or Non - SHG

No in bracket is SD.

5. Results and Discussions

5.1 Descriptive Analysis

In an agrarian economy, food security of households is highly dependent on demographic characteristics of households, resource endowments and their access to the resources, empowerment services available from government, NGO and the community itself, infrastructure and natural and human made shocks among others. Hence, variations in such attributes may highly affect the food security level of households and this section characterizes households using the attributes listed above.

Demographic Characteristics

It is evidenced from different studies that sex of headship is an important factor in food security status of households. Table 1 shows that majority of the surveyed households are headed by male heads (93.6%) but with no significance difference in the proportion of female house heads in both groups. Majority of the non-SHG and SHG households are married (88.61% and 94.80% respectively) but with significantly higher (P – value = 0.042) proportion of unmarried (11.39%) house heads in the non-SHG households compared to SHG households (5.20%). Moreover, SHG households are found to be more literate (58.09%) with slightly higher average year of schooling (see Table 2) compared to the non-SHG counterparts though these differences are not significant (with P-values0.316 and 0.9451 respectively). Moreover, no significant difference of shock experience is observed between SHG and non SHG households though proportion of households who face shock is high in general (64.00%).

Another important factor known to affect food security of households is household size and member composition of households. Household size of SHG households is significantly higher (7.73) compared to the non-SHG households (6.61). Though the different in the number of preschool children of SHG participating households and non-participating households is insignificant (P-value=0.5759), higher number of preteen and teen children are observed in SHG households (1.35 and 2.08 respectively) compared to that of non-SHG households (0.87 and 1.49 respectively). In both SHG and non –SHG households an economically active person lives for an average 1.43 economically dependent member.

Table 1: Qualitative Characteristics of SHG and Non SHG Respondents

Variable		Non - SHG		SHG		X^2 – test Difference
		Count	%	Count	%	P – Value
House Head sex	Female	2	2.53	7	2.02	0.777
	Male	77	97.47	328	94.80	
House Head Marital Status	Unmarried	9	11.39	18	5.20	0.042*
	Married	70	88.61	339	97.98	
House Head illiteracy	Illiterate	38	48.10	145	41.91	0.316
	Literate	41	51.90	201	58.09	
HH Shock Experience	No	31	39.24	122	35.26	0.506
	Yes	48	60.76	224	64.74	
HH house access to clean water	No	20	25.32	100	28.99	0.514
	Yes	59	74.68	245	71.01	
HH house access to Improve Sanitation	No	32	40.51	150	43.48	0.630
	Yes	47	59.49	195	56.52	
Land Fertility (Highly fertile=Yes else No)	No	53	88.33	229	74.35	0.019*
	Yes	7	11.67	79	25.65	
Alternative water source at land (Yes or No)	No	41	68.33	230	74.68	0.308
	Yes	19	31.67	78	25.32	
Total		79	18.59	346	81.41	

*Significant at 5% significant level; **Significant at 10% significant level

Income

The government of Ethiopian has launched series of developments plans to combat poverty and address food security issues during the last two decades. The theme of recent development plans with regard to food has been focused not only on the growth of income of rural households from agriculture but also on the diversification of income (off farm income) (GTP I, 2010). Official reports of government shows that non-farm income sources in rural SNNP contribute about 33% to the total rural income. Out which 9% comes from non-agricultural economic enterprise, 3% from wages and salaries, 3% from remittance and 18% from others (CSA, 2011).

Evidences from Table 2 shows that SHG households drive a little bit higher income from non-farm activities (11, 751.24 Birr per annum) compared to non – SHG households (10, 906.975 Birr per annum) though this difference is statistically insignificant (P-Value=0.8795). SHG households also drives an average of 156.36 Birr per annum of their off-farm income from their members who migrated for work, a bit lower than non-SHG gains (163.79 Birr per annum) but with insignificant difference. Moreover, non-SHG households are found to have average relatively better annual total income and farm income (2, 418, 307 Birr and 2,405,353 Birr respectively) compared to SHG households (2, 392, 797 Birr and 2, 407, 885 Birr respectively) but with higher variability (with SD=10800000 in each case) that draw this difference to be insignificant (with P-values 0.9924 and 0.9924 respectively).

Consumption and Housing Condition

In multidimensional food security analysis, only calorie consumption could not be best proxy for food security. One of the important components that need to be considered while dealing with multidimensional food security analysis is then access to improve service that enable households to consume what they have. Among the elements in access dimension, housing condition with respect to access to clean water and sanitation is important in rural households.

Access to clean water and sanitation is limited for both SHG (40.51% and 43.48% respectively) and non SHG households (25.32% and 28.99% respectively) but with insignificant difference in clean water and sanitation access comparing both groups (with respective p-Value of 0.514 and 0.630). Despite this insignificant difference in access to clean water and sanitation, considerable variations in number of rooms is observed between both groups. SHG households possess significantly (P-value=0.0011) higher number of rooms (3.07) compared to the non-SHG households (2.56). As a result higher number of non-SHG household members (3.34) are living in a room compared to SHG counterparts (2.78).

With regard to daily household calorie intake, SHG households consume higher amount of calorie (158,257 Kcal) per day per household compared to the non – SHG households (78,365.27 Kcal). This pattern is also true when we split calorie intake by source that SHG households consume more calorie from

protein, fat, carbohydrate and from stable foods, carbohydrates and roots (see Table 2). Even the calorie consumption from carbohydrates significantly higher (P- value=0.0982) compared to non-SHG households (almost twice). However, non-SHG households consume a bit higher calorie from protein of animal origin though insignificant.

When we look at the monetary value of household, consumption expenditure on food of SHG households is above double compared to that of non – SHG households and is significant (see Table 2). Same pattern also follows to expense on consumables and total consumption expenditure but with great variability within group.

Table 2: Quantitative Characteristics of SHG and Non SHG Respondents

Variable	Non - SHG		SHG		t – test of mean difference
	Mean	SD	Mean	SD	P – Value
HH Demography					
No of preschool children (< 5 years)	1.91	3.43	1.68	3.25	0.5759
No of preteen children (6 to 9 years)	0.87	1.5	1.35	2.07	0.0528**
No of teen children (10 to 14 years)	1.49	1.93	2.08	2.80	0.0773**
HH size (Man equivalent)	6.61	4.85	7.73	5.02	0.0720**
Dependency ratio	1.41	1.07	1.45	0.99	0.7507
House head year of schooling	4.15	5.48	4.19	4.71	0.9451
Annual HH Income (Birr)⊕					
Income from migrated member	163.79	636.33	156.36	710.73	0.9319
Off farm income	10062.71	40882.47	11751.24	96895.49	0.8795
Farm Income	2405353	9290944	2392797	10800000	0.9924
Total HH income	2418307	9288634	2407885	10800000	0.9937
Housing Condition					
No of rooms of HH	2.56	1.57	3.07	1.12	0.0011*
No of rooms per member	3.34	3.28	2.78	1.96	0.0500**
HH Daily Calorie Intake (Kcal)⊕					
Total Calorie intake	78365.27	124036	158257.00	437816	0.1090
Calorie intake from Protein	15906.61	24578.3	32008.23	90791.31	0.1190
Calorie intake from Protein of Animal origin	1556.47	4111.54	1492.05	2318.91	0.8505
Calorie intake from Fat	45421.28	69505.54	90965.69	244103.6	0.1014

Variable	Non - SHG		SHG		t – test of mean difference
	Mean	SD	Mean	SD	P – Value
Calorie intake from Carbohydrate	20837.07	32901.28	42341.15	114146.5	0.0982**
Calorie intake from Cereals & Roots	71919.11	122676.3	143391.9	415712.5	0.1313
HH Annual Expenditure (Birr)					
Total Food consumption	1991.413	283.0015	4236.125	610.6734	0.0813**
Total expense on Consumables⊕	848.1989	1289.291	1723.744	5218.244	0.1397
Total Consumption	5329.476	8992.334	6935.26	10897.03	0.2238
Land Holding					
Land size	6.81	38.57	3.15	12.33	0.1779
Distance to land (Hrs.)	4.74	9.56	3.71	7.2	0.3385
Asset Holding					
No of Livestock (TLU)	3.50	4.37	5.17	4.46	0.0028*
Value of HH farm Equipment⊕	545.44	2857.35	873.38	4217.29	0.5114
Value of other HH Assets	**2612.74**	5329.58	2646.07	5732.96	0.9624
Value of total Asset	**7397.46**	8732.46	11794.54	13776.25	0.0069*
HH food security					
Average minimum calorie requirement shortfall (Kcal/day/person)	**-2141.913**	**516.2904**	-1462.045	6081.312	0.3218
Level of food Insecurity (%)	0.3792	0.07	0.3778	0.06	0.8594

*Significant at 5% significant level; **Significant at 10% significant level

⊕With Higher Variability within group

Land ownership and land Characteristics

The land area cultivated by farmers is very important as it determines to a large extent the quantity of harvest that contributes a lot to food sufficiency. Hence, Land, especially in rural areas of developing countries, is the primary and loyal means of living. Based on the survey data shown in Table 2, majority of households (86.59%) possess an average 3.75 *Timad* of land and slightly insignificant difference in land holding of SHG (3.15 *Timad*) and non SHG households (6.81) is observed. Another important aspect of land use in rural households is distance of land from residence. On average non-SHG household (4.74 Hrs) travel slightly more to reach their farm land compared to SHG households (3.71 Hrs) but with insignificant difference.

A glance at the land characteristics showed (Table 1) that number of households with highly fertile land of SHG group are significantly (P-value=0.019) higher (25.65%) than the number of households with highly fertile land in non-SHG group (11.67%). It can also be recognized from Table 1 that 25.32% of SHG and 31.67%) of non-SHG possess alternative water source at their land.

Asset Holdings

In many developing countries assets like livestock and farm equipment constitute important component of crop farming. Livestock in Wolaita zone like any other zones of Ethiopia are also sources of traction, food (like meat and dairy products), cash (through sale of live animals) and transportation. It also plays an important role in expressing the wealth position of the farmer, hence, taken as an important source of resistance to shocks.

According to Table 2, the average number of livestock in TLU (Tropical Livestock Unit) per sampled household was found to be nearly 4.9. Comparison of the livestock ownership between SGH and non – SHG households in Table 2 also shows that SHG households' livestock holdings is about 14.77 higher than that of livestock holdings of non SHG households and this difference is significant (P-Value = 0.0028) . Moreover, huge gap in the cattle holdings of partial Package and Full Package is revealed in Table 6 followed by draught animal and poultry holdings.

