

Ethiopian Journal of Economics

Volume XXVII

Number 2

October 2018

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A Publication of
THE ETHIOPIAN ECONOMICS ASSOCIATION
(EEA)

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VOLUME XXVII NUMBER 2 OCTOBER 2018

Published: April 2020

Does the Export Competitiveness of Coffee Improving So far?

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Abstract

The general objective of the study is to examine the export competitiveness and determinants of export performance of the Ethiopian coffee sector. In analyzing competitiveness of the country in its coffee exports, data from UNCTAD-ITC is used for the periods 1991-2016. The Revealed Comparative Advantage (RCA) and Revealed Symmetric Comparative Advantage (RSCA) measures of competitiveness were used for the analysis. Furthermore, a multiple regression (OLS model) has also been employed to investigate the determinants of coffee export competitiveness and performance as well. Results for the RCA and RSCA showed that Ethiopia has comparative advantage in exports of coffee.

The regression analysis revealed domestic consumption level of coffee affects export competitiveness adversely and this relationship is statistically significant. All other variables including domestic production level, world price of coffee, exchange rate and export volume were found to affect export competitiveness positively and the effect is significant. Though domestic producer price affects the export performance of the sector positively, the effect is statistically insignificant. The government of Ethiopia should put measures in place to address current inefficiencies on the supply side, most importantly management of price risk, resulting from the volatile nature of coffee prices, both domestic and international and the gap between the time of purchase of beans from buyers and the sale to exporters, quality control, smuggling, illegal dealers and transaction costs.

Key Words: Coffee, Competitiveness, Export, Ethiopia, RCA, RSCA

JEL Classification: Q27, N70

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1. Introduction

The idea that the world is increasingly becoming more and more interconnected can be seen today from various perspectives. The process of economic integration, globalization and technological advancement strengthen the export development of nations. Export development plays an important role in promoting economic growth and development. It contributes significantly to enhance capital inflow, reduce trade balance deficits, make balance of payments (BOP) surplus, increase employment and expand the production base of a nation. Export is one of the prominent channels of technology transfer from developed economies to the Least Developed Countries (Pack, 1993). Developing countries can expand their markets by allowing firms to export and achieve economies of scale.

As a result of the increasing size of international trade, the concept of export competitiveness plays a vital role in the international trading system. It has been given attention in order to develop national export portfolios. To promote economic development and indeed survival in the global competitive market, it has become an essential component for a country (Sachitra, 2013). Export competitiveness or export performance generally can be measured by several factors, including a real exchange rate, comparative advantages, terms of trade, geographic concentration, trade policies, domestic production and consumption, world income, and prices. This study will employ Revealed Comparative Advantage (RCA), Revealed Systematic Comparative Advantage (RSCA) and simple linear regression to check the export competitiveness of coffee.

Substantial improvement has been made in importing countries with respect to the reduction or removal of certain tariffs. These efforts have been undertaken both within the multilateral framework created by various rounds of trade negotiations of GATT Agreements including the Tokyo, Uruguay and Doha rounds, and within the framework of regional or bilateral agreements. In addition, Member countries of the European Union have applied a preferential trade system to the African, Caribbean and Pacific States (ACP) since 1975. Some countries do not benefit or benefit only partially from tariff reduction measures applied by the European Union within the framework of these trade cooperation agreements. In the case of these countries, for example, only exports of green coffee are exempt from

tariffs, indicating that the creation of added value must take place within the European Union (Cherkos, 2017).

Coffee is outstanding for being produced in nearly all non-arid countries in the tropics. In many of these countries, foreign exchange earnings from coffee exports are of vigorous significance to the balance of payments and to their overall economies. Coffee is an important element of development, generating cash returns in subsistence economies; moreover, production and harvesting of coffee is labor-intensive, and it provides an important source of rural employment, for both men and women. In terms of international trade, coffee is the most valuable tropical agricultural product. According to Utting-Chamorro (2005) coffee is the “second most traded commodity after petroleum” and it also “determines the livelihoods of 25 million poor families”. Its status as a major export for many countries and a determinant of the wellbeing of many national economies, gives it significant importance in the global economy.

According to the IMF Country Report of 2016, Ethiopia relies heavily on agriculture for its foreign exchange earnings. The major agricultural export crop is coffee, providing approximately 35 percent of Ethiopia's foreign exchange earnings (David B., Christian C., 2013 and Yetsedaw E. 2017). Ethiopia is the original home of coffee Arabica and is well-known for its production of high-quality coffee. The export of this commodity has found well-established and profitable markets; providing huge amounts of foreign currency and enhancing economic development (Yetsedaw, 2014).

There have been significant domestic policy reforms in the last decade that have affected the structure and performance of Ethiopia's coffee export sector, not least the creation of a new and modern commodity exchange. From December 2008, it became mandatory for private traders to sell their coffee through the Ethiopian Commodity Exchange (ECX). Gabre-Madhin and Goggin (2005) argued that a commodity exchange in Ethiopia held the potential to produce a more integrated agricultural market, and the introduction of an exchange has been justified from a bottom-up perspective. Certainly, both farmers and traders have seen a better-organized domestic and regional market, and improved agro-processing. In addition, the commodity exchange has had the potential to produce a more efficient and

integrated agricultural market by providing actors with better information about market prices, quality controls and product standards as well as a legal framework to reduce the risk of default. Equally, of course, the success of a commodity exchange depends critically on the economic order and the linking of institutions such as market information systems, quality certification, regulatory frameworks and legislation, arbitration mechanisms, and producer and trade associations.

Tadesse G. (2015) investigated the major determinants of coffee export supply in Ethiopia for the period of 1981-2011. His study employed a Vector Auto Regressive and Error Correction approach to identify the major determinants. It further used the Granger causality test to find the direction of causality between coffee export supply and some of the independent variables. The findings indicated that the real export price of coffee, domestic production, physical infrastructure, and the world supply of coffee all affected Ethiopian coffee exports significantly. The ratio of export plus import to GDP, a proxy for openness to trade, affected exports only in the long run. The report found that the impact of the real exchange rate in both the long and the short run was statistically insignificant. The Granger causality test established bi-directional causality of coffee exports with domestic production of coffee, but direction of causality of coffee exports with real export price and world production of coffee was uni-directional. The policy implication is that improvement in the quality of coffee exports, expansion in domestic production and in the road sector, could all have a significant effect on the supply of coffee for export.

Hussein M and Nandeeswara R. (2015) attempted to analyze the determinants of Ethiopia's Sidama coffee exports in the international market over fourteen years using the Tobit Random Effect Model. The result of the traditional gravity model showed that most of the exogenous variables demonstrated that Ethiopia's GDP was significant and had a positive effect on the export of Sidama coffee. The coefficients of the exporter country's population and importer country's population had positive and negative impact respectively. However, only the economic size of the exporting nation, difference in per capita income and the resistance factor of distance had a significant effect on the Sidama coffee trade. The structure of Ethiopia's foreign trade has meant a concentration of exports to a limited

number of countries; and Europe accounts for almost all exports including Sidama coffee.

Given that coffee is among the top products prioritized by the Government of Ethiopia as a major source of foreign exchange, we looked at the potential determinants of the export performance of the sector to assess the extent to which it is internationally competitive. In doing so, we employed an econometrics technique and a generally accepted measurement of export competitiveness. We also considered the export performance and export competitiveness of the top export exporting countries. This paper then forwarded some implementable solutions for the observed problems of the export performance. Our approach differs from previous studies on export competitiveness as we have employed both RCA/RSCA and econometrics technique at the same time to explore the extent in which Ethiopian coffee is internationally competitive.

2. Coffee as a Global Commodity

Coffee is remarkable for being produced in almost all non-arid countries in the tropics. Over 50 countries produce coffee in significant amounts; in many of these, earnings from coffee exports are of vital importance to the country's balance of payments. A further characteristic is that, with negligible exceptions, coffee is produced in developing countries, including a significant number of least developed countries (LDCs). Consumption, on the other hand, largely takes place in industrialized countries. Coffee is an important agent of development, providing a livelihood for millions of people around the world; generating cash returns in subsistence economies and, since coffee production and harvesting are labor-intensive, providing an important source of rural employment, for both men and women.

Small-scale producers are more vulnerable to economic swings, so if the price of production dips below the amount they receive for the product, producers look for ways to lower the cost of production. Often this results in "threats to the land and wildlife where coffee is grown" perhaps through selling land to developers or plantations, failing to maintain high production standards, or simply neglecting land when producers seek work elsewhere

(Utting-Chamorro, 2005). Coffee is generally sold through the commodities market where price is determined by supply and demand. As an agricultural product, the supply of coffee is dependent upon many factors including weather, trade relations, and market conditions. A freeze in Brazil can decrease supply, resulting in increased prices almost overnight, while the establishment of new coffee producing regions can cause prices to fall (ICO 2015).

As coffee-producing regions tend to be among the more economically poorer regions of the world, poverty in these areas makes it tempting for struggling producers to cut corners in order to make short-term profits. (ICO 2015). Prolonged periods of low prices strain liquidity at the farm level, resulting in less than optimal input use during the following production cycle, negatively affecting yields and quality. The expectation of future coffee prices too low to cover full costs of production can hamper important investments in renovation of coffee plantations. Replanting is particularly important as part of the mitigation of the impact of climate change and to respond to increased pest and disease pressure. Low or negative profitability may also lead to the abandonment of coffee production as farmers may switch to other more profitable agricultural crops. There is widespread concern in the coffee sector that a prolonged phase of low coffee prices could negatively affect the supply of high-quality coffee beans and have adverse effects on household incomes in coffee growing communities. Specific policies need to be formed to address the issues of economic sustainability of coffee production, stabilizing supply in the future and enabling farmers to be fairly remunerated.

Because the health of the coffee market makes a significant difference to small-scale farmers, to coffee quality, and to the local environment, there has been an interest on the part of Northern consumers to get involved in the market. One such way has been to develop certification systems to ensure that standards are kept high. Certification systems developed for the coffee industry may have different focuses, but most include some mix of social, environmental, and economic components. In the meantime, consumers have become increasingly educated about coffee, resulting in exponential growth in the specialty coffee market and coffee with certification. Growth in the Eco labeled coffee industry has led to

competition among labelers and the temptation to exaggerate the benefits of a given Eco label to gain a larger market share. ICO (2015).

2.1 Ethiopian Coffee Industry

The story of coffee has its beginning in Ethiopia where Arabica Coffee originated and where it still grows wild in highland forests. In terms of varieties, all coffees from Ethiopia are typical Arabica; as the original homeland, numerous varieties have developed in Ethiopia. Among these is the well-known Gesha variety, indigenous to Ethiopia (but now best known as Panamanian Geisha after it was transported to Panama in the 1930s). The existence of numerous genetically diverse strains of coffee places Ethiopia at the center of origin, and as the center of diversity and dissemination of the plant.

The cultural heritage of coffee consumption has significantly contributed to sustainable production for centuries in Ethiopia. Coffee drinking in Ethiopia involves a unique ceremony that takes an hour or more. The ceremony has great value in human relations and stimulating discourse. During a coffee session different social, political and economic issues are raised, discussed and solved. It is estimated that the per capita consumption of Ethiopia's estimated 110 million people is around 2.3 kg per year, putting the annual domestic consumption at around 240,000 tons (ICO 2014).

Ethiopian coffee production systems are broadly classified into four: forest (8-10%), semi-forest (30-35%), garden (50-55%), and plantation (5-8%). The basis of Ethiopian coffee culture is rooted in organic farming, agro-ecological sustainability and biodiversity. Ethiopian coffee types are identified by their distinct characteristics such as flavor, aroma, and taste. Due to its unique qualities, exported Ethiopian coffee is commonly used when blending coffees of other origins, but Ethiopian coffee types are increasingly found in specialty markets branded in the specific name of producing areas.

Ethiopia is the first country where coffee was sold according to the location in which it was produced. Known coffee types produced and exported from Ethiopia now include Yirgacheffe, Sidamo, Limu, Teppi, Bebeke, Djimma, Lekkempti, Kaffa and Harrar. These are found growing in

the southern, south-western and eastern parts of the country. New coffee types emerging from the northern producing region include Zege and Ayehu. The profiles of coffees coming from individual growing regions have distinctive and inherent qualities. These match well with the interest of customers who chose to buy certain and selected qualities only.

Coffee is the leading export commodity in Ethiopia which is the biggest coffee producer and exporter in Africa and among the world leaders. Ethiopian coffee has been exported to more than 50 countries, but major current destinations are Germany, Saudi Arabia, Japan, Belgium, United States of America and France. In addition to the significance of coffee as a major export commodity, it provides a means of livelihood for millions of people and plays a vital role in their socio economic and cultural values. Since 90% of the coffee in Ethiopia is produced by smallholder farmers, coffee is an important source of income and employment at farm level.

It is produced mainly in 5 regions of the country, that is in 30 zones or 172 Woredas (districts). Of these, 125 Woredas are considered major producers for export. An estimated 700,000 hectares is devoted to coffee production and overall annual production is 480,000 tons a year, of which some 50% is consumed domestically. 25% million people are directly and indirectly engaged in the sector. (MoT Report 2016).