Though the difference in the value of farm equipment of SHG and non-SHG households is insignificant due to higher variability (SD=2857.35 and SD=4217.29 respectively), SHG households own 6378.34 Birr higher valued assets compared to non – SHG households (see Table 2).

Level of Food Security Insecurity

Considering significance differences in qualitative (in house head marital status and land fertility) and quantitative features (in no of preteen and teen children, household size, no of rooms of household, no of rooms per member, calorie intake from Carbohydrate, total food consumption, no of livestock and value of total asset), undertaking a carful and critical comparison of food insecurity level is important to suggest impact of interventions targeted on food security as such differences can or cannot be due to the intervention. Cognizant of this, Table 2 showed that the average minimum calorie requirement shortfall (Kcal/day/person) of non –SHG households is higher (-2141.913) than their SHG counterparts (-1,462.045) though insignificant. As a result the food insecurity level is almost equal to SHG and non-SHG households (about 38%). This could signify that the SHG intervention at its infant stage to impact level of food security but its components. However, this should be supported by inferential analysis.

5.2 Empirical Results of Estimation

5.2.1 Determinants of food security and Participation in SHG

Table 3 depicts results of the endogenous switching regression model. The first column presents the estimated coefficients of selection equation on being participated in SHG and the second and the third columns present, respectively, the estimated coefficients of the food insecurity function for households that did and did not participate in SHG program.

The results of the estimation of selection/participation equation showed that probability of participation is about 83.53% and suggest information about future participation of households in SHG. Number of livestock in TLU and farm and total income significantly affect the likelihood that households to participate in SHG (Table 3, column (1)). This shows that households could tend to participate in SHG as their livestock holding rises in the near future but will tend to stay aside if their total income raises. However, improvements in farm income will still encourage farmers to join SHG.

The estimates presented in the last two columns of Table 3 accounts for the endogenous switching in the food insecurity function. Both the estimated coefficients of the correlation terms ρ_j are significantly different from zero (Table 3, bottom row). Although we could not have known it a priori, this implies that the hypothesis of absence of sample selectivity bias may not be rejected

However, the differences in the food insecurity equation coefficients between the SHG that and non SHG households illustrate the presence of heterogeneity in the sample (Table 3, columns (2) and (3)). The food insecurity function of SHG households is significantly different (at the 5 percent level) from the food insecurity function of the non SHG household.

The food insecurity function of both SHG and non SHG households are significantly affected by sex, education and age of house head, land holding of the household, shock experienced by household and the place of residence – being living in Kindo Koyisha. The fact that education of the house head (being literate) is negatively and significantly related to food insecurity of SHG and non-SHG households are consistent with the economic predictions that education improves the productive capacity of households and lets them to improve their food security in terms of food availability and utilization. If households face shocks, it made them to prepare themselves to undertake some coping mechanisms like participation in SHG and reduce risk of food insecurity. It may be due to this that both SHG and non SHG household's food insecurity status significantly declines compared to the SHG and non SHG households that do not face shocks at all. Another important significant variable that needs attention is the Woreda dummy. Compared to the Offa residences, households living in Kindo Koyisha are found to be less food insecure. This dictates that food security interventions like SHG may need to have priority to Offa residences in expansion of the intervention compared to Kindo Koyisha.

For SHG households, the size of land possessed significantly and positively affects food insecurity level but negatively and significantly related to the food insecurity level of non SHG households. This indicates that SHG households did fail to use their land efficiently as their land size raises compared to the non SHG households. Moreover, sex of house head was found to negatively and significantly affect food insecurity level of SHG households but positively and significantly influence food insecurity level of non SHG households. This implies that female headed households of SHG households are more advantaged in relation food security compared to then on SHG female headed households. This may shade light to the thinking that SHG intervention should give emphasis to include non SHG female headed households. The household experience as proxied by house head age have also diversified effect on the food insecurity level of households. As SHG house head get older and older their food insecurity significantly raises whereas as the age of non SHG house heads increases, their food insecurity level declines. From this may claim that SHG

intervention should give prior attention to young people when it try to include new participants to SHG.

Table 3: Results of Maximum Likelihood Estimation

Dependent Variable	Endogenous Switching Regression		
	SHG participation (1 or 0)	HHs that Participated (SHG=1)	HHs that did not Participate (SHG=0)
		Level of Food Insecurity	Level of Food Insecurity
Sex of house head (Male =1)	-0.0511479 (0.5948713)	-0.0377783 (0.0188617)*	0.1677671 (0.0463029) *
Age of house head	0.0142232 (0.0095921)	0.0006273 (0.0002418)*	-0.0016536* (0.0009761)
House head literate (literate=1)	0.1485521 (0.2341931)	-0.0098564** (0.0066915)	-0.0396338** (0.0205604)
Livestock (TLU)	0.0549874 (0.0303024)**	0.0012157 (0.000836)	0.0017607 (0.0028161)
Land holding (*Timad*)	-0.0022375 (0.0041385)	0.000785* (0.0002433)	-0.0003775** (0.0002017)
total value of Asset	0.0000147 (0.0000125)	-1.72E-07 (2.66e-07)	1.00E-06 (1.22e-06)
No of preschool child	-0.0247822 (0.0233135)	0.0008155 (0.0009273)	-0.0026407 (0.0021812)
HH size (man equivalent)	0.0087112 (0.0217686)	0.0020332 (.0006416)	0.0008873 (0.0018312)
Total income from migrant member	-0.0002103 (0.0001828)	1.44E-06 (4.82e-06)	0.0000115 (0.000014)
Farm income	0.000072* (7.49e-05)	-2.54E-07 (1.05e-09)	8.35E-08 (2.40e-07)
Total Income	-0.00027* (9.49e-06)	2.54E-07 (1.65e-07)	-8.38E-08 (2.41e-07)
No of rooms	0.1159192 (0.0754466)	-0.0065651* (0.0028384)	-0.0006009 (0.0061035)
Shock (Experience=1)	-0.3052866 (0.2341918)	-0.0473532* (0.0067687)	-0.0316935** (0.0167173)
Woreda (Kindo Koysha is reference)	-0.0346985 (.2076354)	-0.0263401* (0.0070477)	-0.0275752* (0.0158115)
Loan received from SHG	0.6041087 (144913.5)		
Land fertility (high fertile=1)	0.4320798 (0.276673)		
Constant	0.0867033 (2.418451)	0.7072953* (0.0812825)	0.6238601* (0.1904406)
δ_i (Sigma)		0.0534778 (0.00237)*	0.0511244 (0.0055541)*
ρ_i (rho)		0.4656218 (0.18316)*	0.0925893 (0.9283274)*
Log likelihood Ratio Test (LR – test):		**X^2 = 4.42Prob > chi^2 = 0.0354**	

*Significant at 5% significant level; **Significant at 10% significant level

Number of rooms that possessed by households may have income implications through rent especially in the rural towns beyond to utilization implications to food security. However, number of rooms that household possessed seem to negatively and significantly affect the food insecurity of the SHG households only. This may imply that SHG interventions may consider income implications of number of rooms of SHG households to help them improve their food security level.

5.2.2 Conditional Expectations, Treatment and Heterogeneity Effects

The aforementioned endogenous switching regression model can be used to compare the expected food insecurity of households that participated in SHG with respect to the households that did not participate, and to investigate the expected food insecurity in the counterfactual hypothetical cases that the SHG households had not they been participated, and in the counterfactual hypothetical cases that the non-SHG households had they been participated. The conditional expectations for food insecurity in the four cases are presented in Table 4.

Table 4: Conditional Expectation, treatment and Heterogeneity effects

Sub – Sample	Decision to Participate $P(I_i = 1/Z_i)=0.8352762$ (0.1834953)		Treatment Effects
	Participate	Not participate	
Households that Participated (SHG)	0.3743029^{a}	0.3825533^{c}	-0.0082504^{TT}
Households that did not Participate (Non - SHG)	0.3423868^{d}	0.363653^{b}	-0.0212662^{TU}
Heterogeneity effects	0.0314349^{BH1}	0.0189003^{BH2}	0.0130158^{TH}

The expected food insecurity of SHG households is about 0.374, while it is about 0.364 for non SHG households. This simple comparison, however, can be misleading and drive to conclude that on average the non SHG households about 0.01 more food insecure than the non SHG households.

The last column of Table 4 presents the treatment effects of participation in SHG on food insecurity. In the counterfactual case (c), farmers who actually

participated would have about0.8%more food insecurity level than if they did not participate. In the counterfactual case (d) that non SHG households, they would have score about 2.13% less food insecurity level than if they did not participate in SHG. These results imply that participation in SHG reduce food insecurity, however, ever the magnitude of the impact is so small but in the right direction. This can conclude that though SHG intervention so infant to measure its impact, there exist expected (food security improvement) signs of intervention impact.

The effect of base heterogeneity (BH_1 and BH_2) for households that participated is about 3.1% while for households that did not participate is 1.9% (Last row of Table 4). Such differential in food insecurity level may be due to base differences in households of the two groups (SHG and non-SHG households) like difference in skill that do not cause as a result of the intervention. This implies that farmers who decided not to participate in SHG tend to have benefits above the average whether they participate or they do not, but they are better off participating than not participating in SHG. This implies appropriateness of the intervention inclusion criteria used yet. Moreover, the positive transitional homogeneity (TT-TU) effect tells us that the effect of SHG intervention on food insecurity reduction of non SHG households is larger (1.3% higher) than that of SHG households. This result recommends expansion of the program to non SHG so us the intervention able to achieve its food security improvement target through increased effect of the program on non SHG.

6. Conclusions and Recommendations

6.1 Conclusions

This study tried to examine the contribution of SHG project intervention of Terepeza Development Association (TDA) on the food security status of its intervention areas (Kindo Koyisha and Offa Woredas of Wolaita Zone) using a sample 425 households(346 SHG participants and 79 non participants) selected from ten Kebeles representing different agro-climatic conditions and farming system of the intervention areas. We employed FGT type of multidimensional food security index to look in to the food insecurity level of households and endogenous switching regression to estimate a simultaneous equations model

with endogenous switching to account for unobservable factors that influence food insecurity and the decision to participate in SHG or not to participate.

Description of the households' characteristics that found to influence food security of status of agrarians households indicates that significance differences in qualitative (in house head marital status and land fertility) and quantitative features (in no of preteen and teen children, household size, no of rooms of household, no of rooms per member, calorie intake from Carbohydrate, total food consumption, no of livestock and value of total asset) exist between SHG and non SHG groups. Results from food insecurity analysis also indicate that on average 38% of the sampled households are food insecure with no significance difference in both groups.

Results from the analysis of participation highlighted that participation rate of households of the project intervention areas is about 83% and the likelihood of households to participate in SHG is significantly affected by number of livestock in TLU and income.

Similarly, results of the endogenous switching regression showed that food insecurity is affected by sex, education and age of house head, land holding of the household, shock experienced by household and the place of residence – being living in Kindo Koyisha. Education, shock experience and Woreda dummy have negative significant effect on food insecurity status of both SHG and non SHG households whereas sex of house head, age of house head, land holding and no of rooms varied significant effect on food security status of SHG and non SHG households. No of rooms possessed by DHG household is found to influence food insecurity of SHG households negatively and significantly.

Analysis of SHG contribution indicates that participation in SHG program reduces food insecurity, however, households who decides not to participate in SHG tend to have benefits above the average whether they participate or they do not, but they are better off by participating than not participating in SHG. Last but not least, the impact of adaptation on food insecurity is larger for the non SHG households than for the SHG households currently. These results are particularly important to expand the intervention to include needy non SHG in to the program.

6.2 Recommendation

Though it is at its infant, participation in SHG contribute to the food insecurity reductions of households (for both SHG and non SHG). As a result expansion of the intervention may benefit the pro poor in its long term.

As households (either SHG or non SHG) living in Kindo Koyisha are found to be less food insecure compared to Offa residences. Hence, program expansion should give priority to Offa Woreda compared to Kindo Koyisha.

Being female headed household reduces food insecurity of SHG households but raise food insecurity of non SHG households. This may imply that female headed households of SHG households are more advantaged in relation food security compared to the non SHG female headed households. Thus SHG intervention should give priority to female headed non SHG households when program expansion is planned.

As SHG house head get older and older their food insecurity significantly raises whereas non SHG food insecurity level declines. Cognizant of this, SHG intervention should give prior attention to young people when it try to include new participants to SHG.

Annex

Table 5: Calorie supply of item of foods.

Food Item	Energy in Calorie Kcal/g	From Protein	From Fat	From Carbohydrate
Maize /Flour/	33.4	7	18	8
Sorghum	33.7	2	21	10
Barley	35.4	8	19	9
Teff	35.5	8	19	9
Bean	32	7	17	8
Kidney bean	35.4	8	19	9
Pea	34	7	18	9
chick peas	32.7	7	17	8
Cassava	31.8	6	18	8
Enset	19	4	10	5
Potato	10	2	6	3
Sweet potato	13.6	2	7	4
Cabbage or Carrot	2	0	1	0
Tomato or Garlic	3.1	1	2	1
Dry Pepper	31	5	18	8
Onion	7.1	1	4	2
Meat	23.4	8	16	0
Egg/dozen/	14	4	7	3
Butter	73.6	19	38	17
Cooking oil	89.6	23	47	20
Cow Milk	7.9	2	4	2
Sugar	40	7	22	10
Coffee, Tea	11	0	0	0
Lentil	37	8	19	9
Wheat or Rice	35.2	8	19	8
Yam/Taro	11.1	2	6	3
fruits	15.33	3	8	4

Table 6: Conversion factor used to estimate adult equivalence (AE)

Age groups in years	Male	Female
0-2	0.40	0.40
3-4	0.48	0.48
5-6	0.56	0.56
7-8	0.64	0.64
9-10	0.76	0.76
11-12	0.80	0.88
13-14	1.00	1.00
15-18	1.20	1.00
19-59	1.00	0.88
60+	0.88	0.72

Source: World Bank (1986)

Table 7: Equivalent Tropical Livestock Unit

SN	Animal Type	TLU
1	Bulls/Oxen	1.42
2	Cows	1
3	Heifer	0.78
4	Calves	1
5	Sheep	0.2
6	Goats	0.2
7	Horses	0.8
8	Mules	0.7
9	Donkeys	0.8
10	Poultry	0.04

Source: Tilahun et al., 2004; *EHNRI, 2000

Table 8: Weights for Components of food Security with their Thresholds

Dimension	Food security Indicator	Explanation	local weights	global weight	Overall Weight	Z-threshold
Availability	Total Dietary Energy Supply Adequacy	compares food supply/consumption with requirements	0.17	0.25	0.0425	2200 kcal
	Total Food Production	value of total food production	0.16		0.04	2200 kcal
	Share of dietary energy supply derived from cereals, roots & tubers	importance of staples in food supplies/consumption	0.17		0.0425	1.5*median
	Total protein supply	availability of proteins in the HH food consumption	0.23		0.0575	1.5*median
	Total supply of protein of animal origin	availability of animal proteins in the HH food consumption	0.23		0.0575	1.5*median
	Share of food aid	% of food aid in the total Dietary Energy from HH food Supply/consumption	0.05		0.0125	1.5*median
Access	Domestic Food Price Level Index (Food CPI)	food price level relative to prices of other goods for Wolaita Zone for 2016	1	0.24	0.08	Average Food Price relative to other gods in ETH in 2016
	Average distance to HH main services - for all services listed in HOUSEHOLD HOUSING ACCESS TO SERVICES	How much Hrs take to reach HH main services	1		0.08	1.5*median

Dimension	Food security Indicator	Explanation	local weights	global weight	Overall Weight	Z-threshold
	Share of food expenditure of the poor	importance of food in consumption of poorer households	1		0.08	1.5*median
utilization	Access to clean potable Water	if Piped into home or Public tap(bono) 1 else 0	0.28	0.25	0.07	1.5*median
	Access to improved sanitation facilities	if Pit latrine (No water) 1 else 0	0.3		0.075	1.5*median
	Number of rooms	How much rooms do the HH possess	0.24		0.06	1.5*median
	Access to Transitional cooking fuel	if Electricity or Kerosene or Biogas 1 else 0	0.17		0.0425	1.5*median
Stability	Cereal purchase dependency	ratio of cereal food purchased to total food consumed	0.3	0.25	0.075	1.5*median
	% land equipped irrigation		0.2		0.05	1.5*median
	Value of food purchase over total merchandise sales	ratio of value food purchase to value of food sales	0.2		0.05	1.5*median
	Any Shock Experienced	1 if any shock reported in HH Shocks else 0	0.3		0.075	1.5*median

Source: WFP, AFCAS 23 (2013)

Determinants of Adoption of Water using Devices and Water Saving Behaviour in Hawassa, Ethiopia Evidence from Household Survey

Tarekegn Mamo Legamo[1]

Abstract

This paper estimates the driving factors of household water demand management measures. There are several key factors behind household water management measures were identified. Using survey data of around 200 households from Hawassa, we identify the determinants of adoption of water using devices and water saving habits by estimating Probit/logit models of a household's probability to invest in water using devices and ordered probit models for the indexes of water savings habits at home respectively. The results indicate that the wealth effect proxy log income, respondents' family size, and education level are strong predictors of adoption of water using devices. Interms of the pricing variable, we found that households that are both metered and charged for their water use had less probability to invest in water using devices compared to households that paid a flat fee.

Similarly, respondents family size, education level and environmental awareness are strong predictors of water savings habits at home.

Key words: Determinants, water using devices, water savings habits, Hawassa

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1. Introduction

Water scarcity is one of the current and future challenges of developing economies, specifically low income countries in sub-Saharan Africa region. Recently in contrary to shortage in clean access to water sources, there have been the growing demand for sustainable drinking water supply in the residential sectors that draws more attention in these less economically privileged countries. For example, 314millionpeoplein sub-Saharan Africa have no clear water access (UNDP, 2006).To cope with this challenge, needs water planners to pay more attention and accelerate various efforts and enhance sustainable and efficient use of scarce water resources. There exists such actions include adoption of water efficient devices which are under consideration while saving water in and around home(McKenzie et al. 2003, Cohen et al. 2009, Carragher et al, 2012). It has also been confirmed that reducing water consumption at home will not only save money, rather it helpsto reduce the impact on the environment.

Generally, decenteralized decision making in water using devices investment has not been paid attention in many water demand studies, as the existing policy approaches use limited bottom-up modelling options, particularly in developing countries. As this approach needs improvement to capture factors determining the choice of technologies that can affect household water saving habits and how this behaviour is determined by policy instruments of water efficiency.

In Ethiopia, however, taking in to account the need for water efficiency at home the government has introduceda range of demand management measures to enhance residential water conservation activities. Among others, the two common tools(economic and non-economic) are precedence measures while aiming to addressing water scarcity problem, and promoting efficient use of water resources (EWSDP, 2001).

To this end, giving attention to examine the drivers behind water using devices and saving behaviour at home provides new insight for the design and implementation of more effective policies for sustainable water demand management in the region where scarce investment capital resources. It also

helps to determine the relative emphasis that should be given to different types of instruments (economic, non economic or social as well).

Objective of the study

The objective of the study was to identify the determinants of adoption of water using devices and savings behaviour among Hawassa households.

Specific objectives

1. To explore the link between income, water tariff, environmental attitude and adoption of water using devices
2. To examine the effect of socio economic characteristics and environmental attitude on water saving behaviour

Research questions

In order to meet the envisaged objectives, the study addresses the following two research questions:

1) Do household income, water tariff (implicit price) and environmental attitude influence adoption of water-efficient devices?
2) Do socio-economic characteristics and environmental attitude determine household water saving behaviour?

Literature Review

As to the economic tools for residential water demand management options, domestic water pricing policy considers imposing additional water price to increase water efficiency and reducing wasteful consumption. Similarly, allocation of property rights over the use of water is also considered as economic measures by the demand-side approach. While, the use of regulations to control water demand, promotion of public awareness on importance of water, reduction of reticulation and other losses of water production, and efficient and sustainable use of water sources are under non-economic measures (EWSDP, 2001). Nonetheless, in developing countries like Ethiopia, particularly in rural areas, these measures (pricing and non-pricing) are less applicable, because of the use of non-piped water sources. In urban areas, there exists relatively applicable water pricing policy that helps to promote distributional efficiency in residential water uses. However, yet, there have been significant variations

in water consumption among the community because of the presence of water appliances for pipe connected households. For instance, in East Africa region on average 64% piped households have flush toilet and they use 19.2 litres per capita (Thompson and Porras, 2001).

Some more water demand studies have reported that household component of water conservation can be achieved through installation of water efficient devices supplemented by water savings behaviour (Graften et al. 2011). Non-price conservation measures include socio-demographic factors and household water savings behaviour assumed in water efficiency scenarios.