3. Research Methodology

3.1 Data Type, Sources and Method of Analysis

- a. Data Type:** Data type for this study is basically secondary data collected from different sources. However, we have also informally consulted individuals who are involved/well informed about the export sector. Though their input is not included in the analysis separately, their information has provided benchmarking and cross checking for the result obtained from the formal methods of data analysis employed.
- b. Data Sources:** The main sources used in this study include the International Coffee Organization, International Trade Centre, Ethiopia Revenue and Customs Authority, ECX, Ministry of Trade, National Bank of Ethiopia.
- c. Method of Data Analysis:** After collecting the necessary data for the variables included in the model and the variables used to calculate RCA

from the above-mentioned sources, we employed RCA, RSCA and an econometrics tool to assess the determinants of export performance and export competitiveness of the sector.

A. Revealed Comparative Advantage (RCA)

The RCA analysis is largely based on contributions of Balassa (1977) and Vollrath (1991). The concept of RCA was introduced by Balassa in 1965 to identify the relative trade performances of countries. In this model, it is assumed that the commodity pattern of trade reflects inter-country differences in relative costs as well as in non-price factors.

The RCA indicates whether a country is in the process of extending the products in which it has a trade potential, as opposed to situations in which the number of products that can be competitively exported is static. A measure of revealed comparative advantage is used to help assess a country's export potential. It can also provide useful information about potential trade prospects with new partners. RCA measures, if estimated at high levels of product disaggregation, can focus attention on other nontraditional products that might be successfully exported.

Revealed Comparative Advantage (RCA) is one of the measures of international competitiveness and has gained general acceptance (Utkulu and Seymen, 2004). It is based on conventional trade theory and measures a country's exports of a commodity relative to that of a set of countries. RCA indices evaluate export performance as the total exports of a specific product, divided by the total exports of that country, compared to the world exports of the product, divided by total world exports. The factors that contribute to movements in RCA are economic: structural change, improved world demand and trade specialization. The RCA index is defined as the ratio of two shares. The numerator is the share of a country's total export quantity of the commodity of interest in its volume of total exports. The denominator is share of world exports quantity of the same commodity in total world exports volume. RCA is defined as follows:

$$RCA_{ij} = (X_{ij}/X_{it}) / (X_{wj}/X_{wt}) \quad (1)$$

Where, RCA_{ij} represents the RCA of a given country i ,

X_{ij} represents the export volume of product j in country i ,

X_{it} represents the total export volume of country i ,

X_{wj} represents the export volume of product j of the world and

X_{wt} represents the total export volume of the world.

$RCA < 1$: the product has no capacity of competitiveness

$1 < RCA < 2.5$: the product has a low capacity of competitiveness

$RCA > 2.5$: the product has a high capacity of competitiveness

B. Revealed Symmetric Comparative Advantage (RSCA)

The Revealed Symmetric Comparative Advantage measure reflects the RCA in its symmetric form as an index of competitiveness.

$$RSCA = \frac{RCA - 1}{RCA + 1} \quad (2)$$

Where the RSCA ranges from [-1 to +1]. The closer the value is to +1, the higher the competitiveness of a country in the commodity of interest.

C. Multiple OLS Regression

In assessing the determinants of export competitiveness, the study applied an econometrics technique, a multiple OLS analysis, using different variables identified according to various studies conducted on export competitiveness. Export competitiveness is indexed by the RSCA and will be explained by the independent variables which include domestic production of coffee, the price of domestic currency per unit of foreign currency, the volume of export, world coffee price, domestic consumption and domestic producer price. The OLS regression equation will be:

$$RSCA_t = F [DPC_t, EXR_t, EXP_t, WCP_t, DCC_t, DPP_t] \quad (3)$$

Where,

- $RSCA_t$ = Revealed Symmetric Comparative Advantage at time t
- DPC_t = Domestic Production of Coffee (tons) at time t
- EXR_t = Exchange Rate of Birr in terms of USD at time t
- EXP_t = Export volume of coffee at time t
- WCP_t = World Price Coffee at time t

DPPt = Domestic Producers Price at time t

DCCt = Domestic consumption of coffee at time t

The above expression can be rewritten as follows after it is transformed into a log-log form of equation:

$$\text{LnRSCAt} = \beta_0 + \beta_1 \text{LnDPCt} + \beta_2 \text{LnEXRt} + \beta_3 \text{LnEXPt} + \beta_4 \text{LnWCpt} + \beta_5 \text{DPPt} + \beta_6 \text{DCCt} + \varepsilon_t \quad (4)$$

Where, ε_t = white noise error term and others are log-form of the variables presented above.

Both the dependent and explanatory variables are expressed in a logarithmic form, the coefficients β_1 - β_6 take to mean the elasticities. Of all those coefficients, the sign of the first three betas are attention-grabbing testing the hypothesis developed above.

Table 1: Description of variables and source of data

Var	Description	Expected Sign/Remark
RCA	Is composed of four important variables: World total export of all products, World total export of coffee, Ethiopia total export of all products, Ethiopia total export of coffee.	Not in the regression
RSCA	Revealed Systematic Comparative Advantage of coffee obtained from the results of RCA	Dependent variable
DPC	Domestic production of coffee in tons is taken from ICO	Higher production implies higher export level.
EXR	Exchange rate of domestic currency in terms of foreign currency. Equivalently this can be used for the degree of devaluation	Devaluation motivates domestic exporters expected to have positive effect
EXP	A time series data on total export of coffee taken at HS code of 2 digits. For this paper, it is taken from ITC but cross checked with the data from ICO. Increasing totals does not necessary mean that Ethiopia is more competitive. It instead depends on the total export of the country and the ratio of world coffee export to world total export of all products	Can be positive or negative
WCP	Data on World Price of coffee is obtained from International Coffee Organization data base and the higher the international price of coffee is, the higher exporters will tend to sell abroad.	Positively related
DPP	Domestic producer's price of coffee will have an adverse effect on the motivation of domestic exporters to export their product to the rest of the world. Exporters will find it profitable to sell their product domestically provided that the relative price is higher.	Negative effect
DCC	Domestic consumption of coffee is simply obtained from the difference of domestic production and total export of the sector.	Potential negative effect on export performance and then competitiveness as well.

4. Data Presentation, Analysis and Discussion

4.1 Overall Trade Performance of Ethiopia

As discussed above, the degree of openness to international trade shows how much an economy is exposed to international relationships or the degree of integration with the external market. Developing countries export primary products (agricultural products) for cheap international prices and import in turn capital goods including machinery, chemicals and automobiles for higher prices causing trade balance deficits. Ethiopia's circumstances today are no different from those under which the trade balance of the country has been in deficit for the last decade or so.

According to the expenditure approach of measuring GDP, if imports exceed exports then the GDP of a country will deteriorate, other things being constant. However, this deterioration can be counterbalanced and compensated by the gains resulting from imports.

Table 2: The Trends of Export and Import for Ethiopia from 2008 -2016 in Billions of Birr

Indicators	2008	2009	2010	2011	2012	2013	2014	2015	2016	Average
Economic Growth	8.69	12.66	13.07	8.65	10.58	10.26	10.39	7.34	10.9	10.28
Export Value	42.88	42.97	62.72	85.95	77.04	77.26	79.44	70.53	64.74	67.06
Growth	-0.57	0.22	45.96	37.04	-10.36	0.28	2.82	-11.22	-8.20	6.22
Import Value	115.93	117.43	151.87	162.49	177.01	179.39	198.56	228.17	224.62	172.83
Growth	6.65	1.30	29.32	6.99	8.94	1.34	10.69	14.91	-1.56	8.73
Trade balance	-73.05	-74.46	-89.15	-76.54	-99.97	-102.1	-119.1	-157.7	-159.9	-105.77
Openness, % GDP	42.69	39.67	47.11	48.23	45.40	41.47	40.74	39.66	35.79	42.31

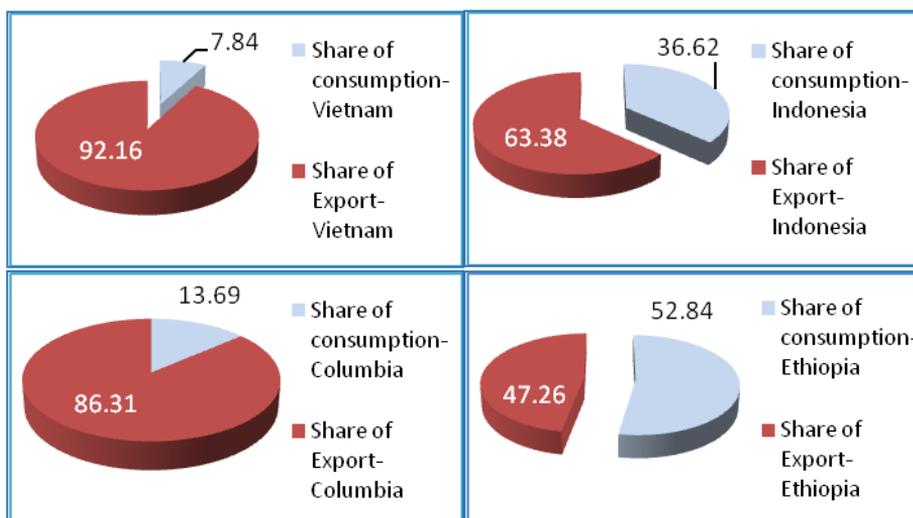
Source: NBE and authors' computation

4.1.1 Coffee production, consumption and export performance of top producers in the world

Ethiopia is one among the largest producing and exporting countries of coffee products in the world. Coffee production has contributed substantially to both domestic and foreign earnings in the country. Moreover, coffee also serves as a primary source of labour, especially for rural smallholder farmers. Ethiopia is fifth in the world in total production, according to statistics from the International Coffee Organization, and many of its Arabica beans are recognized internationally for their high quality. However, in this birthplace of coffee, a conflict is brewing over who gets Ethiopia's best beans. The government wants dollars to build infrastructure, and so it has ambitious targets to increase coffee exports, capitalizing on world-wide demand for its high-end Arabica beans. But Ethiopians, Africa's top coffee consumers, want to keep the beans at home; and with urban incomes rising, Ethiopian coffee drinkers increasingly want better quality. In most cases, the domestic price is higher than international prices and as a result, exporters are reluctant to export their product into international markets. They prefer to sell their product at home rather than export to the rest of the world. The government wants exports to be promoted to raise hard currency.

The pie charts below are drawn-up using the average data from 2010-2016 extracted from International Coffee Organization for the purpose of comparison. They show the shares of coffee consumed domestically on average, Vietnam exported over 92 percent of its total production and domestic coffee consumption is only about 8 percent. Coffee has been the major source of foreign exchange and domestic consumption has remained small. Similarly, Columbia has exported over 86 percent of its production annually with only 14 percent is consumed at home. Indonesia and Brazil have been larger domestic consumers but both have kept exports significantly higher than domestic consumption. By contrast, in Ethiopia for the last seven years, while domestic consumption and export volume have almost balanced, domestic consumption has continued to be slightly higher than export volume.

Figure 1: Share of domestic consumption and export volume for the top five coffee growers



While demand for specialty coffee is creating a new and expanding market for Ethiopian beans, the push to export also comes as coffee countries face steep competition. Currency devaluations in the world’s largest Arabica producers have pushed farmers to export beans, but Ethiopia is also competing against other African producers like Uganda, Kenya and Tanzania to export premium beans, and these are countries in which people mostly drink tea and produce coffee largely for export. Without gains in production and with steady competition at home, Ethiopia’s answer may not lie in exporting more coffee but in simply charging more.

Compared to top coffee producers like Brazil and Vietnam, domestic consumption of coffee in Ethiopia is far larger. The level of export for other top producers is usually significantly greater than the quantity of coffee being consumed domestically. In Ethiopia, according to the data extracted from the International Coffee Organization, the average share of coffee being exported and consumed domestically for the last ten years is estimated to be 47.26 percent and 52.84 percent respectively.

Though there have been fluctuations in the quantity of coffee produced and the export levels of coffee, the amount of coffee consumed domestically shows no decrease, rather the reverse. Indeed, any decrease in

domestic production is reflected solely in a decrease of export volume. Whenever, domestic production levels decrease, export volume decreases but not domestic consumption.

Table 3: The growth rate of domestic coffee production, domestic coffee consumption and export in ‘1000 sixty-kilogram bags

Year	Domestic production	Growth-Rate	Domestic consumption	Growth-Rate	Export	Growth-Rate
2005	5550.74	-	2748	-	2802.74	-
2006	5966.68	7.49	2894	5.31	3072.68	9.63
2007	4948.99	-17.06	3048	5.32	1900.99	-38.13
2008	6931.20	40.05	3210	5.31	3721.20	95.75
2009	7500.38	8.21	3383	5.39	4117.38	10.65
2010	6798.41	-9.36	3383	0.00	3415.41	-17.05
2011	6233.01	-8.32	3400	0.50	2833.01	-17.05
2012	6427.44	3.12	3550	4.41	2877.44	1.57
2013	6575.26	2.30	3625	2.11	2950.26	2.53
2014	6713.98	2.11	3700	2.07	3013.98	2.16
2015	7296.98	8.68	3725	0.68	3571.98	18.51
2016	7650.00	4.84	3750	0.67	3950.00	10.58

Source: ICO

The trend of domestic coffee consumption has continuously increased over time, while the lines for domestic production and export of coffee show fluctuations. Roughly speaking, the quantity of domestic consumption of coffee exceeded the level of coffee exports between 2010 and 2015 and from 2015 has started to be balanced. This shows the domestic demand for coffee is continuously increasing and the Ethiopian people are strengthening their tradition of drinking more cups of coffee, and this in turn results in higher domestic prices. When domestic prices increase and become relatively higher than international prices, exporters always seek to sell their product domestically, despite the government strategy of export promotion to accumulate hard currency. Shortages of foreign currency affect the government’s financial capacity to import products from the rest of the world. A combination of these circumstances affects the overall economy adversely.