Studies have shown that installation and use of water efficient appliances (toilet, shower, tap and washing machine, and etc.) change the household water use characteristics if they are supplemented by water conservation education program (Willis et al 2011, and Unity water, 2015-06-25:http://www.unitywater.com). And, Fider et al (2010) have indicated that the water efficient devices use as the effective tools for household water savings practices before the implementation of other alternative options. According to them, higher household stock efficiency increases up to 25% of water savings by reducing consumption, since it is low cost demand side alternative approach to adopt measurement of individual consumption. Similarly, the four years longitudinal study underlines household's with extra water savings technologies are likely to have higher water savings (Lee et al, 2011). The present result also coincides with the work of Mayer et al (1999), which, revealed that household water savings behavior is determined by appropriate water demand management strategies such as water metering, water restrictions, and installation of water savings devices.

Family water conservation choices, particularly water efficient devices were investigated by few studies, and these studies have highlighted the relationship between water saving habits and environmental behavior. Accordingly, Renwick and Archibald (1998) study two stage joint factor analyses in low flow toilets, shower head, and new irrigation methods and structure of household in water use. Both price and non-price policy measures reduce water consumption with a relative effect of family size and income.

Graftel et al (2011) also estimated two models, forming water demand equation with respect to water use at price, income, water saving appliances ownership and structure of household. They use ordered probit model for the analysis of different water conservation practices. Another literature in the past estimates household water demand model and examine the influence of conservation and public education program (Neiswediomy, 1992).

Using a household survey in OECD countries, Millock and Negues (2010) studied factors affecting the adoption of household water using devices in relation to water conservation behaviour. They investigated determinants of adoption of four water appliances (washing machine, flush toilets, low flow shower head and rain water collection tank). The authors identified factors of appliance decision associated with socio economic characteristics (age, education and income), attitudinal and behavioural variables (perception of environmental threats), price and non-price policy variables (money savings, water conservation habits, metering and labeling). According to them environmental attitude and ownership status strongly predict adoption of water efficient-equipment. Policy-related variables, metered and individually charged one's, have higher probability to invest in water efficient-equipments.

McKenzie et al (2003) examined the impact of water efficient technologies to reduce water use for toilets in Africa include four basic measures: low-volume toilet cisterns, dual flush toilet cisterns, and toilet retrofit devices.

Environmental attitude has a strong and significant relationship with family water savings behaviour and technology choices, as for environmental awareness determine regular household water savings behavior (Gilg and Bar, 2006; Nancarrow and Syme, 1989; Henrich 2007). These studies underline understanding the efficiency, opportunities and impacts of water savings activity to reduce consumption. On the contrary, other findings argue that there is no direct correlation between environmental attitude and water conservation practices and overall water use, but still it increases the specific water savings behavior (Nancarrow et al, 1997; Grafton et al, 2009).

3. Materials and Methods

3.1 Study area

The study area, Hawassa is a capital of the Southern Nation's Nationalities and Peoples Regional State and located on the shores of Lake Hawassa in the Great Rift Valley; 273 km south of Addis Ababa via Debre Zeit and 1125 km north of Nairobi. The City lays on the Trans-African High Way-4 an international road that stretched arched from Cairo (Egypt) to Cape Town (South Africa). Geographically the City lays between $7^0 3'$ latitude North and $38^0 28'$ longitudes east.

The city administration has a registered population of 316,842, with the annual growth rate of 4.02 percent and covers an area of 157.2 km^2 (CSA 2007). The city is divided in to eight sub-Cities and 32 Kebeles, These Eight sub-Cities are Hayek Dare, Menehariya, Tabore, Misrak, Bahile Adarash, Addis Ketema, Hawela-Tulla and Mehal Ketema sub-City.

3.2 Survey Description

The data comes from a household survey, which was conducted in April 2014 by the authors in collaboration with Southern Ethiopia Water Resources Bureau. The data collected on a range of variables including water saving appliances ownership (flush toilet, flow tap, shower, and dishwasher, bath and washing machine), frequency use of installed appliances, water savings behaviour(turn off water while brushing teeth, take showers instead of baths to save water, plug the sink when washing the dishes and gardening in the coolest part of the day to reduce evaporation), socioeconomic variables(age, family size, occupation, income and expenditure), and environmental awareness variables(agreement on responsibility to conserve water, agreement on water scarcity, and agreement on willingness to pay in cash for water protection).

3.3 Survey Sampling

A two stage sampling procedure was used for the selection of observation units. First, selection of sub-cities were purposively taken out of eight administrative sub-cities (Menhariya, Bahile Addrash, Tabore, Hayk Dare, Addis Ketema,

Misrak k. Ketema and Mehal Ketema). Second, we also purposively selected 14 kebeles (two kebeles per sub-city) as there are connected households in all kebeles. The proportion of number of households in each kebele to the total number of households in the kebele was calculated and this proportion was used to determine the number of sample households to be included in the sample. Finally, we randomly drew sample of 200 adult respondents from 14 kebeles. For the reason of the criteria of being connected to pipe water networks only 169 (85%) were used for the final analysis. Households using additional water sources were not included, non-pipe connected households and other primary source users were also excluded from the sample. Seasonal variable is also excluded due to limited time and resources.

Trained data collectors were assigned for mapping of the survey households. Accordingly, the survey team visited the randomly selected sample house and make a contact to responsible person in that household, mostly head of the household either male or female.

3.4 Econometric Model

In this study, we use logit model to analyse household ownership decision on water-efficient devices (dependent variable with different discrete choices), whereas water savings behaviour with ordinal responses (dependent variable with ordinal outcome) was analysed using ordered probit model.

The adoption of household water using devices for a discrete data is being analyzed and a modeling choice is adopted from Green (2012: 681).

The probability of adopting water using devices by a household is described inline with logistic regression when the dependent variable is binary and independent variable is in any form of measurement scale (Verbeek, 2004). If y is the dependent variable, it takes the value of either 1 or 0.

Therefore, the logistic regression model to estimate the probability of adopting water using devices is specified as follows.
Pr (household i say "yes "to j devices) =F ((X′β)……(1). Logistic or normality assumptions for F (.) give rise logit and probit models respectively

(empirical modeling used by Millock and Nagues 2010, and Dupont and Renzetti, 2013).

The researchers assume that the household decision to own water using devices and if his/her indirect utility does not observed, the specific choice that a particular household make, conditional upon its circumstances. The possession ($Y1*=1$) or absence ($Y1*=0$) of the device is dependent upon observable explanatory variables which are described by a vector, X. Elements in the vector include the structure of specific explanatory variable. Equation (1) indicates that determination to water using device decision that a household might make.

Modeling water saving behavior

To estimate water saving habits at home we use ordered logit/probit model with associated probabilities for the different ordinal responses using the Modeling choice adopted by Graftel et al., 2011, and Espineria et al. 2014). In ordered logit, we expect that a household may decide on water savings habit in daily water use with the possible outcome with different ordinal choices (e.g., not applicable, occasional, often, very often). The following equation describes the ordered logit:

$$*y=X'\beta+\varepsilon y*=X'\beta+\varepsilon$$

Assuming that ε is normally distributed the log-likelihood function in this case allows for each of the K segments represented. Again, maximization of the log-likelihood function provides estimates of the parameters of interest, both the β's and the μ's.

4. Survey Results

4.1 Sample description

Summary of sample survey was described in Table 1. The average monthly household income is 4078 ETB given an average family size of five. This gives a monthly per capita income to be 815 ETB. The majority of the respondents (65%) were male and theywere38 years old on average. Monthly household water consumption varies between 350L and 62500L. According to the survey data, the average monthly water expenditure of the household is 34.67 birr. Thus, a household spends only 0.85% of his or her monthly income on water services. This is the lowest cost of household water expenditure rate as compared to the World Bank's recommendation, which states a household should spend up to a maximum of 5% of his/her monthly income on water. This implies that a household living in the study area can afford to spend more if he or she is provided with improved water access.

Table 1: Summary statistics of respondents owning water using devices and saving behavior

Variable	Mean	Minimum	Maximum	Std. Dev.
age	38.3846	20.0000	72.0000	9.51127
HHsize	5.18935	1.00000	12.0000	2.25719
HH income	4078.75	1000.00	15000.0	2431.29
HH expenditures on water (implprice)	34.067	2.00000	250.000	33.9438
Dummy male household head	0.650888	0.000000	1.00000	0.478106
Dummy female	0.520710	0.000000	1.00000	0.501056
Dummy college education	0.680473	0.000000	1.00000	0.467679
Dummy private business	0.579882	0.000000	1.00000	0.495044
Water consumption	8193.27	500.000	62500.0	7735.22
Water using device	0.727811	0.000000	1.00000	0.446410
Water saving habits	2.14793	1.00000	4.00000	1.28476
Awareness of environmental protection	0.85207	0.000000	1.00000	0.35608

As to owning water using devices, 137(81.08%) of respondents have installed one or more water using devices and 32(18.93%) have not owned it. Based on the survey results, the most commonly used water using devices are flush toilet

(73%), followed by flow tap (51%), bath (39%), shower installed (43%), washing machine (25%), and dishwasher (46%), respectively.

Responses on water savings behavior are present in percentage in daily saving activities at home with ordinal choices (not applicable, occasionally, often and very often). Turning off the water flow while brushing teeth48.5 percent said it was not applicable, 13.6 occasional, 11.24 often, 45 very often. Taking shower instead of baths was not applicable by 56.8 percent, occasional by 14.8, often by 19.52, very often by 8.87 respondents respectively. Plugging sinks when washing dishes, it was not applicable by 54.4%, occasionally applicable by15.97%, often by 18.34%, very often by11.24%. And, gardening in the coolest part of the day to reduce evaporation was not applicable by73.37%, occasionally by 6.5%, often by 10.65%, very often by 10.65%.

4.2 Econometric Results

The first section of the econometric result presents the characteristics of household water efficiency in terms of adoption of water using devices from binary logit model. Dropping the outliers, 169 observations of the household survey was used in this survey analysis. We use univariate logit model to estimate determinants of owning household water using devices (flush toilet, flow tap, shower, bath, washing machine, dish washer). To carry out univariate logistic regression we designate the value 1 for households owning at least one or more water using devices and those households have not owned water using devices were represented by zero value. The major expected determinants were implicit price, income, family size, and education.

Diagnosis test was carried out with the likelihood tests, number of cases predicted, multicolinearity test using Variance inflation factor (VIF) in the two models. See Tables 4 and 5.

The econometric estimation using logit model (Model 1) clearly indicates that investment decision (adoption) is strongly affected by socio-economic variables.

Table 4: Estimated results from logit model-household survey

Binary logit Model (n=169)					
Dependent variable: water device					
	Coefficient	**Std. Error**	**z**	**p-value**	
const	-16.1297	3.53359	-4.5647	<0.00001	***
implprice	-0.0758003	0.194217	-0.3903	0.2043	
l_income	0.21158	0.452051	4.8923	<0.00001	***
hhsize	0.256735	0.106933	2.4009	0.01636	**
education	1.42103	0.437785	3.2460	0.00117	***

The econometric analysis of the determinants of adoption of water using devices points a negative sign but not significantly affected by water tariff. Lower water tariff has a negative and significant effect on investment decision (owning water using devices). In the other hand, the result indicates increase in the average water tariff may encourage households to adopt water using devices.

The result from the analysis reveals that a change in wealth as indicated by log income (0.21) has a positive significant effect on household adoption of water using devices in line with empirical literature.

Respondents attaining higher education level is found to have significantly associated with household adoption of water using devices across the survey households. As we control for log income and other variables, education and family size capture a positive and significant effect on owning water using devices in the study household. While the differences among a continues variable age and the differences in dummy variables (gender, family type, and private business) were not found to have significant correlation with owning water using devices. The estimation result does not reveal the link between environmental attitude and adopting water using devices.

Econometric estimation from indexes of household water saving habits presented using order logit model as follows. Order logit model was used to estimate household water saving habits interms of the daily saving activities(performance) at home with ordinal choices (not applicable, occasionally, often and very often).

In Table 5 the econometric estimation result out of model 2 reveal that the implicit price or water tariff has a positive and significant correlation with household water saving habits at home. Respondents education status turn out to have a positive and significant association with water saving habits at home.

Table 5: Estimated results of ordered logit model-household survey

Ordered logit Model (n=169) Dependent variable: water saving habits					
	Coefficient	**Std. Error**	**z**	**p-value**	
Const	-2.95579	0.742539	-3.9807	0.00007	***
Implicit price	0.0128311	0.00526252	2.438	0.0148	**
hhsize	0.292009	0.102243	2.8560	0.00429	***
Education	2.23723	1.05144	2.1278	0.03336	***
D-awareness	0.679409	0.421451		1.6120.1069	

Family size variable captures a positive and significant effect on water savings habit at home. Education variable has also a positive and significant correlation with water savings habit at home. Respondents age, gender, occupation (private business), and income were not statistically significant predictors of water saving behaviour of households.

Econometric analysis pointed that environmental awareness has a significant effect on most water saving behaviors in line with the current state of knowledge.

Table 6: Dignosis test

Diagnosis test			
Tests	**Model 1**	**Model 2**	**Model 2**
Mean dependent var	1.562130	1.863905	
Log-likelihood	-219.3765	-185.9221	
Schwarz criterion	459.2725	433.4029	
S.D. dependent var	1.084517	1.079765	
Akaike criterion	446.7529	395.8441	
Hannan-Quinn	451.8336	411.0862	
Number of cases 'correctly predicted'	69 (40.8%)	97 (57.4%)	
Likelihood ratio test Chi-square (1)	52.6199	27.2815	
Prob> Chi-square	[0.0000]	[0.0000]	

Colliniarity test result from Variance inflation factors are presented below.

Table 7: Variance Inflation Factors

Model:1	VIF	Model:2	VIF
l_income	1.222	hhsize	1.086
hhsize	1.101	D2_warness	1.106
D2_education	1.240	l_income	1.053

Table 7 describes the variance inflation factors in both adoption model(1) and water savings model(2) which indicates that -Minimum possible value = 1.0, Values > 10.0 may indicate a co linearity problem.
VIF (j) = 1/ (1 - R (j) ^2), where R (j) is the multiple correlation coefficient between variable j and the other independent variables.

5. Discussion

This research paper examines factors that determine household water saving behaviour and ownership of water efficient devices in relation to socio-economic and environmental attitudes in Ethiopia.

The findings of this paper show that the impact of socio-economic characteristics on owning water using devices. Among the economic variables, implicit price and income capture a positive and significant effect on household investment decision. Unlike the result with a significant impact in this research, in developed countries the effect of income on adopting water using devices decision is not clearly explained. As we discovered from the current state of knowledge, there have been a negative effect of income on household investment decision on water efficient devices and low income elasticity of demand (De Oliver, 1999; Martinez-Espineira and Garcia-valinas, 2014). However, the result in this study is consistent with the recent findings of study that indicates income is the main driver of eco-friendly investment decision and to subsidy it , that can induce adoption of water using devices by a household. Study in Spain, using simulation in different policy scenarios, for example, has showed that when household income moved to the next income bracket, then, the probability of investment decision on efficient devices changes accordingly (Marinez-Espineira et al, 2014).

Positive and a significant income effect on investment decision have also sought by some more scholars (Berk et al, 1993; Reniwick and Archibald, 1998; in California, USA, Diane P, et al., 2013 in Canada, Millock and Nagues, 2010 in OECD).

Education variable is found to have an impact on both water savings behaviour and ownership decision of water efficient devices. In the study area, the researchers expected that education may enhance opportunity and help finding jobs. In turn, households can earn income through employment and afford to purchase water efficient devices. More educated respondent's family implies more willingness to engage in water conservation practices and understand water scarcity problem, and choose water saving devices, in turn which increases efficiency. This result matched with those studies indicating a positive effect of education on water conservation choices and investment decisions on water efficient devices (Berk et al 1993, Gilg and Bar, 2006, Lam, 2006, Millock and Nagues, 2010, Organization for Economic cooperation and development, 2011, Martinez-Espineira et al. 2014).In contrary to this results, recent empirical finding illustrate that education and income did not prove significant effect on water savings behavior (Adams, 2014).

In contrast to the hypothesis in this study, our survey result does not justify the impact of environmental attitude on investment decision of water using devices in the study household.

7. Conclusion

Efficient use of water supply at family level has been considered as a relevant policy instrument in the residential water demand side management inorder to increase equitable water distribution in low income countries.

Public sector investments in clean drinking water supply are not the only means at the disposal of households to improve access to potable water sources but understanding of household water using practices, their choice and preferences are important tools in residential water demand management measures.
Important lesson from this paper is that variation in economic and environmental variables are crucial to understand what motivates preferences

and choices across survey households in terms of underlying investment decisions on water using devices and water saving behavior.

The government should play important role (soft) to promote public education or information campaigns to raise more environmental awareness and often their effect on actual decision making in residential water demand management efforts.

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Market Chain Analysis of Coffee in Dale District of Southern Ethiopia

Wendmagegn Belete[1]

Abstract

The major objectives of this paper are to investigate the main coffee marketing channels and to identify the determinants of household coffee supply in Dale district. The study is based on the information generated through a formal survey conducted in the major coffee producing areas of dale district with 123 coffee producers and 36 coffee traders. The channel analysis of the commodity identified five marketing routes. The main market participants for coffee marketing of the district were coffee producers, coffee producer cooperatives, coffee producer's cooperatives union, coffee collectors, retailers, wholesalers, ECX and consumers. The coffee marketing performance result reveals that 36.9% and 34.13% of total gross marketing margin were added to coffee price in channel I and channel II respectively. Out of the total gross marketing margin, 9.6% was captured by coffee collectors, while 27.3% goes to wholesalers in channel I and out of the total gross marketing margin in channel II, 34.13% goes to wholesalers. The results of econometric analysis using OLS model shows that sex of the household head, education level, coffee productivity, extension contact, price of coffee, and access to market information were found to be the significant variables influencing coffee marketable supply positively. Whereas, distance to the nearest market and non-farm income were found to be the significant variables affecting coffee marketable supply negatively

Key Words: Coffee, Marketable Supply, Marketing Channel, Marketing Margin, OLS model

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1. Background[2]

Ethiopian economy is basically dependent on agriculture which contributes about 40 % of GDP, and 80% of exports (John and Nebil, 2010). Currently, coffee is the major agricultural export crop which contributes more than 65% of the country's foreign exchange earnings. In the country, where about large numbers of the population is under poverty, coffee cultivation plays a vital both in the cultural and socio-economic conditions of the nation. According to World Bank report, about 25% of the Ethiopian population depends directly or indirectly, on coffee production, processing and marketing (World Bank, 2009).

Dale district is found in Sidama zone, Southern Nations, Nationalities and Peoples Regional State (SNNPR). In the district, most farmers (96%) are growing coffee as the main source of income. Coffee is an important cash crop in Dale district covering 15.35km^2 planted with plants and crops used as a shelter. In 2011 total of 59 111.6 quintals of washed and 112 499.56 quintals of unwashed coffee were produced and traded in Dale district.

The Ethiopian current regulation requires all coffee to be inspected at the center in Addis Ababa and Dire Dawa. It should be noted in this regard that, coffee produced from different regions or Zones is required to be assembled and transported to the central market in Addis Ababa and Dire Dawa. The Coffee Standard and Quality Inspection and Auction Centers (CSQIAC) of Ethiopia monitor the production and exportation of all coffee through the system. In the supply chain, Ministry of Agriculture (MOA) and Ethiopian Commodity Exchange (ECX) are responsible for inspecting, organizing and coordinating the classification, grading and auction sale of the coffee supplied to central markets in Addis Ababa and Dire Dawa with their own operational rules, regulations, and modalities (ECX, 2009).

This important commodity has been given greater attention by the country, and it was the first cash crop with which the Ethiopia Commodity Exchange (ECX) commenced trading operations in April 2008 so as to improve the coffee

[2]I like to provide my profound gratitude to Jema Haji (PhD) for his supervision and guidance throughout the development of this work.

markets in Ethiopia. ECX claims that, agricultural markets in Ethiopia before 2008 had been characterized by high costs and high risks of transacting, with only one third of output reaching the market, and besides, small-scale farmers, who produce 95% of Ethiopia's output, came to market with little information and are at the mercy of merchants in the nearest market they know, and they are unable to negotiate better prices or reduce their market risks (ECX, 2009).

Despite being the birth place of coffee with diversified landscape and suitable climate for growing large quantities of coffee and being a country that produces high quality coffee with a distinct flavor and where one of the highest valued coffee in the world called '*Mocha*' is produced in the country and is the leading exporter of the famous *Arabica* coffee*;* the sector has not developed fast and the export volume has not shown a rapid growth. As a result the country's export represents only about 3% of the world's export (ECEA, 2012).

A well developed market for food crops in developing countries like Ethiopia provides access to consumers who depend on the market for their food supplies and to farmers, who needs to shift from subsistence to market oriented production system (Lutez, 1994). The transformation of the production system for domestic and export agricultural commodities requires the existence of efficient marketing system that can transfer the produced agricultural commodities from the point of production to the required market at the least possible cost.

Even though the government deals with coffee marketing, there are still a lot of problems faced by the farmers (Aklilu and Ludi, 2010). For instance, farmers reported government's insufficient regulation of the price of coffee where collectors and suppliers set their own price which is usually below the market price as announced by the government.