4.2 Empirical Analysis

4.2.1 Revealed comparative advantage

The Revealed Comparative Advantage (RCA) is an index used in international economics for calculating the relative advantage or disadvantage for a certain country in a certain class of goods or services as evidenced by trade flows.

This study has conducted a RCA index analysis for Ethiopia and other top producers/exporters in order to assess the degree of advantage or disadvantage that they have in the international market. As discussed above, a RCA index greater than one indicates countries have a comparative advantage in the sector whereas a RCA index less than that offers a comparative disadvantage in the international market.

Table 4 shows a comparison of the Revealed Comparative Advantage indexes for coffee for the period of 2006 to 2016 based on the data extracted from the UNCTAD-ITC database. The RCA indices of Ethiopia and other countries including the top producers of coffee in the world (Brazil, Vietnam, Columbia and Indonesia) and in Africa (Ethiopia, Uganda and Kenya) are summarized for comparison. The table indicates that the RCA index of coffee for all the countries is greater than 1 which indicates that all of these countries gain comparative advantage from their coffee exports.

Ethiopia's coffee sector in general enjoys significant comparative international advantages owing to its quality, production potential and available raw materials, highly disciplined workforce and reasonable prices; and it boasts the largest RCA.

Given the comparative advantages of coffee, the product has the potential to gain a significant market share in the global market and to become a world class supplier of high quality processed and raw coffee beans, though a value-added export is more recommended than exporting the raw product. However, the extent to which these comparative advantages translate into a competitive advantage on international markets depends on a number of other factors, especially the overall technical efficiency of the sector, labour productivity, and the quantity and quality of the locally supplied raw materials.

Table 4: Revealed Comparative Advantage of Ethiopia and the Top Producers

Country	RCA Ethiopia	RCA Brazil	RCA Vietnam	RCA Columbia	RCA Indonesia	RCA Uganda	RCA Kenya
2006	330.43	17.34	24.72	49.32	4.72	159.60	31.91
2007	254.96	16.50	30.72	45.01	4.34	154.81	31.56
2008	255.80	15.34	24.57	37.14	5.27	170.40	22.26
2009	142.23	15.42	18.86	29.83	4.40	111.25	28.06
2010	187.24	16.08	15.99	29.99	3.22	109.44	25.04
2011	162.79	15.76	14.32	23.45	2.56	108.64	19.19
2012	178.16	13.15	17.20	18.03	3.65	87.72	24.28
2013	156.31	12.69	12.91	21.83	4.30	118.02	23.02
2014	155.62	15.89	13.03	27.14	3.49	107.12	22.36
2015	154.64	15.66	8.02	38.83	4.28	95.53	22.67
2016	143.82	13.60	7.98	41.22	3.62	77.65	23.40
Average	192.91	15.22	17.12	32.89	3.99	118.20	24.89

Source: Authors' calculation of data extracted from ITC

The RCA index of the coffee of Ethiopia is much higher than the other countries including the largest coffee producer, Brazil, pointing to a promising capacity for exploitation relative to other countries. However, given other constants, these RCA figures are simply used for the sake of comparison between the top coffee exporters. A RCA index does not necessarily mean the comparative advantage is absolutely higher for Ethiopia compared to others. There are various other factors to be considered including the total export of all products of the countries viz-a-viz the total export of coffee. Other countries have more diversified exports than Ethiopia which mainly depends upon coffee as a source of forex.

We noted earlier that the RCA is the ratio of two different ratios, that is, a share of a country's total exports of the commodity of interest divided by total exports, and volume and its share of the world total export volume of the product against total world exports. The decreasing trend of Ethiopia's RCA in the coffee sector shows that the composition of the exportable products of the country is expanding. We argue that the export sector of Ethiopia is dominated by few products, and the composition is increasing as

shown in the increase of the volume of Ethiopia’s total export of all products compared to the export volume of coffee. Ethiopia is now experiencing a decreasing comparative advantage, but its RCA has been stable over years and remains substantially much greater than other countries investigated in this study.

4.2.2 Revealed systematic comparative advantage

In addition to the RCA, this study also carried out a RSCA analysis to investigate the export competitiveness of coffee for the period 2006-2016. For the purpose of comparison, the coffee export data of the top coffee growers both worldwide and in Africa were considered. RSCA ranges from -1 to +1. The closer the value is to +1, the higher the competitiveness of a country in the commodity of interest.

Table 5: RSCA index of top coffee producers and exporters

Country	RSCA Ethiopia	RSCA Brazil	RSCA Vietnam	RSCA Columbia	RSCA Indonesia	RSCA Uganda	RSCA-Kenya
2006	0.99397	0.89093	0.92225	0.96025	0.65054	0.98755	0.93922
2007	0.99219	0.88570	0.93695	0.95653	0.62556	0.98716	0.93858
2008	0.99221	0.87763	0.92179	0.94755	0.68118	0.98833	0.91403
2009	0.98604	0.87822	0.89931	0.93513	0.62975	0.98218	0.93118
2010	0.98938	0.88292	0.88230	0.93546	0.52610	0.98189	0.92321
2011	0.98779	0.88065	0.86946	0.91821	0.43829	0.98176	0.90092
2012	0.98884	0.85864	0.89011	0.89492	0.57022	0.97746	0.92089
2013	0.98729	0.85390	0.85619	0.91240	0.62234	0.98320	0.91673
2014	0.98723	0.88158	0.85741	0.92893	0.55453	0.98150	0.91439
2015	0.98715	0.87998	0.77825	0.94979	0.62154	0.97928	0.91552
2016	0.98619	0.86297	0.77734	0.95263	0.56711	0.97457	0.91805
Average	0.98893	0.87574	0.87194	0.93562	0.58974	0.98226	0.92115

Source: Authors’ computation using UNCTAD-ITC database

The index of RSCA is closer to +1 for the product throughout this period indicating that Ethiopia held comparative advantage in the sector in the world market. Looking at the average Revealed Systematic Comparative Advantage index of Ethiopia, 0.98893, it is very close to one. This indicates

that, the sector is internationally competitive in the world market for coffee and it is considered preferable to others, due to taste and quality relative to other countries.

Generally, the results of both the Revealed Comparative Advantage and the Revealed Symmetric Comparative Advantage indices demonstrate Ethiopia's comparative advantages in the export of coffee. It is true that if the RCA indicates a country has a comparative advantage over a specific product, then it is likely to get a RSCA closer to an index 1. The reverse also holds true, with a comparative disadvantage, the RSCA index will be negative and closer to -1. In this specific table, the RSCA of all the top exporting countries is positive and show significantly larger figures.

4.2.3 OLS regression result

Prior to running the OLS regression on the determinants, all the variables included in the model needed to be checked for their stationarity. In most cases, economic variables are non-stationary at their level. However, in a few circumstances, time series data sets can be stationary if a growth is being used. According to A.H. Studenmund (2014), any time series whose mean and variance do not change with time is a stationary series. That is if both mean and variance are not varying over time and if the correlation coefficient of variables and the lagged variables depend on the lag lengths, then the time series is said to be a stationary time series. If either of the above properties is violated, that is if neither a mean nor variance change with time then the series is non-stationary. If a non-stationary variable is being regressed on another non-stationary dependent variable, the result will lead to a spurious regression (M. Verbeek, 2004) in which inferences based on such regression would be confusing and estimators provide false estimators.

In order to know whether the variables included in our model are stationary or non-stationary and to make sure that the regression result obtained is not spurious, it is best to use a non-stationary test, a Unit Root Test as indicated in Studenmund (2014). Then, after having all variables included in the specified model being stationary, the problem of spurious regression will not be relevant. Traditionally, sketching a time series plot of variables can be used to identify if the series is stationary or non-stationary by simply looking to see if it is trending up or trending down.

In this study, the researcher has used an ADF-test to check the stationarity of the variables. All the variables were found non-stationary at their level after being transformed into logarithmic form. Regressing the non-stationary variables on some non-stationary variables will not help to investigate the determinants of coffee export, so we must difference the variables to convert them into stationary data. Variables should be continuously differenced until they are found to be stationary. In line with this, all the variables become stationary after differencing them once with the exception of domestic coffee consumption level which only became stationary after the second differencing. The following table presents the detailed ADF test of stationarity.

Table 6: Unit root test of stationarity using Augmented Dickey Fuller

		Augmented Dickey Fuller Test			Remark
		P-Value (without constant)	P-Value (with constant)	P-Value (with constant & trend)	
RCA	Level	0.4194	0.5088	0.8671	
	1st difference	0.0000***	0.0011***	0.0051***	I(1)
LnDCC	Level	0.06609	0.1667	0.3770	
	1st difference	0.2387	0.4787	0.1582	I(2)
LnDPC	2nd difference	0.0000***	0.0000***	0.2778	
	Level	0.9992	0.6991	0.0013	I(1)
LnEXR	1st difference	0.0000***	0.0000***	0.0000***	
	Level	0.9999	0.9834	0.0000***	I(1)
LnDPP	1st difference	0.0000***	0.0000***	0.0000***	
	Level	0.7645	0.3740	0.5146	I(1)
LnEXP	1st difference	0.0000***	0.0006***	0.0037***	
	Level	0.9775	0.6677	0.0000***	I(1)
LnWPC	1st difference	0.0000***	0.0000***	0.0593*	
	Level	0.7610	0.3651	0.1635	I(1)
	1st difference	0.0000***	0.0005***	0.0034***	

Source: Authors' computation using GRETL

*, **, *** shows the significance level at 10%, 5% and 1% respectively.

H0: Not Cointegrated is tested against H1: variables are cointegrated.

After checking for the stationarity of variables and ensuring they are stationary the next task is running the OLS regression. In order to investigate

the main magnitude of the determinants of export competitiveness in the case of Ethiopia, this study has considered, export volumes, exchange rates, domestic production levels, domestic consumption levels, world coffee prices and domestic producer prices. A simple OLS regression was performed using the log-log form where the variables are changed using logarithmic form.

With regard to the signs of the explanatory variables, the following table reveals that signs are as expected as we hypothesized during the earlier steps of this research. In this model, all the explanatory variables (export volume, exchange rate, domestic production, level, domestic consumption level and world coffee price) are found to be significant at 1% though the domestic producer price is insignificant at any level.

Table 7: Model: OLS, using observations 1991-2017 (N = 27)

Dependent variable: *l_RCA*

HAC standard errors, bandwidth 2 (Bartlett kernel)

	Coefficient	Std. Error	t-ratio	p-value	
Intercept	11.6818	3.90712	2.9899	0.0072	***
LogDCct	-19.5915	3.88929	-5.0373	<0.0001	***
LogDPCt	25.4453	6.09525	4.1746	0.0005	***
LogEXPt	11.4011	2.75193	4.1430	0.0005	***
LogEXRt	2.17949	0.458655	4.7519	0.0001	***
LogDPt	-0.702225	0.432469	-1.6238	0.1201	
LogWPt	1.50055	0.365848	4.1016	0.0006	***
Mean dependent var	4.661525	S.D. dependent var	0.987188		
Sum squared resid	3.712978	S.E. of regression	0.430870		
R-squared	0.853462	Adjusted R-squared	0.809501		
F(6, 20)	33.81780	P-value(F)	1.88e-09		
Log-likelihood	-11.52731	Akaike criterion	37.05461		
Schwarz criterion	46.12547	Hannan-Quinn	39.75185		
Rho	0.301819	Durbin-Watson	1.324771		

Therefore, the equation according to the output using the GRETL Software package can be rewritten as follows:

$$\text{LogRCA}_t = 11.682 - 19.56\text{LogDCC}_t + 25.45\text{LogDPC}_t + 11.4\text{LogEXP}_t + 2.18\text{LogEXR}_t + 1.50\text{LogWCP}_t$$

(3.907) (3.889) (6.095) (2.752) (0.459) (0.366)

N = 27 year

R² = 85%

Adjusted R² = 81%

Values in parenthesis are standard errors

As presented in the table, domestic production level of coffee, the exchange rate, export volume of the product and world price of coffee all affect the degree of competitiveness positively and this relationship is statistically significant. However, domestic consumption level and export competitiveness are negatively related and this relationship is also statistically significant. The domestic producer price has a negative implication on the degree of competitiveness, though this impact is statistically insignificant.

We looked at the sign and magnitude of the effects of a unit change in the independent variables on the export competitiveness where it is measured by the RCA index for comparison purpose with those regressors that affect competitiveness. [[This now makes sense to me – does it to the authors??]] Referring to model above, on average with all things being equal, a one-unit change in the domestic consumption level shows a 19.6 percent change in the Revealed Comparative Advantage index of the country. More specifically, when the domestic consumption of coffee increases /decreases by 1 percent, on average, the export competitiveness of coffee will decrease/increase by 19.6 percent. This result is consistent in line with the findings of D. Boansi and C. Crentsil (2013). Tadesse G. (2015) investigated the major determinants of coffee export supply in Ethiopia for the period of 1981-2011 using VAR and an Error Correction Model. The findings of his study indicated that the real export price of coffee, domestic production of coffee and world supply of coffee significantly affected coffee export supplies.

However, in Ethiopia what is domestically consumed is part of the coffee which the ECX has refused to export due to problems of quality. Not all domestic consumption is of low quality non- exportable coffee, but much of it is. As a result, the figures may not correctly indicate the impact of domestic consumption of coffee on the sector's export competitiveness. Ethiopia also exports different types coffee including washed and unwashed,

roasted and unroasted, and these may also provide differences on pricing. We have used a 2-digit HS code that the UNCTAD ITC data base generates for this specific product.