The efforts of increasing agricultural production and productivity have to be accompanied by a well performing marketing system which satisfies consumer demands with the minimum margin between producers and consumer prices. Higher prices for producer can encourage farmers to adopt new technologies and increase production (Wolday, 1994). However, there are external and international problems that influence the marketing efficiency in Ethiopia.

Because of the productivity and institutional limitations, to export coffee distant but rewarding markets emanate from low marketable surplus with high transaction costs. Again, dependable marketing system is not yet developed to market coffee. Market infrastructures and marketing facilities are not well developed. This in turn, reduces incentives to transactions (Mohammed, 2012). Therefore, improving the position of smallholders to actively engage in the market is one of the important challenges.

The coffee commodity chain faces its own complex set of problems, including various constraints on production, processing and marketing. For example, in specialty/gourmet segments of the international coffee market, Ethiopia occupies a unique place with an impressive selection of distinctive coffee profiles. There is considerable potential to increase the proportion of specialty coffee exports (used in premium blends or sold as single origins) if quality and consistency are guaranteed (Westlake, 1998). Many analysts have also proposed increasing the quantity of washed coffee as it sells at significant premiums over unwashed coffee (FDRE, 2003).

Market chain analysis is supposed to be the current approach working in studies of such type of production and marketing problems. Analysis of the market of coffee base on market structure, conduct and performance taking into consideration the product and location specificity will, therefore, be useful to identify the bottlenecks and come up with possible solution.

Different studies were conducted in line with coffee marketing. Ruth *et al*. (2002), in the private marketing chain, coffee farmers from Jimma get approximately 27% of the export price. The authors indicated that the small share is attributable to the rather long marketing chain. Mohammed (2012) also identified the major factors that affect the supply of coffee in Nensebo district of Oromiya region using 2SLS regression econometric model. The results of his econometric analysis shows that output, access to market information, family size and distance to market as the main factors affecting coffee supply to the market. Dessalegn (2009) studied the performance of coffee marketing in south west Ethiopia, Bench Maji zone using Engle and Granger Co-integration and error correction model. The study indicated that there is no efficient use of

available information by the participants and thus markets are not fully integrated.

So far, to the writer's knowledge, there has been no study undertaken in Dale district to analyze the coffee market chain. This study therefore, attempted to contribute to filling the information gap by investigating the coffee marketing chains and factors affecting coffee supply in Dale district.

Thus, the objectives of the study were to analyze the market structure, conduct and performance of coffee market and to identify the determinants of market supply of coffee at farm level in the study area.

2. Research Methodology

2.1. Description of the Study Area

Dale district is one of the 19 districts in the Sidama Zone of SNNPR region and covers a total area of over 30,212 ha, located at about 320 km south of Addis Ababa along the main highway to Moyale, about 5km to the left after traveling 40km from the region capital Hawassa. Geographically the district is located in $6^0$44" N latitude and $38^0$28'' E longitude (WoFED, 2013).

The mean annual rainfall of the district recorded at Awada Research Center ranges from 1041 mm to 1448 mm. Mean temperature in the district ranges between 11^0c to 22^0c. The district is subdivided into 36 *Kebeles*[3] and all those produces coffee.

The population of the district was estimated to be 256,579 of which women accounts 127,007 (49.5%) and men accounts 129572 (50.5%). The average growth rate of population for the district was estimated to be 2.8 percent.

According to the data obtained from the Bureau of Agriculture and Rural Development, average land holding size owned by individual farm household was 0.5 ha. Coffee production is the main economic activity with total area coverage of 15,367 hectare.

[3]Smallest administrative unit

2.2 Data Types, Sources and Collection Procedures

For this study, both primary and secondary data were used. The source of the primary data was cross-sectional collected from sample intended to represent the population. The data were collected formally by using pre-tested semi-structured questionnaire. The data focuses on prices, volume and direction of trade, identification of market participants, relationship among marketing agents, role of marketing agents, number of buyers and sellers in the market, marketing functions, facilities and services, production and marketing costs, production and marketing support services, major constraints and opportunities, and other socioeconomic variables of coffee producers and traders.

Secondary data were collected by reviewing documents from different governmental and non-governmental sources, published and unpublished documents and farmer's cooperative union so as to back up the primary data. The secondary data were focused on coffee production and marketing system, coffee price, number of licensed coffee traders, legal requirement to enter into coffee trading business and data on other socioeconomic variables.

2.3 Sampling Procedures and Sample Size

The sampling frame of the study was the population list of coffee producer households in the sampled *kebeles* and a multi stage sampling techniques were employed to draw appropriate sample households.

Dale district was purposively selected for the reason of high production of coffee. Sample farm households were drawn from the five[4]purposively selected rural administrative *kebeles of the district* for their high coffee production volume. Survey questionnaires were administered through a simple random sampling based on proportional probability sampling technique. To determine

[4]Awada, Gane, Masincho, Moto and Wenenata

the sample size, Yamane's sampling formula[5] (1970) was used. Accordingly, 123 coffee producer households were selected.

The sites for the coffee trader's survey were market towns, which were selected based on the flow of the coffee produce from the study district. Two market towns (Yirgalem and Hawassa) were selected for the traders' sample. The total sizes of coffee traders were36. The number of permanent coffee traders in the main coffee marketing channel in the study area was limited; hence all of them were employed in the traders' survey.

2.4 Methods of Data Analysis

2.4.1 Descriptive statistics

Descriptive data analysis methods such as ratios, percentages, means, variances and standard deviations were used in order to examine socioeconomic and institutional characteristics of coffee producers and traders in the marketing channels, and the structure, conduct and performance of coffee markets in the study area.

Market structure

Structural characteristics like market concentration, industry maturity, product differentiation, government participation, barriers to entry and exit, were the basis to be considered. In this regard, one can categorize markets as perfectly competitive, monopolistic, or oligopolistic (Bain, 1968; cited in Pomeroy and Trinidad, 1995). Among the major structural characteristics of a market is the degree of concentration, that is, the number of market participants and their size distribution and the relative ease or difficulty for market participants to secure an entry into the market (Gebremeskel *et al.*, 1998). Market concentration was used for evaluating the market structure in the study area.

[5] $n \quad \frac{N}{1 \quad N(e)^2}$

Where: n= Sample size; N= Total number of coffee producer households; e = level of precision with 95% confidence interval.

Market concentration: Market concentration is defined as a number and size distribution of sellers and buyers in the market. Other factors, such as the firm's objectives, barriers to entry, economics of scale, and assumptions about rival firm's behavior, were relevant in determining the degree of concentration, the relationship between concentration and behavior and performance (Scherer, 1980).

$$MS_i \quad \frac{V_i}{V_i}$$

Where, MS_i = market share of buyers i.
V_i = amount of product handled by buyer i.
$\sum V_i$ = Total amount of product

$$C \quad \sum_{i\ 1}^{r} S_i$$

Where, C = concentration ratio handle
S_i = percentage share of i^{th} firm
r = number of largest firm for which the ratio is going to be calculated

Kohl's and Uhl (1985) bring into play as a rule of thumb, four largest enterprises' concentration ratio of 50% or more (an indication of a strongly oligopolistic industry), 25-50% (a weak oligopoly) and less than that (competitive industry). The problem associated with this index is the arbitrary selection of r (the number of firms that are taken to compare the ratio).

Market conduct

Market conduct refers to the behavior of firms or the strategies used by the firms in their pricing, buying and selling activities. There are no agreed up on procedures for analyzing the element of market conduct. Market conduct defines the conditions which make possible exploitative relationships between sellers and buyers. This is done via unfair price setting practices which Smith

(1985) classified as collusive, predatory, or exclusionary. A systematic way to detect indications of unfair price setting practices and the condition under which practices are likely prevail. Moreover, they cover the following topics: (i) the existence of formal and informal marketing groups that perpetuate such practice, (ii) formal and informal producer groups that affect bargaining power, (iii)the distance from the major market and its impact on prices, and (iv) The feasibility of utilizing alternative market outlets. The following indicators were taken into consideration for this study; traders' price setting, purchasing and selling strategies, formal and informal marketing group that affect the bargaining power.

Market performance

Analysis of the level of marketing margins and their cost components were made to meet the second objective. Estimates of the marketing margins are the best tools to analyze performance of market. Marketing margin was calculated taking the difference between retail and producers prices.

Marketing margin: Calculating the total marketing margin was done by using the formula below. Computing the total gross marketing margin (TGMM) is always related to the final price paid by the end buyer (in the ECX market) and is expressed as a percentage as cited in Mendoza (1995). The cost and price information used to construct marketing cost and margin were gathered from coffee market chain actors such as, collectors, service cooperatives, retailers, union and exporters and the total gross margin was determined using:

$$TGMM \quad \frac{\text{Consumer price} \quad \text{producer price}}{\text{Consumer price}} \quad 100$$

It is useful to introduce here the idea of "producer participation", "producer portion" or "farmers portion", or "producers gross margin" (GMMP) which is the proportion of the price paid by consumer that belongs to the producer. Producer that act as a middle men also receive an additional marketing margin.

$$GMM_p = \frac{\text{Price paid by the consumer} - \text{Gross Marketing margin}}{\text{Price paid by consumers}} \times 100$$

In marketing chain with only one trader between producer and consumer, the net marketing margin (NMM) is the percentage over the final price earned by the intermediaries as his/her net income once his marketing costs are deducted.

$$NMM = \frac{\text{Gross margin} - \text{Marketing cost}}{\text{Price paid by consumer}} \times 100$$

Another parameter related to marketing margin is the producer's share. The producer's share is the ratio of producer price (ex-vessel) to consumer price (retail). The producer's share can be expressed as

$$PS = \frac{P_x}{P_r} = 1 - \frac{MM}{P_r}$$

Where, PS = The producer's share
P_x = Producer price of coffee
P_r = Consumer price of coffee
MM = Marketing margin

The above equation tells us that a higher marketing margin diminishes the producer's share and vice-versa. It also provides an indication of welfare distribution among production and marketing agents.