On average, a one percent change in the domestic production of coffee and the export volume of coffee leads to 25.44 percent and 11.4 percent changes in the export competitiveness respectively. Holding everything to be constant, a 1 percent change in the value of domestic currency in terms of foreign currency, normally dollars will have an impact of 2.18 percent change in the export competitiveness of coffee. Yusuf M and Gnul M. (2013) have found that the export volume has a positive impact on the export competitiveness of a country. Our findings are compatible with their results.

Generally speaking, most of the results we obtained are consistent with the hypothesis or expected sign of independent variables included in the model to explain the export competitiveness with the exception of the domestic producer's price of coffee, found to have a positive but statistically insignificant effect. We started our regression including the ratio of world price to domestic price as regressors but then found these to be correlated with one or more of the explanatory variables and therefore excluded them.

Regarding the diagnosis, the study has performed different procedural tests (including Autocorrelation using Durbin-Watson, Heteroskedasticity using White tests, Multicollinearity using VIF, Outlier using CUMSUM1) to come up with this final stage. It is evident the model specification we followed does not exhibit any statistical problems and as a result can be taken as a good representation of the variables.

The accuracy of the fit (R-squared and Adjusted R2) of the model elaborates considerable relationship of the variables. About 85.3 percent (using R-squared) and about 81 percent (using Adjusted R2) of variations in the export competitiveness of coffee are described by the variations in the independent variables included in the model. The Durbin-Watson statistic also shows that the error terms are not serially correlated.

¹ See the outcome of those diagnosis tests in the annex

5. Conclusions and Recommendations

5.1 Conclusions

This study has aimed to identify the factors that affect the export competitiveness of the coffee sector in Ethiopia. Its conclusions:

According to data from ITC, more than half of the total amount of domestic coffee production is domestically consumed; only 47.26 percent of production is exported to the rest of the world. Top coffee producers export most of their production. The domestic consumption level of coffee in Ethiopia is increasing with time.

The RCA index of coffee for all the countries considered is greater than 1 which indicates that all these countries have a comparative advantage from the export of the product. Ethiopia's coffee sector in general enjoys significant international comparative advantages owing to its quality, production potential and available raw materials, highly disciplined workforce and cheap prices. Both Revealed Comparative Advantage and Revealed Symmetric Comparative Advantage show that Ethiopia has a comparative advantage in export of coffee.

Domestic consumption level of coffee affects the export competitiveness of the product adversely and this relationship is statistically significant. Higher consumption level at domestic level means export competitiveness will be reduced.

All other variables including domestic production level, world price of coffee, exchange rate and export volume are found to affect the export competitiveness positively and the effect is significant. Domestic producer price also affect the export performance of the sector positively, but the effect is statistically insignificant.

Results for the RCA and RSCA show that Ethiopia is experiencing a decreasing comparative advantage, but it has continued to remain much greater than other countries considered.

5.2 Recommendations

In order to enhance Ethiopia's competitiveness in the coffee market amid anticipated increases in supply-side competition in the near future,

measures should be put in place to address current inefficiencies in the supply side. These should include most importantly management of price risk (affected by the volatile nature of coffee prices, both domestic and international and the gap between time of purchase of beans from buyers and sale of it to exporters), quality control, smuggling, and transaction costs. This could be achieved to large extent by reducing the gap between time of purchase of the berries/beans from buyers and the time of auction, setting high quality standards for the beans to be auctioned, and closely watching non-auctioned exports, ensuring payment of fairer prices to growers and appropriate transmission in times of increment, and by putting in place measures to reduce the number of intermediaries in the supply chain to help minimize unnecessary competition. Finally, we would recommend appropriate and significant investment in yield-enhancing innovations for the coffee sector.

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Residential Pricing in Addis Ababa: Do Urban Green Amenities Influence Residents' Preferences for a House?¹

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Abstract

Urban green amenities can play a vital role in realizing sustainable development and healthy life in cities. However, the direct economic value of green amenities is seldom measured in monetary terms, and studies on urban green amenity valuation in developing countries, including Ethiopia, are scanty. This study uses the hedonic pricing method to investigate the impact of urban green amenities on subjective as well as actual rental prices of residential houses in Addis Ababa. Results indicate that residents attach a positive value to urban green amenities. Specifically, the availability of, and access to, attractive landscape and natural features in a nearby area increase the average price of a house by 45 percent. Similarly, availability and access to parks increase the average rental value of a house by 50 percent. This indicates that residents are willing to pay for green amenities in their neighborhood. Incorporating green amenities in designing urban residential areas and real estate developments can provide premium benefits to investors.

Keywords: Urban green amenities, residential pricing, environmental valuation, and hedonic pricing

JEL Classification: Q57; Q56; P41 and R21

¹ **Acknowledgments:** This paper is an output of the Ecosystem Services Accounting for Development (ESAfD) research program. This research program is financed and supported by the Swedish International Development Cooperation Agency (Sida) and Swedish Environmental Protection Agency (SEPA) in collaboration with the Environment for Development (EfD) initiative. We are very grateful to Addis Ababa City Administration and district officials who assisted us in mobilizing the residents in Addis Ababa for Focus Group Discussions and to all residents who were participated in our FGDs and household surveys.

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1. Introduction

The majority of the world population currently live in urban areas. In 2014, people residing in urban areas have reached 53 percent; this figure is expected to grow further to 66 percent by 2050 (UNDESA, 2014). The rate of urbanization is higher in developing countries, including those in Africa, despite the current low level of urban population and according to UNDESA (2014), Africa is urbanizing at a faster rate than other areas and will reach 56 percent by the year 2050, a 25 percent increase from 2014. As the world continues to urbanize, sustainable development challenges will be increasingly apparent in cities. The problem will become more acute in low and middle-income countries where the pace of urbanization is fast; and formulating integrated policies will be crucial to improve the lives of urban dwellers and sustain a healthy city environment.

In Ethiopia, the current rate of urbanization is high. According to the World Bank (2015), urbanization in Ethiopia is increasing by 5.4 percent a year, putting it among the fastest ten urbanizing countries in the world. This provides both an opportunity to transform the economy and a challenge to manage the negative impacts of urban expansion. It also highlights such factors as rural-urban migration, expansion of existing cities and transformation of small rural villages into towns as the main drivers of the current rapid urbanization in Ethiopia. Rapid urbanization demands balanced investments in basic infrastructure including health, education, road facilities, clean water supply, sewage services, housing and recreational facilities (AfDB, 2016). The provision of these facilities is providing a challenge in Ethiopia's urban areas including the capital city, Addis Ababa.

Addis Ababa is easily the largest urban area in Ethiopia and serves as the headquarters for the African Union (AU) and other international institutions including the United Nation Economic Commission for Africa (UNECA). Already facing growing environmental challenges, the city is expanding with unbalanced development of infrastructure and services. Among other problems, this has created an issue over the provision of adequate housing for residents and of green amenities. As one response, the city government designed a structural plan that designated around 22,000 hectares of land within the city, about 41percent of the Addis Ababa's total

land area, for green area development. The successful implementation of this and protection of green amenities in Addis Ababa, however, also requires support from the private sector including real estate developers, individual house builders and buyers. Assigning an economic value to urban green amenities, green spaces, parks, street trees and other related urban ecosystem services, is also vital to implement the plan. In this context, understanding the value residents place on urban green amenities can provide important insights for urban planners and decision-makers to develop the city's green infrastructure.

Studies on the impact of urban green amenities on the price of residential houses have been very limited in developing countries particularly in Africa. Most concentrate on developed and emerging or middle-income economies. In middle-income economies, for example, studies such as Jim and Chen (2006), Chen and Jim (2010), He et al. (2010), Chaudhry (2013), and Zrobek et al. (2015) have reported varied results and have provided limited conclusive knowledge to inform policy makers. In developing countries, there has been a misconception that more attention should be given to development with less interest or care for environment, resulting in a lack of concern. However, recent evidence has encouraged the possibility of pursuing development at the same time as ensuring environmental protection; Wakeford et al. (2017) and Okereke et al. (2019) have provided detail of encouraging practices of green innovation among industrial firms, and institutional platforms in Ethiopia have begun to promote green industrial development. This underlines the possibility that developing countries can pursue green development paths virtually from the outset of their development, unlike most developed countries which facilitated economic development first and had to start to cleanup later. Studies on environmental protection in developing countries are urgently necessary to support green policy design and implementation.

A second reason for the limited study of the impact of urban green amenities on house prices in developing countries has been a lack of the required data. The standard hedonic studies use secondary data on the market price of houses to estimate the value of environmental goods and services. This method has an advantage when property sales and their characteristics

are generally readily available⁴. However, applying a hedonic pricing method is challenging in developing countries for two main reasons. Market prices of houses are commonly distorted due to high transaction costs resulting from the asymmetric information and involvement of several intermediaries in house market value chains. As a result, the existing price of houses does not reflect the actual preferences of house buyers. Secondly, the secondary data on house prices is usually not available especially in developing countries such as Ethiopia. In fact, relying on secondary data on house prices for non-market valuation of environmental goods and services is unlikely to capture the real value people attach to the amenities under consideration. Using the subjective valuation of environmental goods, however, can help fill the gap in data.

In Ethiopia, studies on the valuation of urban green amenities are nonexistent. There are some Master's theses level, including Juhar (2014) and Teshager (2014), which focused on estimating the economic value of parks and forests, improved urban waste management practices and river water quality improvements. Juhar (2014) examined the valuation of forests in rural areas, while Teshager (2014) investigated residents' willingness to pay for the improvement of urban river quality. Sema (2010) found differences in house prices across various districts in Addis Ababa although the reasons for locational deviation in residential prices remained unclear. Overall research on the effect of environmental valuation and the role of green amenities on house prices in Ethiopia have been unavailable.

This study aims to contribute to the existing literature in two main ways. First, it combines subjective house values and actual rental prices to investigate the impact of urban green amenities on residential house prices within the hedonic pricing framework. Secondly, our study contributes to the ongoing debate about the need to consider environmental protection, at the same time as addressing pressing issues of poverty eradication in the context of developing countries. Our results provide evidence that people value environmental quality and hence policies targeting development to help to create a balance with the environment.

⁴ For details of the application of a hedonic pricing model: http://www.ecosystemvaluation.org/hedonic_pricing.htm (date 10-07-2017)

The second section of the paper presents a brief review of related literature; Section 3 is devoted to our methodology and is followed by our empirical results and discussion. Section 5 provides conclusions.

2. Literature Review

Indirect values of environmental amenities are commonly measured through their effect on the value of properties like residential houses. The typical empirical approach for estimating the value of green amenities is to measure their effect on house prices using the Hedonic Pricing (HP) method. As noted by Monson (2009), the hedonic pricing model can help in measuring the effects of both tangible and intangible characteristics of a house, including outside influencing factors, on its price. Several studies in different countries have employed the hedonic pricing method to estimate the value of environmental goods and services, although others have used contingent valuation and choice experiment methods.

One of the issues among existing literature has been inconclusive results regarding the impact of urban green amenities on house prices. Studies such as Luttik (2000), Tajima (2003), Jim and Chen (2006), Adekunle et al. (2008), Conway et al. (2008), Chen and Jim (2010), Chaudhry (2013), and Giergiczny and Kronenberg (2014) all found urban green amenities had a positive effect on residential house prices in developed and middle-income countries. Conversely, He et al. (2010) and Zrobek et al. (2015) did not find any positive effects of green amenities on residential prices.

Luttik (2000) investigated the effect of various environmental factors on the price of houses using the hedonic pricing method in Netherlands. His result indicated variations in house price by landscape types with a house with a garden facing water connected to a lake produced a 28 percent higher price. Similarly, Tajima (2003) showed that the proximity to urban open spaces had a positive impacts on property values, while proximity to highways had negative impact. Giergiczny and Kronenberg (2014) estimated the value of street trees in the city center of Lodz in Poland using the choice experiment approach and indicated that residents were

willing to pay the highest price for greening streets and confirmed the general importance of planting trees.

Studies in middle-income countries similarly reported varied results regarding the effects of urban green amenities on residential prices. Jim and Chen (2006), Adekunle et al. (2008), Chen and Jim (2010), Lo and Jim (2010), Donfouet et al. (2011) and Chaudhry (2013) all found that urban green amenities had a positive impact on residential prices. Chaudhry (2013) used the hedonic pricing method to examine the impact of key environmental attributes on the market rates of residential plots in the city of Chandigarh in India and indicated that proximity to lake and leisure valley chains of green spaces raised housing prices by about 10 and 2 percent respectively. The study demonstrated the possibility of increasing prices of urban residential property in areas near the lake. Jim and Chen (2006) indicated that a view of green spaces and proximity to water increased housing prices by 7.1 percent and 13.2 percent, respectively.

Chen and Jim (2010) analyzed the amenity and dis-amenity effects arising from the heterogeneous urban landscape in the Chinese city of Shenzhen. They indicated that residential gardens were the most attractive landscape attraction resulting in an average increase in house prices of 17.2 percent. Lo and Jim (2010) investigated residents' recreational use of urban green spaces and assessed their monetary value using CVM in Hong Kong. The result indicated over 80 percent of the respondents were willing to pay to recover a hypothetical reduction of urban green spaces area by 20 percent due to urban development. This suggested resident placed a significant monetary value on the non-marketed services of urban green spaces, a value that could provide an important addition to green space planning and nature conservation as part of city development and management.

Adekunle et al. (2008) assessed an economic valuation of the environmental service functions of forest trees in urban areas of Nigeria using CVM. Donfouet et al. (2011) also analyzed the preferences, attitudes and motives of urban park visitors towards a policy that aimed at endowing a park with more amenities using CVM. The study revealed that 78 percent of respondents were willing to pay an increased entrance fee if the park was endowed with more amenities. The results also indicated that improved urban parks could result in increased welfare gains for the visitors and improve environmental quality.

However, He et al. (2010) and Zrobek et al. (2015) did not find a positive association between the prices of residential houses and environmental amenities in middle-income countries. While He et al. (2010) indicated the negative effect of accessibility of recreational facilities and parks on house price in Beijing, they also showed the main determinants of house purchase prices were the price of land, the ratio of the area of building to the total area, and the distance to city downtown amenities. Zrobek et al. (2015) qualitatively surveyed residents' choice of residential locations in Poland and indicated the quality of the environment was not the main criterion in determining choice of residential location despite high levels of environmental awareness among the respondents. A quiet neighborhood and scenic value were regarded as the most important determinants.

Along with these inconclusive results about the role of green amenities in house prices, a key consideration in the literature is the issue of spatial location. Urban amenities are not single house specific in the sense that several observations in a sample share the same amenities, and it is, therefore, necessary to control spatial correlation of variables, a point missed by the majority of existing studies. According to Cho et al. (2008), while people put a positive value on green amenities, the type of features preferred varies according to the location or the degree of urbanization. This emphasizes that spatial issues are important in green amenity valuation. Conway et al. (2008) estimated the effect of green spaces in Los Angeles, controlling for spatial autocorrelation. The results showed that neighborhood green space in the immediate vicinity of houses had a significantly positive impact on house prices. One interesting aspect of the findings of these studies is that there is variation between clustering and non-clustering of data at spatial levels. So, consideration of spatial aspects of the data is required because green amenities and other neighborhood infrastructures are not specific to a given house. Houses in a similar area share common facilities and tend to have somewhat similar values, but most of the existing literature on hedonic pricing does not provide for this spatial autocorrelation.

In Ethiopia, studies on the value of green urban amenities particularly on residential pricing are lacking, though a few Master's thesis studies have tried to estimate the economic value of parks and forests, of urban waste management or of river water quality improvements. Juhar

(2014) applied CVM to measure the value of forests in Ethiopia using the case of ‘Wof-Washa’ natural forest, and the findings indicated the respondents’ willingness to pay Birr 19.75 per year for forest conservation. Teshager (2014) estimated households’ willingness to pay for protection of river water from pollution in Addis Ababa using the choice experiment method. He found that respondents were willing to pay an yearly average of Birr 90.34, 12.89 and 27.87 and 1.48 for improved river water quality, river water volume, recreational facilities and a riparian buffer zone, respectively. Sema (2010), however, indicated that location had a substantial influence on housing prices in Addis Ababa, noting a 10 percent rise in plot area increased housing prices by 5.5 percent and 4.5percent around CMC and Alemgena areas of the city, respectively.

Overall, empirical studies concerning the valuation of urban ecosystem services in the Ethiopian context are limited. This underlines that the need for research on urban ecosystems and greening activities are needed to support sustainable urban planning and implementation decisions.

3. Methodology

3.1 Data

We conducted a survey of 640 households in five sub-cities of Addis Ababa. The survey covered 21 Woredas⁵ located in the major river basins of Addis Ababa. However, data obtained from 350 households were used for the empirical analysis of this particular paper for two practical reasons. First, we focused only on the demand side of the housing market and estimated buyers’ value of urban green amenities. We, therefore, excluded the observations of the households who owned the house they were living in. The second reason is that some of the respondents provided ‘I Don’t Know’ responses and were hence excluded from the analysis due to missing values for key variables.

Our sampling followed a two-stage procedure. At the first stage, out of the 700 Enumeration Areas (EAs) in the five sub-cities, we identified 237 EAs around and within the buffer area of the major rivers and river lines

⁵ A *woreda* is the administrative unit equivalent to sub-district under sub-cities in Addis Ababa.

using the 2007 population census of Ethiopia. Then we randomly selected forty EAs out of the 237 EAs in which to conduct the survey. Each EA has on average 150-200 households. The second stage involved the selection of 16 households from each EA using equal probability systematic sampling procedures. We selected a central starting point in each EA from which we identified four quadrants to ensure representation of samples from all directions. The identification of the sample starting point in the EA was undertaken by using GPS coordinate points around the central part of the enumeration area and visualizing the X and Y coordinates to plot a point on the map. We then selected four households from each of four directions (north, south, east and west) using a random walk pattern approach. Four enumerators were assigned to each EA to gather the data by selecting the households with the help of eligibility screening questionnaires with the enumerators walking north, south, east and west.

Using a random walk pattern, we selected every 15th household in EAs having at least 175 households. For EAs with total households of less than 175, we selected every 10th household for interviews. In case where the selected household was not available for interview, the survey team revisited twice and if they could still not find the head of the household, they substituted the next household available (n+1) on their random route walk. We pilot tested the questionnaire on 20 households before conducting the final survey, improving on the basis of the feedback provided. The questionnaire included various questions related to socioeconomic characteristics of the respondents' and urban green amenities.

3.2 Model Specification

This study applied the standard hedonic pricing approach to measure the value of urban green amenities in residential pricing in Addis Ababa, Ethiopia. According to Monson (2009), a hedonic pricing model can help to measure the effect of intangible characteristics on the overall transaction price of a house. It explains observed economic behavior when there are many and different personal preferences in the housing market. Common factors included in a hedonic pricing model are a wide array of location features, physical features, environmental features,

economic factors, and preferences of individual households and their unique needs (Monson, 2009; Liebelt et al., 2018). Consequently, we specify our empirical model as indicated in Equation (1):

$$P = \alpha + \beta X + \gamma Z + \varepsilon \quad (1)$$

where P is the average price of house representing the value of the house (in our case the subjective value buyers' attach to the house and the rent they actual pay). The fixed value of α is the minimum price a buyer is willing to pay for a home before even considering all of the qualities and environmental amenities. In Equation (1), X represents the vector of house characteristics and Z is the environmental features peculiar to the particular location of the house. Parameters, β and γ are vectors of monetary value that correspond to the house characteristics and the green urban amenity features of the house, respectively. The final term ε stands for a vector of random error that includes unpredictable determinants of the house price.

In our hedonic price model, we consider the house buyer's subjective price of house and actual monthly rent value as a function of house location, materials with which a house is built, the characteristics of house itself, the nature of surrounding environment and green amenities. We estimate two separate models to investigate the value of urban green amenities in residential pricing in Addis Ababa. The respondents' subjective house price is used as a dependent variable in the first model; the actual rental price per month is considered as the dependent variable in the second model. Location is defined in terms of the sub-city in which the house is located; house characteristics include house construction materials, size of the compound, the size of the house area, house renovation, and the total number of rooms and bedrooms of the house. Neighborhood facilities included access and quality of secondary schools, access to piped water, and safety and crime conditions. Environmental amenities include the view of attractive landscapes and nature areas, street views and availability, and access to, parks and green spaces. For spatial concerns about the

commonness of green amenities in a given vicinity, we included the sub-city as a control in the explanatory variable.

4. Results and Discussion

4.1 Descriptive Analysis

Out of the total sample, only 30.2 percent of respondents lived in the house they owned with about 64.5 percent lived in the house they rented. The remaining 5.3 percent were using the house in which they were living without payment. For the purpose of empirical analysis, this study focused on the demand side and chose 413 households who do not own the house and who wanted to buy it. As we noted above, 63 observations were dropped due to ‘I Don’t Know’ and no response. Our empirical analysis is therefore based on the responses obtained from 350 households.

Table 1: Descriptive statistics of the main variables of house characteristics

Variables	Details of variables	Mean	SD*	Min	Max
House price	Continuous variable measured in USD ⁶	20,372	36,600	110	296,053
House rent	Continues variable measured in USD	18	44.8	0.09	350.9
House renovation	Dummy variable taking the value ‘1’ if house is renovated (Yes) or ‘0’ if not	0.42	0.49	0	1
Total rooms	Continuous variable measured in numbers	2.25	1.28	1	17
Bedrooms	Continuous variable measured in numbers	0.93	0.65	0	3
Compound (house) size	Continuous variable measured in meter square	73.9	202.8	6	3500

*Standard deviation

As indicated in Table 1, the mean price of a house was found to be 20,371 USD with the maximum price being 296,052 USD. The average

⁶ US Dollars

monthly house rent value was about 18 USD. The number of total rooms, bedrooms and the size of house compound areas were important house characteristics that might influence buyers' choice of a house. The average number of the rooms was 2 with a minimum being 1 and a maximum of 17, with the majority of the houses having a small number of rooms. The average number of bedrooms was about one, though there were also houses with no specific standalone bedrooms; the maximum number of bedrooms was found to be three. In addition, the size of the house compound showed significant variation. The mean area of respondents' living compounds was about 74 square meters, with a minimum of 6 sq. mt. and a maximum of 3500 sq. mt. The high variation in the size of the living compound was reflected by a standard deviation of about 203 square meters.

As shown in Table 2, only 7 percent of the respondents had separate bathrooms. This indicates that the majority of houses lack basic facilities for sanitation services. In addition, only about 2 percent of houses had air conditioning, that is access to fresh air through a window. Other important facilities for residential houses in cities are access to reliable piped water and electricity supply. About 91 percent of the respondents have access to piped water, and although the proportion of sample households without water access is relatively small, the lack of reliable and potable water supply is critical given its implication for the health and sanitation of residents. About 22 percent of the residents believed that their neighborhood was less privileged concerning the availability of drinking water supply while about 37 percent believed that their area was more fortunate as compared to other areas (see Figure 1). Access to electricity is found to be about 99 percent (Table 2) but its reliability was limited due to frequent power outages in the city.

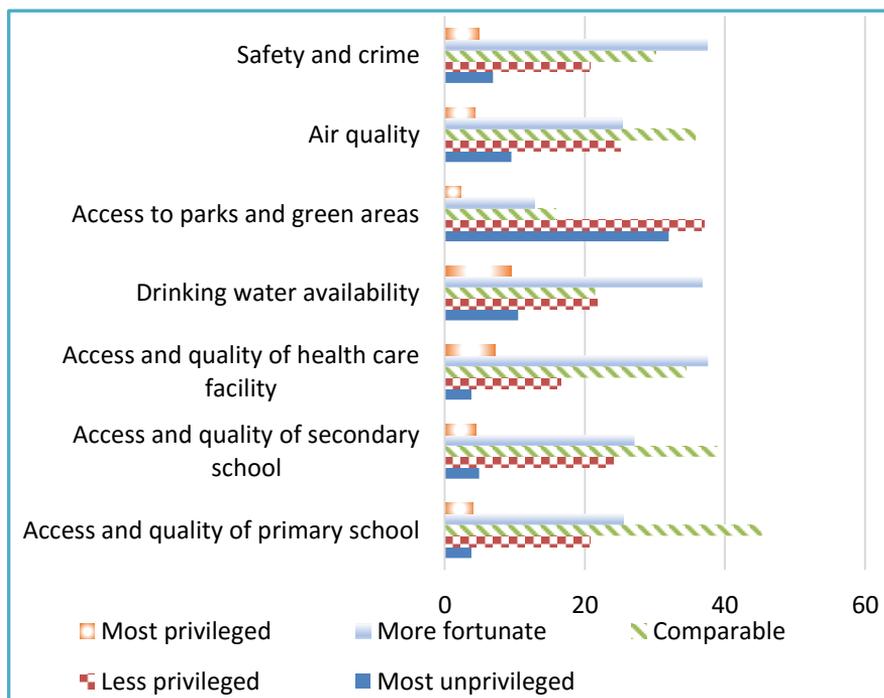
Table 2: Description of access and availability of urban green amenities and other facilities

Variable	Description of variables	“Yes” response (%)
Bathroom	Dummy variable for the availability of separate bathrooms. The variable takes the value 1 if ‘Yes’ and 0 if ‘No’	7.4
Air conditioning	Dummy variable for the availability of air conditioning in a house, taking the value of 1 if ‘Yes’, 0 if ‘No’	2
Piped water	Dummy variable for the access to piped water for a house, which takes the value 1 if ‘Yes’, 0 if ‘No’	90.7
Electricity	Dummy variable for the access to electricity for a house which takes the value 1 if ‘Yes’, 0 if ‘No’	98.7
Landscape, and nature view	Dummy variable for the view to attractive landscapes, and nature areas which takes the value 1 if ‘Yes’, 0 if ‘No’	21.7
Attractive street view	Dummy variable for the view to attractive streets with trees and other features which takes the value 1 if ‘Yes’, 0 if ‘No’	24.3
Other attractive view	Dummy variable representing the view to other attractive features (other than landscapes, nature areas, and streets) which takes the value 1 if ‘Yes’, 0 if ‘No’	7.7
Green space availability	Dummy variable for the availability of green spaces or areas covered with trees, grasses and others which takes the value 1 if ‘Yes’, 0 if ‘No’	37
Parks availability	Dummy variable for the availability of parks around the living area which takes the value 1 if ‘Yes’, 0 if ‘No’	48.9

Regarding the urban green amenities, about 22 percent of the respondents had a view of attractive landscapes and nature areas. Landscape and nature areas include any environmental features including mountains, forests, valleys or related features. Similarly, about 24 percent of the houses have attractive street views. The availability of green spaces and parks near to the residential area also determined the attractiveness of the location and about 37 percent of respondents agreed that there were green spaces or areas covered by trees, grasses and other features around their house. Despite

concerns that the status, size or development of a park might not be as good as they wished, more than 48 percent of the residents indicated that their house was located near to a park (see Table 2).