2.4.2 Econometric model

All the sampled coffee farmers of the study area supply coffee to the market. Hence, the dependent variable is the amount of coffee supplied to the market in Dale district which is a continuous variable. In this study, multiple linear regression models were fitted to survey data to identify the determinants of

coffee supply to the market. Following Green (2003), the multiple linear regression model is specified as:

$$Y_i = \beta X_i + U_i$$

Where, Y_i =a vector coffee supplied to the market by the sample farmers
β = a vector of estimated coefficient of the explanatory variables
X_i= a vector of explanatory variables
Ui= disturbance term

Table 1: Summary of dependent and independent variables used in the model

Variables	Explanations	Variable type	Measurements
Dependent variable			
Qt–SUPP	**Quantity supplied**	**Continuous**	**Kilograms**
Explanatory variables			
CRED–ACC	Access to credit	Dummy	0=No; 1=Yes
MKT–INFO	Access to market information	Dummy	0=No; 1=Yes
SEX	Sex of household head	Dummy	0=F; 1=M
AGE	Age of household head	Continuous	Years
CO–LAND	Area allocated for coffee	Continuous	Hectare
CO–PROD	Coffee productivity	Continuous	Kilogram
EXT–CNT	Extension contact	Continuous	No. of contacts
EDU–HHH	Household education level	Continuous	Years of formal schooling
FAM–SIZE	Household family size	Continuous	Man equivalent
FAR–SIZE	Size land holding	Continuous	Hectare
PRC–LAG	Coffee price in 2013	Continuous	Birr
DST–MKT	Nearest market distance	Continuous	Kilometer
NONF–INC	Non–farm income	Continuous	Birr

3. Results and Discussion

3.1 Sample Characteristics

Average age of sampled household was 39.54 years (12.66)[6] and average family size was 5.54 persons (2.73) per household. With respect to education level average number of years of schooling was 8.29 years (2.2). In the study area, demand for credit is influenced by availability of cash on hand. The sampled household accessed credit both from formal and informal sources. The average amount of credit taken by the farmers was 6 335.6 birr (2 234.62).

The government has been attempting to fill the required knowledge gap and achieve food-self sufficiency in the country by placing at least two development agents (DA's) in each *kebeles* and building farmer training centers (FTC). In the study area the average number of extension contact by the respondent was 18.65 (18.5) per year.

Sampled households also reported that they have to travel on average 1 hour (0.48) to get the nearest market center. In all the selected *kebeles* the market is available for 6 days per week, except Sunday. Regarding the market information access about 20.3% of coffee producing sampled households reported that they have price information of the nearby market, 14.6% of coffee producers obtained price information from the central market and 17% had access to market information from both markets before they sold their coffee product.

3.2 Major Production and Marketing Problems

Land scarcity was indicated as one of problems constraining production of coffee by 76.4% of coffee growing farmers. The survey result also indicated that an average land holding size of per household is about 1.36 hectares. About 97.6% of the sampled farmers identified coffee plant diseases called *Gibrill* and *CBD* as a bottleneck for coffee production which results in deterioration of natural coffee quality.

[6]Numbers under parenthesis represents standard deviation

Lack of market information and infrastructure problem were also reported by 79.7% and 81.3% of the sampled farmers. In the study area village markets are connected with district town by poorly paved roads that constrain buyers to come to the market or farmers to take coffee to district town market where there are more buyers.

Price setting was also indicated as another major problem as reported by 85.4% of the sampled farmers. Farmers couldn't set price for their coffee. The reasons stated were market power of traders, unstable coffee price, and lack of timely and reliable coffee price information from the central market.

3.3 Coffee Marketing Channels

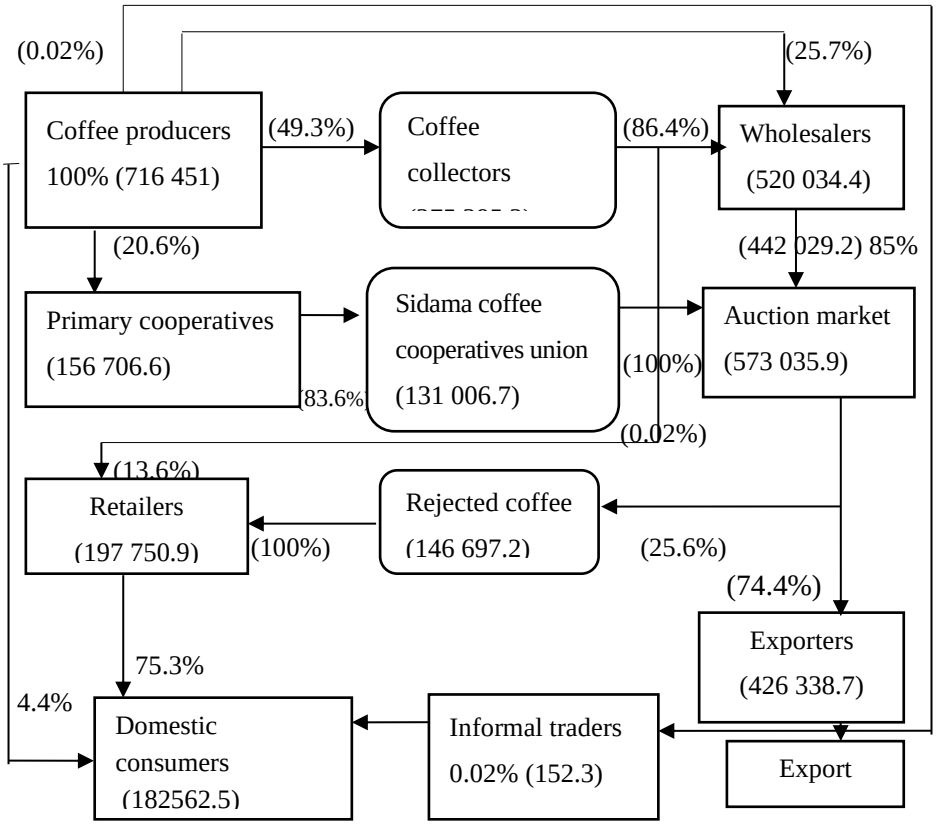
Coffee marketing participants in the study area includes producers/farmers, coffee collectors/assemblers, retailers, wholesalers, coffee producing farmer's cooperatives and final consumers of the product. As stated in Mendoza (1995), Coffee marketing channels is the sequence of intermediaries through which coffee passes from farmers to ultimate consumers. The analysis of marketing channels is intended to provide a systematic knowledge of the flow of goods and services from their origin (producers) to the final destination (consumers).

The study revealed that coffee passes through several stages before it reaches the ultimate consumers. These stages were local collection centers, processing, storage and transporting, grading, exporting and domestic distribution. Generally, in the study area five major marketing channels of coffee were identified.

Producers → Collectors → Wholesalers → Auction (ECX) → Exporters → Export
Producers → Wholesalers → Auction (ECX) → Exporters → Export
Producers →Primary cooperatives →Union →Auction (ECX) →Exporters →Export
Producers → Collectors → Retailers → Domestic consumers
Producers → Domestic consumers

Among these, channel I and channel II were the principal coffee marketing channels for both forms of coffee (red-cherry and sun-dried coffee).

Figure 1: Coffee marketing channel



3.4 Degree of Market Concentration

The concentration ratio is expressed in terms percentage of the market controlled by the biggest X firms. Four firms (CR4) concentration ration is the most typical concentration ratio for judging the market structure (Kohls and Uhl, 1985). A CR4 over 50% is generally considered as a tight oligopoly, CR4 between 25% and 50% is generally considered as a lose oligopoly and a CR4 less than 25% is considered as no oligopoly at all. Since the number of traders at each sample market level was few, therefore, the analysis of the degree of market concentration ratio was carried out for all traders. It was measured by the percentage share of volume of coffee handled by the largest four traders.

The primary coffee market is characterized by un-concentrated suppliers. Coffee market shows concentrated buyers in the sampled coffee markets. The degree of market concentration analysis was carried out in Yirgalem and Hawassa town sample markets. Concentration was calculated by taking annual volume of purchased coffee in 2013/2014.

Table 2: Traders concentration in Yirgalem Town

Number of traders	Cumulative frequency of traders	% of traders	Cumulative % of traders	Quantity Purchased in kg	Total quantity purchased in kg	% share of purchase	% cumulative purchase
(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
1	1	4.762	4.762	550380	550380	25.1	25.1
1	2	4.762	9.524	430300	430300	19.6	44.7
1	3	4.762	14.286	270600	270600	12.3	57
1	4	4.762	19.05	181355	181355	8.3	65.3
1	5	4.762	23.81	179800	179800	8.2	73.5
1	6	4.762	28.572	149545	149545	6.8	80.3
1	7	4.762	33.334	125300	125300	5.7	86
1	8	4.762	38.096	112400	112400	5.1	91.1
2	10	9.524	47.62	23300	46600	2.1	93.2
1	11	4.762	52.382	37499	37499	1.7	94.9
2	13	9.524	61.906	15785	31570	1.4	96.3
1	14	4.762	66.668	23400	23400	1.1	97.4
3	17	14.286	80.954	6713	20140	0.9	98.3
1	18	4.762	85.716	14700	14700	0.7	99
2	20	9.524	95.24	5450	10900	0.5	99.5
1	21	4.762	100	6600	6600	0.3	100

Source: Own computation, 2014

As indicated on Table 2 and Table 3 coffee markets at Yirgalem and Hawassa were strongly oligopolistic in the hands of few coffee traders. CR4 measures concentration ratio that the top four or 19.05% of the traders controlled 65.3% of the coffee market in Yirgalem and 26.67% of the coffee traders controlled 69% of the coffee market in Hawassa in 2013/2014.

Table 3: Traders concentration in Hawassa Town

Number of traders	Cumulative frequency of traders	% of traders	Cumulative % of traders	Quantity Purchased in kg	Total quantity purchased in kg	% share of purchase	% cumulative purchase
(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
1	1	6.67	6.67	344550	344550	22	22
1	2	6.67	13.33	343380	343380	21.9	43.9
1	3	6.67	20	258500	258500	16.5	60.4
1	4	6.67	26.67	135300	135300	8.6	69
1	5	6.67	33.33	100650	100650	6.4	75.4
1	6	6.67	40	76600	76600	4.9	80.3
1	7	6.67	46.67	74910	74910	4.8	85.1
1	8	6.67	53.33	66850	66850	4.3	89.4
1	9	6.67	60	61500	61500	3.9	93.3
2	11	13.33	73.33	18175	36350	2.3	95.6
1	12	6.67	80	30400	30400	1.9	97.5
1	13	6.67	86.67	20616	20616	1.3	98.8
2	15	13.33	100	8800	17600	1.1	100

Source: Own computation, 2014

Applying the market structure criteria suggested by Kohls and Uhl (1985), the coffee market shows strongly oligopolistic market in both Yirgalem and Hawassa market towns. This suggests that there is market imperfection because few traders seem to have monopolized the coffee market.

3.5 Marketing cost and profitability analysis

Marketing margin is defined as the percentage of the final weighted average selling price taken by each of the marketing chain actors. The margin must cover the cost involved in transporting the produce from one place to the other and provide a reasonable return to those doing the marketing.