Figure 1: Residents’ perception about neighborhood infrastructure and environmental facilities



In addition to green amenities, the relative access and quality of education and health infrastructure and facilities also determine residents’ choice of location. Figure 1 presents residents’ perception about the facilities in their house location areas. About 45 percent of respondents indicated that their village was comparable to other areas in the city in terms of primary school access and quality. In addition, about 21 percent rated their neighborhood less privileged while about 4 percent ranked it as most unprivileged concerning primary education access and quality. As far as secondary education was concerned, a slightly lower proportion of respondents (about 4 percent) agree that their village was unprivileged compared to other areas in the city, but about 39 percent believed that their neighborhood compared adequately with other villages in the city regarding

the quality and access to secondary education. About 25 percent and 27 percent of respondents believed that their neighborhood was more fortunate regarding access and quality of primary and secondary education. A higher proportion of respondents said their village was more fortunate than other areas in the city concerning the access and quality of health care facilities (Figure 1). Put in specific terms, about 38 percent of respondents believed their neighborhood was more fortunate compared to other areas in the city. About 7 percent of the residents rated access and quality of health care facilities in their village as most privileged compared to other areas.

Safety and crime condition in a given area is also an important factor for residents' preference of a location. The respondents were asked to rate the safety and crime conditions in their neighborhood as compared to other places. Results indicated about 37 percent of the residents believed their village was more fortunate compared to other places in the city. About 30 percent and 21 percent of respondents rated their neighborhood comparable or less privileged, respectively. It should be noted the ratings are only based on the respondents' perceptions and beliefs about their neighborhood relative to other villages they know in the city.

The residents were also asked to rate the air quality in their neighborhood in terms of smoke, smog, particles, dust and smell. About 39 percent of the respondents rated the air quality in their neighborhood comparable to other places in the city; but 9.5 percent believed that the quality of air in their village was most unprivileged in comparison to other areas. A contradiction in responses to air quality was that a similar proportion of respondents (about 25 percent) rated their neighborhoods as less privileged or more fortunate than other areas.

4.2 Empirical Results

In the empirical analysis, we have used the regression analysis of both linear and log-linear hedonic pricing model specifications. We checked the appropriateness of functional form using a Box-Cox test. The test result indicated lower Residual Sum of Square (RSS) values (516.77 and 1132) for the log-linear regression model as compared to linear specification (3.5132e+11 and 455664) for house price and rent models respectively. We

rejected the null hypothesis stating that the two models are the same due to high Box-Cox static of 457.39 for house price and 455.70 for rent model tests that are greater than the critical value of 341.39 Chi-square estimates at 5 percent level of significance and 325 degrees of freedom. The result showed that log-linear models fit our data very well, implying that house prices have no linear relationship with the explanatory variables where marginal values increase with the house attributes but start declining after certain higher levels. Hence, we reported the regression results from the log-linear model specification that include the natural logarithms of dependent variables, namely the average subjective price of a house (the value residents willing to pay) and the actual monthly house rent value.

Furthermore, we also checked the multi-collinearity problem among the variables using the Variance Inflation Factor (VIF) test. The test result showed the mean VIF value of below 1.5 with VIF values for all individual variables less than 3, indicating no multi-collinearity among the variables in both models. We also controlled for potential spatial correlation by adding the sub-city in the regression analysis. Unlike the standard hedonic pricing approach, we controlled for the socio-economic factors in modelling the subjective values people attach to houses. Results indicated that the income of household affects resident's willingness to pay and the rent value they attach to the house. For instance, households with higher income were willing to pay higher house prices and rental value as compared to low-income groups. This indicates that the value of houses depends not only on the house characteristics and environmental factors but also on people's ability to pay (wealth).

Effects of location factors on house value

One of the factors that affect residential prices is the location of the house. As presented in Table 3, residents are willing to pay a higher price for houses located in Lideta sub-city as compared to Gulele and Kirkos sub-city. This might be because of residents preferred central locations in the city and their convenience for commute to work. Lideta and Kirkos sub-cities are centers for businesses and residential apartments with relatively better infrastructure, including connectivity to the new Light Railway Transit. In addition to the physical location of a particular house, residents also care

about the facilities available around the location of a house. These include access and quality of economic and social infrastructures such as schools, water, and other related facilities. As a result, we included variables representing access and quality of neighborhood infrastructures as dummies taking one for most privileged and fortunate responses as compared to another neighborhood, zero otherwise. Our regression results of the house price model show that access and quality of school do have a positive effect on house value. This is reflected by the positive and statistically significant coefficient of access and quality of secondary schools. Access to piped water also increased the price of house respondents willing to pay. Contrary to our expectation that safety and crime condition of an area would influence house value, the coefficient was found to be statistically insignificant in both house price and rent models.

Effects of house characteristics on the house value

In addition to location, the type of materials which the house is constructed can determine the price and rental value of a house. The material by which the house built can affect the strength and durability of a house. To examine this effect, we incorporated the categorical variable of the main materials for house construction using concrete, bricks, wood with mud and cement, metal sheet and stones. For this purpose, we keep concrete as a base variable. Our results indicate that residents paid 156 percent and 51 percent lower prices respectively for houses that were built of a metal sheet and stones, and wood with mud and cement, as compared to concrete. The results indicate that rent values were respectively 164 percent, 208 percent and 257 percent lower for houses constructed with bricks, wood with mud and cement, and wood with mud as compared to concrete. In Addis Ababa, most houses are old and not built with modern construction materials; the majority are built of wood with mud, and of cement with wood and mud.

The size of the house area, the total number of rooms and bedrooms were also found to be important factors that affect the value residents assign to the house. An increase in the area of a house increased the price residents were willing to pay by 1.2 percent and significant at 1 percent, keeping other things constant. However, it turned out to be statistically insignificant in the rent model. The price of houses that residents were willing to pay also

increases by about 16 percent as the number of total rooms increases. The total number of rooms has no statistically significant effect on the house rent value, but the number of bedrooms can negatively affect the rent value by up to 60 percent. The probable reason for this is that when residents rent a house, they can adjust rooms for different purposes. The size of house area, the number of total rooms and bedrooms explain the subjective price of the house rather than its rental value as the coefficients of these all turn out to be statistically insignificant in the rent model, except for the number of bedrooms. The compound size, however, significantly and positively affects the house rental value, as compound size increased by square meter, the rental value increased by 0.09%. Residents attached higher rental values to a renovated house. Renovated houses (those houses that have had major renovation during the last two years) have 176 percent higher rental value as compared to non-renovated houses.

Table 3: Regression results from the hedonic house price and rent models

Variables	Subjective price model		Rent model	
	Coefficients*	P-value	Coefficients	P-value
<i>Sub-city (Base variable: Gulele)</i>				
Lideta	1.22***(0.226)	0.000	0.289 (0.546)	0.597
Kirkos	0.698** (0.306)	0.023	-0.565 (0.188)	0.188
Arada	0.297 (0.204)	0.147	-0.348 (0.313)	0.266
Addis-Ketema	0.301 (0.261)	0.250	0.290 (0.396)	0.465
Household Sex	0.185 (0.202)	0.361	-0.203 (0.330)	0.539
Household age	-0.0026 (0.004)	0.583	-0.010 (0.006)	0.122
Marital Status	-0.0073 (0.209)	0.972	0.243 (0.325)	0.454
Household Income	0.263** (0.957)	0.006	0.651*** (0.144)	0.000
<i>House construction material (Base variable: Concrete)</i>				
Brick	-0.349 (0.456)	0.444	-1.649 (0.832)	0.048
Wood with mud and cement	-0.518*(0.296)	0.081	-2.088**(0.620)	0.001
Wood with mud	-0.143(0.302)	0.635	-2.57*** (0.613)	0.000
Metal sheet & stones	-1.56 ** (0.635)	0.014	-1.515 (0.959)	0.115
Compound size	0.0002 (0.0002)	0.169	0.0009* (0.0005)	0.082
House area size	0.012** (0.004)	0.006	0.0016 (0.006)	0.794
House renovation	0.021 (0.160)	0.892	1.762*** (0.257)	0.000
Total rooms	0.166** (0.051)	0.001	0.096 (0.068)	0.158
Bedrooms	0.435** (0.134)	0.001	-0.601** (0.215)	0.006

Variables	Subjective price model		Rent model	
	Coefficients*	P-value	Coefficients	P-value
Access to quality secondary school	0.440**(0.178)	0.014	0.036(0.283)	0.897
Piped water access	0.391*(0.204)	0.056	0.298(0.204)	0.498
Safety/crime	-0.246 (0.158)	0.120	-0.102 (0.227)	0.653
Street view	0.237 (0.164)	0.149	0.237 (0.164)	0.149
City buildings view	-0.168 (0.220)	0.446	-0.043 (0.297)	0.885
Landscape and nature areas view	0.456** (0.189)	0.017	-0.177 (0.317)	0.577
Park availability	-0.07(0.166)	0.643	0.508** (0.253)	0.045
Green spaces availability	0.197 (0.159)	0.217	-0.129 (0.270)	0.632
Constant	9.50*** (0.556)	0.000	1.15 (0.829)	0.164

Figures in parenthesis are robust standard errors. *** p<0.01, ** p<0.05, * p<0.1

Impact of urban environmental and green amenities on the house value

Green amenities and other factors can affect the buyers' preferences and hence determine the value residents attached to a house. As indicated in Table 3, in addition to parks, the availability of attractive landscape and nature views near to the house has a positive determination on the price of the house. Keeping other factors constant, the view of an attractive landscapes and natural features increase the price of the house by 45 percent, which is statistically significant at 10 percent. The positive and statistically significant effect of a view of landscape and natural features on the price of the house can be expected in Addis Ababa. Residents prefer locations closer to urban forests and mountains. Our result are consistent with the findings of Chen and Jim (2010) who showed an increase in house price with availability of a garden area. We did not, however, find statistically significant evidence of the effect of park availability on the subjective price of houses that residents were willing to pay. This is similar to the finding of He et al. (2010) who reported no positive influence of accessibility of parks on the price of a house in Beijing. However, our results did indicate a positive and statistically significant relationship between availability of parks and house rent value. Rent value increases by about 50 percent for houses

located around the areas where parks are available. This provides evidence that residents put a positive value on green infrastructures in urban areas.

5. Conclusion

This study has examined the impact of green amenities on the residents' willingness to pay for residential houses in Addis Ababa, Ethiopia. For this purpose, we employed a hedonic pricing model with a focus on the demand side of the housing market. The results indicate that house characteristics and infrastructure influence the price and rent value of a house. Specifically, we find that the type of house construction materials, location and the size of the compound, renovation and access to secondary school influence the price of a house in Addis Ababa.

Moreover, the empirical results from the log-linear regression analysis indicated that residents attach positive value and reveal strong preferences for urban green amenities. This is reflected by the positive impact of attractive landscape and nature views, as well as the availability and access to parks in the urban area. Specifically, residents are willing to pay a 45 percent higher price for a house having a view of attractive landscapes and nature. Similarly, residents are willing to pay 50 percent higher rent for houses that have access to parks. The findings of this study highlight that landscape and nature views, as well as availability and access to urban green amenities are important factors affecting residents' decision to buy or rent a house. Residents are willing to pay higher prices for a house located around urban green amenities. Including green amenities in designing urban residential areas and real estates can, therefore, provide a positive gain for the investors and help to build green cities. Our analysis also implies that subjective value measures of house prices can be used as a proxy for house prices. It can explain residents' preferences for urban environmental services in areas where the data about the housing market is limited or not available. Thus, the subjective valuation of residents about house attributes can be used to study the relationship between house prices and urban environmental services in developing countries.

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Agricultural and Rural Transformation in Ethiopia: Obstacles, Triggers and Reform Considerations

Getachew Diriba¹

Abstract

Ethiopia's agriculture has shown remarkable resilience over many years but is now increasingly failing. In spite of national efforts, the number of poor and food insecure population has remained very high, with an estimated 25 million people at the threshold of survival. The numbers of people on emergency and safety net program assistance have been consistently increasing both in aggregate number and in spatial manifestations, now covering nearly all the Regional States. In addition, Ethiopia's import of cereals, edible oil and lint cotton, has continues to rise dramatically, costing over a billion dollars every year. This is an underlying trend that should alarm policymakers and development practitioners alike.

The traditional factors of production, land, labor and capital, have now been merged with the knowledge system. The real difference between the rich and poor countries is no longer only endowment of the factors of production as they used to be; rather it is how effectively nations, and people, utilize knowledge. Knowledge, that is scientific invention, technology, innovation, and the internet are all growing at an accelerated rate leaving far behind countries such as Ethiopia.

Important incentives and reform priorities are suggested as a basis for enacting agricultural and rural transformation including supportive legal environment, facilitate and support agricultural mechanization and input distribution as well as encourage and support decisive private sector participation and leadership in agricultural and rural transformation.

Keywords: Agriculture, agricultural transformation; rural transformation, technology, innovation, institution, private sector, urbanization, credit, finance, incentive, Getachew, Diriba, Ethiopia, agricultural growth, hunger, poverty, food insecurity, agricultural inputs, growth without transformation.