Labor cost which includes (weeding, pruning, harvesting, cost of food item during group work, loading and unloading, etc.) was the principal cost of coffee growers consisting about 57.5% of the total cost. Cost of transport (farm to home, home to market or sometimes market to home when the price is very low) was also the second major cost of producers followed by cost of land, materials and tax with consisting 15.4%, 12.4%, 12.2% and 2.5% respectively.

The gross marketing margin for coffee collectors and coffee wholesalers were birr 521.9 and birr 1492.7 in channel I respectively. However, the gross margin of wholesalers was birr 1863.71 in channel II due to the direct transaction with farmers. The Woreda agriculture office reported that currently the office developed a law to encourage the direct transaction between coffee growers and wholesalers in order to improve farmers benefit and coffee quality.

The marketing margin analysis indicated that the total wholesaler's gross margin was 1 492.7 birr in channel I and 1 863.71 birr in channel II. The producers share from the auction market was 63.1% in channel I and 65.87% in channel II. This difference might support the theory that as the number of market agents increases the producers share decreases.

To summarize, 36.9% and 34.13% of total gross marketing margin was added to coffee price in channel I and channel II respectively. Out of these 9.6% was gross margin of coffee collectors, while 27.3% was that of wholesalers in channel I and out of the total gross marketing margin in channel II about 34.13% was gross margin of wholesalers.

Officially, coffee collectors are expected to earn a commission of 0.25 cents per kg of *Jenfel*[7] or 0.30 cents per kg of clean coffee beans. This is not motivating if we consider the cost they incur which may lead them to loss. In practice however, collectors did not incur loss in their operations. Their operation is commonly based on commission negotiated with wholesalers or lowering purchase price from producers and sale to wholesalers at a price level which can cover their cost and generate some profit. Based on the data obtained from wholesalers coffee collectors actually earn a price margin of up to 0.45 cents per kg of *Jenfel* or 0.60 cents per kg of clean coffee depending on the purchase price from coffee producers.

[7] Unwashed coffee

3.6 Determinants of Household Coffee Market Supply

Coffee is produced mainly for market and is one of the most important cash commodities for Dale district farmers. Data from sampled respondents indicated that 92% of the total coffee produced in 2013/2014 production year was supplied to the market.

Before running the OLS regression model, all the hypothesized explanatory variables were checked for the existence of multicollinearity, omitted variable, heteroscedasticity and endogeinity problem and addressed accordingly. The overall goodness of fit of the regression model is measured by the coefficient of determination (R^2). Hence, the overall model goodness of fit represented by adjusted R^2 value is 67.01%. This result indicates that about 67% of the variation in farm level marketable supply of coffee was attributed to the hypothesized variable

Econometric Result

Among the thirteen hypothesized variables only eight variables namely sex of the household head, education level of household head, quantity of coffee produced, access to extension service, price of coffee in 2013, distance to the nearest market, non-farm income and access to market information were found to be the significant.

Sex (SEX): Both men and women take part in the production and marketing of coffee. As expected, sex of the household head influenced market supply of coffee positively and significantly at 5% significance level. The positive sign implies that if the household is male headed it leads to an increment of coffee to be supplied to the market by 0.049 kilogram. Tshiunza *et al.* (2000) studied about determinants of cooking banana in Nigeria, they found male headed household tend to produce more cooking banana for market than female headed.

This can be explained by the fact that males have relatively better labor advantage to produce more and supply more volume.

Education level (EDUHH): The model output verifies that this variable is positive and statistically significant at 5% significance level. One additional

year of formal education level leads to an increase in marketable supply of coffee by 0.013 kilogram. The positive and significant relationship may indicate that formal education determines the readiness to accept new ideas and innovations, and easy to get supply, demand and price information which enhances farmers' willingness to produce more and increase volume of sales. Zekarias *et al.* (2012) studied market chain analysis of forest coffee in south western Ethiopia and found that education level has significant positive effect.

Coffee productivity (COPROD): It is taken as a proxy for quantity produced; it indicates household with high level of productivity had also supplied more to the market. It affects the volume of coffee supplied to the market positively and significantly at less than 1% significance level. The model result shows that a one kilogram increase in coffee productivity per hectare resulted in 0.334 kilogram increase in the volume of market supply of coffee. A study by Zekarias *et al.* (2012) on market chain analysis of forest coffee in south western Ethiopia found that Quantity production has significant effect.

Extension contact (EXTCNT): Result of the study indicated that extension service was positively and significantly affected the volume of coffee product supplied to the market at 1% significance level. If number of contacts to the extension agent increased by one the amount of coffee supplied to the market increases by 0.005 kilogram. This suggests that extension service avails information regarding technologies which improves production of coffee that affects the volume coffee supplied by the household to the market positively.

The result of this study goes along with the findings of many authors. For instance, Yishak (2005) and Rehima (2006) found that access to extension service on improved maize seed, red pepper and improved haricot bean respectively affected marketed supply of each of the commodities significantly and positively.

Price of coffee in 2013 (PRCLAG): The price of coffee in 2013 was previously expected to have positive sign in determining the volume of coffee supplied to the market. The model result also revealed that the variable coefficient was positive and statistically significant at 1% significance level. The positive and significant relationship indicates that as the last year price of coffee at the

market raised by one birr the quantity of coffee supplied to the market also rises by 0.169-kilogram next year.

Distance to the nearest market (DSTMKT): This variable was expected to adversely affect quantity of coffee supplied to the market. It was argued that distant markets increases producers marketing cost which in turn reduces the volume of output supplied to the market. The result obtained from the model output indicates that the variable affecting volume of coffee marketed surplus negatively. An increase in one hour walking time to the nearest coffee market will lead to a decrease in the quantity supplied by 0.123 kilogram. The variable was also statistically significant at 5% significance level. Earlier study by Mohammed (2012) also revealed that market distance affecting marketed supply of coffee negatively in Nensebo district of Oromia.

Table 4: OLS results of determinants of coffee market supply

Variables	Coefficient	Standard error	t-ratio	p-value
Constant	2.767***	0.246	11.24	0.000
Sex	0.049**	0.024	2.07	0.041
Age	0.001	0.002	0.59	0.554
Education	0.013**	0.006	2.01	0.047
Coffee productivity	0.334***	0.036	9.13	0.000
Extension	0.005***	0.002	3.32	0.001
Lagged price	0.169***	0.035	4.78	0.000
Credit	0.018	0.034	0.51	0.609
Market distance	-0.123**	0.058	-2.29	0.024
Family size	-0.007	0.005	-1.40	0.164
Farm size	0.012	0.044	0.30	0.768
Coffee land	0.056	0.057	0.97	0.333
Non-farm income	-0.001***	0.000	-2.63	0.010
Market information	0.084**	0.033	2.52	0.013

Source: Own computation, 2014

Dependent variable=quantity supplied, N=123, R^2= 0.6701, ***, ** and * shows the values statistically significant at 1%, 5% and 10% respectively.

Non–farm income (NONFINC): The argument was as the farmer's income from non-farm income increases as compared with farm income sources they will

tend to minimize agricultural activities and focuses on those non-farm activities which they benefits more. This leads to decrease in their volume of farm output or coffee produced and supplied to the market. The result of the model indicated that this variable affecting supply of coffee negatively and it is statistically significant at 1% significance level. As the farmers non-farm income increases by one unit the coffee product volume supplied to the market to decreases by 0.001 kilogram.

Market information (MKTINFO): it was hypothesized to affect the volume of coffee supplied positively. The variable's coefficient is positive and statistically significant at 5% significance level. The coefficient also confirmed that accessing market information to farmers will tend to increase the marketable supply of coffee by 0.084 kilogram. Earlier study by Mohammed (2012) also indicated that access to market information affecting market supply of coffee positively in Nensebo district of Oromia.

4. Conclusion and Implications

The study investigated the market chain analysis of coffee product in the Dale district of southern Ethiopia. The study objectives were identification the marketing channels and determinants of coffee market supply in the study area.

The study identifies five major marketing channels. Though the coffee marketing channel in the study area was relatively short, the existence of informal traders in both rural and urban areas discouraged the legal/licensed traders. These informal traders do not pay taxes and can affect price in the market. The informal traders are also making the price margin at the expense of producers by reducing the farm gate price or by cheating weighting scales.

The result of marketing costs and margin analysis imply that coffee producers incurred the highest cost which was birr 1725.5 followed by wholesalers which incurred birr 815.32. The coffee collectors bear the lowest cost birr 468.52. About 36.9 percent of total gross marketing margin was added to coffee price in channel I. Out of the total gross marketing margin about 9.6% was gross margin of coffee collectors, while 27.3% was that of the wholesalers. Hence, the study pointed out that all marketing participants of the commodity operated

at profit. This indicated that all the marketing agents were advantageous through the channel.

The average coffee wholesalers retained significant annual total net benefit than producers and coffee collectors. The estimated annual net benefits of a typical coffee producer, coffee collectors and coffee wholesalers in Dale district were birr 4887.96, birr 2 016.54 and birr 255 354.21 respectively. This implies that coffee trading is relatively highly profitable at the wholesale level.

Regarding determinants of marketable supply of coffee with the help of multiple linear regression model analysis was employed with thirteen hypothesized variables. The result pointed out that only eight variables namely sex of the household head, education level of household head, quantity of coffee production, price of coffee in 2013, distance to the nearest market, non-farm income, access to extension service, and access to market information were found to be significantly affecting the market supply of coffee at household level.

Coffee plant diseases called *Gibrill* and *CBD* were the bottlenecks for coffee production for about 97.6% of the coffee growing farmers. Therefore this problem should be taken as serious by the respective government bodies and take action to tackle it by improving the farmer's production system through extension agents. In addition to this there should be enough supply of farm inputs for the farmers to reduce the effect.

Since the coffee market in the study area was oligopolized, government should attract other traders to enter into coffee trade by improving the existing credit system and giving different incentives in order to make the market more competitive.

Existence of informal traders in the coffee market discouraged the legal traders to expand their business or enter into the market (for new traders). Hence the government should take action to protect the legal traders from unfair competition with informal traders either by preventing informal traders not to participate or convincing them to become legal.

Improving the market infrastructures is another area of intervention to improve the coffee marketing system in the study area. Due attention should be given to the improvement of communication networks in different coffee production sites and marketing centers of the study area.

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Appendix Table 1: Test for multicollinearity

Variable	VIF
Non-farm income	9.09
Lagged price	7.98
Distance from the nearest market	7.93
Extension service	7.87
Land holding	7.26
Age	6.64
Coffee land	6.29
Productivity	5.20
Credit	2.68
Family size	2.14
Household education level	1.95
Access to market information	1.92
Sex of the house hold head	1.06
Mean VIF	5.23

Source: Own computation, 2014