JEL Classification: O13

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1. Introduction²

We can do anything we want –provided we can find a way. We are constrained by nothing except our own ignorance. Plagues and droughts have no cosmic meaning –but we can eradicate them. Wars are not a necessary evil on the way to a better future –but we can make peace. No paradise awaits us after death –but we can create paradise here on earth and live in it for ever, if we just manage to overcome some technical difficulties.

Yuval Noah Harari, Homo Deus, A Brief History of Tomorrow, 2015: 200

This paper assesses the state of agricultural and rural conditions of Ethiopia; describes the extent, speed and depth of agricultural and rural transformation; and provides policy options for the relevant parties. It is premised on the progress Ethiopia has registered in social, economic and infrastructural development, as well as on policy experimentation over past decades. On average, Ethiopia's economy has been growing at 10% per annum over the past decade. Progress has also been made in expanding rural and urban roads, from 19,000 km of roads in 1990 to 121,171 km in 2019. Ethiopia has also registered a gross educational enrollment ratio of 27.55 million in 2015/16 of which 1.32 million (some 4.8%) graduate each year expecting to join the labor force (MOE 2016). The number of students in various levels of educational establishments is very large, and it is equivalent to, for example, the entire population of Madagascar, or the combined population of Togo, Sierra Leone, Libya and Swaziland. Notwithstanding the continuing need to enhance quality of education, this is a great success story of educational expansion. The vast expansion, however, represents massive demand for jobs across all sectors of the economy.

During the past decades, in aggregate, poverty has declined, in monetary terms, from 45.5% in 1995/96 to 23.5% in 2015/16. By contrast, the

² The discussion paper is abridged from the author's book: *Overcoming Agricultural and Food Crises in Ethiopia: Institutional Evolution and the Path to Agricultural Transformation*. The first edition was published in 2018 at the Master Printing, Addis Ababa, Ethiopia, and Amazon, USA 2018. The second edition will be published later this year.

multi-dimensional poverty index³ remains at 83.5% with intensity of deprivation at 58.5%, according to the 2019 Human Development report. The share of food in household expenditure has fallen from 60% in 1995/96 to 55% in 2015/16 (the National Planning and Development Commission 2018). The Ministry of Agriculture reports⁴ that agriculture contributes 27.5 billion dollars or 34.1% to the GDP, employs some 79% of the population, accounts for 79% of foreign earnings, and is the major sources of raw material and capital for investment and market. Furthermore, the Ministry plans to increase wheat productivity from 2.7mt/ha in 2019 to 4 mt/ha by 2023 and reduce wheat import from 1.7 million mt in 2019 to zero by 2023. The MOA envisages achieving this by acid soil and vertisol management, intensification, expanded use of irrigation, mechanization, and private sector partnership.

Meanwhile, Ethiopia's population is estimated at 113.56 million accounting for 1.47% of the world population; it now ranks number 12 in the list of countries by population, according to an online Worldometers world population data. The population under the age of 29 years accounts for 69% or 76 million people with median age of 18.8 years, and 23.2 million people (21.1%) urban population. It is expected to increase by 1.9% per year reaching 136 million people in 2030. During the same period, the economy is forecast to grow, on average, by around 7%.

2. Challenges of Agricultural and Rural Transformation in Ethiopia

2.1 A Brief Overview of Ethiopian Agricultural Policies and Programs

Ethiopia's agricultural modernization was conceived at the turn of the 20th century by Emperor Menelik II (1889-1913) who had had a voracious appetite for modernization: he initiated modern housing, eucalyptus tree planting to mitigate urban firewood demand, introduced irrigation, built a railway system, and established key ministries including the Ministry of Agriculture. Emperor Haile Selassie I (1930-1974) expanded Menelik's vision of modernization but both emperors were hindered by the lack of organizational, human and other capacities (see Diriba, 2018). It was only from 1960 onwards

³ The Multidimensional Poverty Index (MPI) identifies multiple deprivations at the household and individual level in health, education and standard of living

⁴ MOA 2019: Transforming Ethiopian Agriculture: Power Point Presentation, Briefing for Agricultural Scholar Consultative Forum, April 2019, Addis Ababa.

that modest progress was recorded following the establishment of agricultural high schools and colleges with the support of USAID's Point 4 Program. Subsequently, a series of bilateral and multilateral technical assistance plans were offered to develop agriculture, including the creation of a Comprehensive Agricultural Package Program, the establishment of an Extension Program Implementation Department (EPID) within the Ministry of Agriculture, and other packages. The most ambitious plan to transform Ethiopian agriculture was drawn up in 1967 by USAID contracted through the Stanford Research Institute (SRI)⁵. Completed in 1969, the SRI study consisted of eight program areas for transformation; unfortunately, it ran into difficulties over tenure constraints and the ensuing 1974 revolution in Ethiopia.

The revolution and the military government which brought an end to the imperial administration launched a turbulent period (1974-1991) in Ethiopia's contemporary political and economic history. The most consequential action, from the agricultural perspective, was the nationalization of rural lands, ending one of the oldest feudal systems in Africa, if not the world. Overall, however, other policies of the People's Democratic Republic of Ethiopia (PDRE), the Derg regime as it is usually referred to, induced massive poverty and hunger throughout Ethiopia (Diriba, 2018).

The Ethiopian People's Revolutionary Democratic Front (EPRDF)⁶, established itself as the Federal Democratic Republic of Ethiopia (FDRE), came to power in May 1991 and with the peasantry as its principal political ally, it expressly gave priority to the peasant sector of the economy. This was evidenced in the November 1991 Ethiopia's Economic Policy for the Transition Period (EPRD, 1991); the 2001 rolling framework to guide Ethiopia's development plan, the Agricultural Development Led Industrialization (ADLI) policy; and the subsequent Five-year Development

⁵ The eight program areas were: Program 1 - Farm inputs and agricultural production consisting of farm machinery, feed; Program 2 - Agricultural Package programs; Program 3 - Supplemental irrigation for agricultural production; Program 4 - Agricultural credit; Program 5 - Processing agricultural products; Program 6 - Marketing and export program; Program 7 - Improving agricultural techniques and technology; and Program 8 - Manpower resources for agricultural development including skilled manpower needs, manpower supply and type of training. See http://pdf.usaid.gov/pdf_docs/PNAAK861.pdf

⁶ As this is being prepared, the coalition front has been formed into a single Prosperity Party consisting of three of the four original coalition members as well as extending membership to five other regional parties; the TPLF, the principal founder of the coalition, opted out of the Prosperity Party.

plans. These have included: Sustainable Development and Poverty Reduction Program (SDPRP) 2001-2005, inspired by the multilateral Poverty Reduction Strategy spearheaded by the World Bank; the Program for Accelerated and Sustained Development to End Poverty (PASDEP) 2006 to 2010 ; and the Growth and Transformation Plan (GTP)I (2011 – 2015) and GTP II (2016-2020).

During the initial period and subsequently from 1991 through 2010, the FDRE focused on poverty reduction. It achieved a significant drop in the rate of poverty and the number of hungry (CDRC, 2019). In 2011, the EPRDF articulated its first five-year Growth and Transformation Plan (GTP), and in December 2010 it established the Agricultural Transformation Agency (ATA) to support agricultural transformation.

According to the Government's self-assessment of the GTP I performance, "Ethiopia has registered rapid, broad-based and inclusive economic growth that has led to substantial decline in monetary poverty, the proportion of the population living below the national poverty line fell from 38.7% in 2003/4 to 23.4 percent by 2014/2015; real GDP growth rate averaged 10.1 percent, and the share of agriculture and allied activities in the overall GDP declined to nearly 39% by the end of 2014/15. Crop and livestock subsectors accounted for 27.4% and 7.9% of GDP respectively, while the residual was accounted for by forestry and fishing⁷."The Government self-assessment concluded that "*the decline in the share of agriculture is an indication of structural shift from agriculture to industry and service sectors*" (author's emphasis). As noted earlier, the multi-dimensional poverty index reveals a different and often-depressing condition of Ethiopia's population.

Contrary to the Government's declared 'structural shift', Ethiopian agriculture has remained essentially antique and rainfall-dependent, an all-too-obvious reality throughout the country. Rural Ethiopia, a definition that covers the vast majority of the population, is still typified by lack of roads, services, and with only 59.5% population, primarily urban, with access to electricity and even that only intermittent, and 95% of the rural population relying on firewood for cooking, heating and lighting. There is no evidence of agricultural transformation, nor has there been evidence of sizeable expansion in the manufacturing sector commensurate with the vision of the ADLI. By the end of the GTPI, the government recognized that despite the progress made in a

⁷ See GTP II introduction section which assesses GTP I performance.

number of sectoral areas, one fourth of the population still lived below the poverty line, that is in monetary measure; urban and rural unemployment remained very high, and the agricultural sector remained dependent on rainfall using traditional methods with minimal application of modern agricultural inputs. In an after-thought, the government admitted that ‘there has been limitation in terms of structural change’. In effect, there had been no structural change at all.

The GTP II period (2016-2020) has coincided with a turbulent political period, starting after the May 2015 election and continuing to the present time with political turmoil displacing large segments of the population. As a result of changes in the ruling coalition, the EPRDF government leadership, and the launching of extensive reform processes, GTP II performance is expected to be below expectation. Government estimates suggest that GDP growth rates for 2018 would be around 7% with further reduction in growth in all sectors. The expectations for agriculture’s growth have been lowered to 4.1%, though the long-term growth rate is far below this.

The EPRDF government has also experimented with a number of policies and programs, expanding organizational outreach to the rural population, and, as we will see, has been able to register quantitative crop production increases, especially in cereal crop production and productivity. The categorization of chronically food insecure population into a Productive Safety Net Program (PSNP) has created a formalized welfare assistance program, but this requires continued international assistance that the prevailing Ethiopian economy cannot sustain without foreign aid. Despite these modest efforts, Ethiopia has not managed to start any multi-sectoral structural transformation nor has it been able to put agriculture on the path of transformation.

2.2 Obstacles to Agricultural and Rural Transformation in Ethiopia

Ethiopia’s agriculture has shown remarkable resilience over many centuries but is now increasingly failing. This was demonstrated by the remarkable way it has sustained a steadily increasing Ethiopian population with millennia-old tools and systems of production. Ethiopia is one of the original centers for crop and livestock domestication that started during the Neolithic revolution ten thousand years ago. Since then, Ethiopian farmers have continued to utilize their ancient system of production despite changing ecological and population pressures, feeding, if with difficulty, Ethiopia’s growing population

into the 21st century with their generationally acquired wisdom and skills. Equally, Ethiopian agriculture is increasingly failing as farmers work to expand agricultural lands at a great cost to the environment and the delicate ecological system, thereby risking the very fabric of their own livelihood. Systemic obstacles to agricultural and rural transformation in Ethiopia can be summarized as lack of sustained and intergenerational commitments to transformation, constitutional and legal constraints, government crowding out the private sector leadership, lack of mechanization options and constrained input supply system, lack of effective and accountable organizational capacity, lack of agricultural and rural financial and credit facilities and environmental degradation (see Figure 6, Box 1). Ethiopia's institutions have refused to recognize the devastating impact of technologically-lagging agriculture despite awareness of the 4th industrial revolution that would have relieved pressure on the land and offered a respite from the numerous dimensions of food insecurity.

The rising tide of hunger and poverty

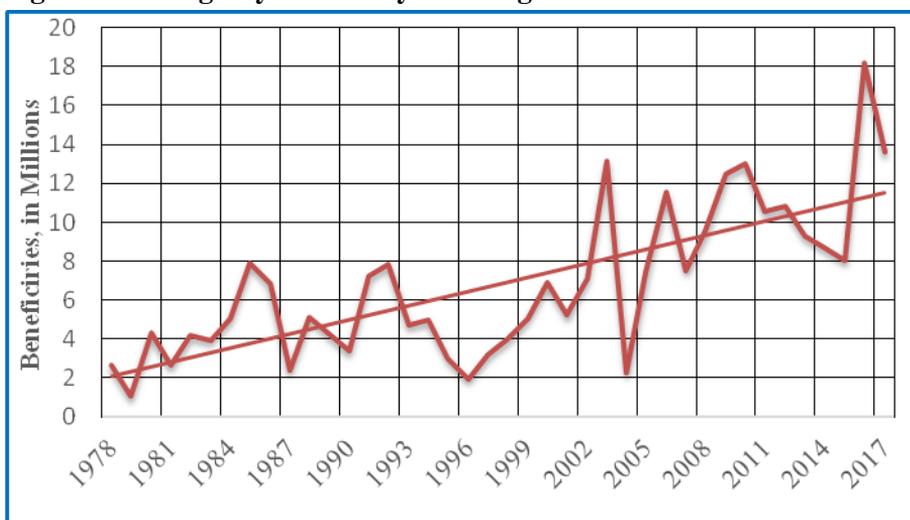
It is almost unbelievable that policymakers, scholars and practitioners, with knowledge about the most advanced technologies in the world, failed to anticipate the problems of food security and agricultural development before they unfolded. They failed to recognize the seriousness of the danger even when the problems had actually revealed themselves; and they failed to take decisive and bold action after the problems appeared at national level, along with human, environmental, economic and political consequences. It demonstrated a real crisis of vision, a total failure of understanding, naïvely assuming Ethiopia's agriculture could continue essentially in its present form and shape.

To be fair, and as briefly introduced above, Ethiopia has been tinkering with the concept of agricultural and economy-wide 'modernization' since the turn of the 20th century with limited success. Since 2000, efforts have been made to develop infrastructural expansion - roads, educational facilities, housing construction in major urban centers, hydro-electric generation plants, modest expansion in manufacturing and service industries - though the emphasis has been concentrated in Addis Ababa, the federal capital, and a few other regional State capitals. Efforts to develop agriculture have also brought about a modest quantitative growth, especially in cereal crop productivity per unit area. These efforts have resulted in nearly two decades of 10% GDP growth, and the reduction of income poverty from 45% in 1995 to 23% in 2018. While this might appear impressive, the number of poor and food insecure

population has remained very high, with an estimated 25 million people at or below the threshold of survival. And more specifically, the numbers of people on emergency and safety net program assistance have been consistently increasing (Figure 1) over the past 40 years, 1978-2017. Not only has the aggregate number of people depending on welfare assistance increased, there has also been a steady expansion in spatial manifestations, now covering nearly all the Regional States. This is an underlying trend that should alarm policymakers and development practitioners alike.

In addition, Ethiopia’s import of cereals (wheat, rice, barley), edible oil and lint cotton, continues to rise dramatically, now costing over a billion dollars every year (Figure 2). Given the foreign currency constraints the country is grappling with, it is disconcerting to witness growing import demands for products that could easily be home grown.

Figure 1: Emergency and Safety Net Program Beneficiaries: 1978 – 2017

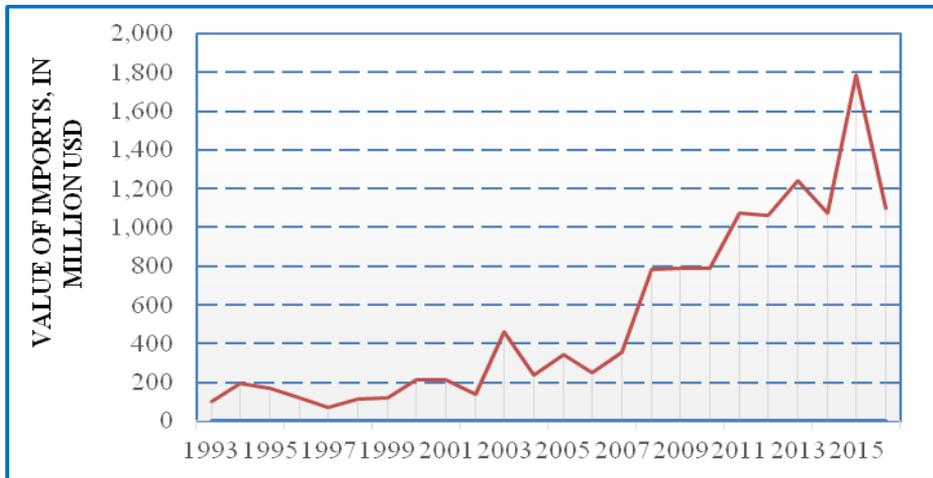


Source: Author, based on the NDRMC and MOA data.

The paradox is clear. At one level, there is a story that offers successful production and productivity increases amongst (some) progressive farmers in Arsi, Bale, part of Showa, parts of Tigray and Somali regional states and other areas. They have invested their resources to ‘acquire’ agricultural lands, employ tractors and harvesters, and optimized the use of agricultural inputs. They have succeeded in increasing land and labor productivity. They have successfully improved their lives and livelihoods. It is, however, a ‘success story’ that demonstrates the potential of

Ethiopian agriculture- if conditions are right. This is no more than a partial ‘success story’, and represents no more than a tiny proportion of farm households which built on the historical opportunities of rural development projects of the 1960/70s. At another level, Ethiopia is desperate to export agricultural commodities to earn foreign currency that are in critical demand even when some of the export commodities are not competitive regionally and internationally. Most agricultural commodities are exported without value addition (for example, sesame seeds or other pulse crops, and live animals).

Figure 2: Value of Imported Cereals, Dairy Products, Edible Oil and Cotton, 1993- 2016 (USD)



Source: Author, based on the FAOSTAT data.

Input and output price constraints

Smallholder farmers are faced with input and output price constraints: imported cereals are sold at subsidized prices to ‘stabilize local grain prices’, and food aid deliveries dampen local grain prices. Delayed delivery of agricultural inputs, absence of credit markets, and lack of access to agricultural technology are the hallmark of Ethiopia’s agriculture in the 21st century.

At the most fundamental level, Ethiopia’s problem has been the way it has ignored the scientific progress that has provided economic and social solutions, eased human hardships from want of food, improved and accelerated transportation, invented tractors and harvesters that have eliminated the need to depend on the backbreaking antique farming methods and making agriculture work easier and more enjoyable. The traditional factors of production, land,

labor and capital, have now been merged with the knowledge system. The real difference between the rich and poor countries is no longer only endowment of the factors of production as it used to be; rather it is how effectively nations and people utilize knowledge. Knowledge, that is scientific invention, technology, innovation, and the internet, are all growing at an accelerated rate leaving far behind countries such as Ethiopia. As Harari (2015: 212) points out, “the greatest scientific discovery was the discovery of ignorance. Once humans realized how little they knew about the world, they suddenly had a very good reason to seek new knowledge, which opened up the scientific road to progress. Inventions such as the steam engine, the internal combustion engine and the computer have created whole new industries from scratch. As we look twenty years into the future, we confidently expect to produce and consume far more in 2036 than we do today.”

The other side of the story is one of stagnation and decline. The vast majority of smallholder farmers live in perpetually substandard conditions, relying on traditional systems, unable to meet food consumption needs and other demands at the most basic level. Their farms are severely undercapitalized, they work on fragmented and declining landholdings, facing severe and chronic food insecurity, unable to invest in agricultural inputs (chemical fertilizer, improved seeds), or withstand seasonal risks of crop failure or animal deaths. They face continuous poverty and hopelessness. Many are now forced to rely on welfare assistance and depend on imported cereals (Figures 1 and 2).

The most persistent obstacle to Ethiopia’s agricultural and rural transformation is insufficient appreciation of the magnitude of the danger or of the consequences of the steadily increasing problems of agricultural and rural areas (see Figure 6, Box 1). As already indicated, there has been a total lack of intergenerational leadership recognizing the limits of the traditional techniques of farming, the pitiful living conditions of the vast majority of rural populations near or below subsistence and participating in agricultural practices that lead to extreme environmental and natural resource degradation. This does not mean that these problems are unknown - they are after all in the public domain. Numerous studies have provided detailed analyses of ‘systemic bottlenecks’ in agriculture (see ATA 2014). These have been repeatedly expressed in terms of delayed agricultural input deliveries, lack of access to agricultural machinery, absence of financial services, poor agricultural extension systems, incoherent national agricultural research systems, uncoordinated seed systems, and many other

challenges (FAO 1986, 2018, 2019, ATA 2013-2016, Diriba 2018, UNIDO 2013, ILRI 2017, and numerous other studies and project appraisal reports).

A WIDE⁸ study reveals changes taking place in rural Ethiopia: "... increasing divisions and inequalities and disrupted long-standing relationships between social categories: between the rich and the poor, between those with access to land and/or capital and those with too little or none, and, in different respects, between generations and gender. There are also growing disparities between better connected and less well-connected communities, and between areas and households within communities that are close or further from roads and urban centers. in much of the country and four bridge communities, the difference between being landless, having a quarter of half a hectare or more than one and, for the few who are better off, two hectares or more, can mean the difference being destitute, barely surviving, managing an independent livelihood or thriving and being part of the wealthy elites" (Pankhurst and Dom, 2019: 13 - 16).

Ever since the problems of agriculture and rural areas began to become visible at the national level, Ethiopia's leaders including relevant players in the sector appear to have been preoccupied with other issues, making no more than short-term responses for agricultural development and neglecting any radically different possibilities. There has been a recurrent crisis of vision. The issue has been clear enough: the prevailing systems of agricultural production have produced numerous fissures and concerns for the environment, for human wellbeing and for the national economy. It is a commonplace that some 20 million or more people live in a chronic state of food deprivation at the most basic level; more than 7.8 million are recipient of permanent welfare assistance under the Productive Safety Net Program. These figures are steadily increasing both in number and in area. Every year, another 3 to 5 million people have to be assisted with emergency humanitarian food aid programs; the numbers that constantly face risks and vulnerabilities are more numerous than the PSNP and emergency assisted population combined. The cost of hunger and poverty remains exceptionally severe for the economy and the population. A Cost of Hunger Study (AU/WFP/ECA 2013) estimated that hunger cost Ethiopia \$2.9 billion USD, equivalent to 16.5% of GDP. This is expressed in lost productivity, poor educational performance, healthcare and related expenditures; the environmental and political costs of hunger, including social unrest, were barely documented in financial terms. All this has increased in the last six years; and

⁸ WIDE – Wellbeing Illbeing Dynamics in Ethiopia - is an ongoing longitudinal study of 20 rural communities in Ethiopia since the mid-1990s.

there has to be a limit to Ethiopia's costly neglect of agricultural and rural transformation.

Property right dilemma

Another critical obstacle to agricultural and rural transformation is legal and constitutional, that is the prevailing property rights that have produced land fragmentation, persistently declining land per capita, and an increasingly landless population. Legally, the constitutionally sanctioned 'public land ownership' provides farmers with formidable challenges: land fragmentation, land shortage, the lack of capacity to capitalize land, and environmental degradation on a massive scale. Official data on landholding presented in Table 1 shows that 38% of households access less than 0.5 hectares of land, 23.65% access between 0.51 to 1.0 hectares, 24% between 1 and 2 hectares, and that only the remaining 14% of households access more than 2 hectares of land. At present productivity levels, it is only those households which farm more than two hectares of land which can achieve basic subsistence under normal conditions. Households with less than one hectare of land are often unable to fulfill household needs including necessary food consumption at the most basic level. The problem of size is not just the inability to produce enough crops to meet consumption, it also means it is impossible to save and create wealth. The persistent decline in the size of farmland also represents a formidable challenge in applying mechanized farming or of obtaining long-term capital investment on land.

Ethiopia's agricultural organizations and multiplicity of actors are disorganized and incoherent in their approach to the technological challenges. Political authorities, development practitioners, researchers, technologists, businesses, and entrepreneurs offer no system of coordination and collaboration to help deal with the massive obstacles facing farmers. Ignoring the conditions facing the vast majority of Ethiopia's smallholder farmers is more than merely reckless; it has serious human, environmental, and political costs.

As Table 1 shows, land shortage is chronic in most parts of the country with resulting severe degradation of soil and forest resources. In response, the Ethiopian government encourages farmers to employ 'clustering/ communal farming' by adjoining adjacent plots (*kuta-getem - ኩታ-ገጠም እርሻ*) to help improve productivity. 'Clustering farming' may have an appearance of offering respite; however, it is impractical, does not resolve the underlying structural and legal constraints to property rights and the desire to consolidate land, nor does it result in any decisive increase in income, and or labor productivity frontiers.

Table 1: Number of Holders by Land size (ha) - 2014/2015

Regional States	< 0.1	0.1 – 0.5	0.51 – 1.0	1.01 – 2.0	2.01 – 5.0	5.01- 10.0	> 10	Total	% share
Tigray	61,989	242,870	245,102	256,116	120,235	7,908	1,158	935,378	5.51
Afar	479	4,124	2,683	1,717	416			9,419	0.06
Amhara	315,832	924,145	1,089,212	1,423,634	718,963	35,558	2,033	4,509,377	26.57
Oromia	295,494	1,376,669	1,516,824	1,772,376	1,169,506	143,707	7,483	6,282,059	37.01
Somali		21,695	21,991	27,893	16,525	1,623		89,727	0.53
Benishangul Gumuz	27,008	55,186	46,041	47,057	37,393	5,958	1,172	219,815	1.29
SNNP	595,716	2,477,863	1,067,941	539,482	147,127	9,187	1,681	4,838,997	28.51
Gambela	9,184	20,227	7,399	3,931	1,190			41,931	0.25
Harari	1,328	9,309	8,239	5,167	989			5,032	0.15
Dire Dawa	646	9,033	9,345	3,772				22,796	0.13
Federal	1,307,676	5,141,121	4,014,777	4,081,145	2,212,344	203,941	13,527	16,974,531	100.00
%age	7.70	30.29	23.65	24.04	13.03	1.20	0.08	100.00	

Source: Based on CSA data

Organizational inefficiencies and incoherence

Where there has been some effort to respond to organizational challenges, in the form of policies or programs, these have repeatedly imposed taxes and duties, been characterized by input delivery inefficiencies arising from inaccurate and/or delayed demand estimates and delayed distribution to households, especially of chemical fertilizers, pesticides, and herbicides. It has all helped to make prices of agricultural inputs and machinery unaffordable. As of May 2019, some import duties were being lifted but full benefits of tax exemptions to smallholders have yet to be realized, especially in absence of rural and agricultural banks and credit facilities.

Another dimension of any response to organizational challenge has been the lack of priority access to foreign currencies to import agricultural inputs and machinery, creating a vicious cycle. The shortages resulting from the lack of agricultural development have forced the government to import wheat and vegetable oils to meet deficits in national demand which might otherwise bring bread riots or a similarly historical troublesome situation. With credits and financial services limited, and largely inaccessible to the vast majority of the farming population, the slow pace of agricultural services has retarded development in agriculture, and indeed in other sectors of the economy, perpetuating hunger and poverty and risking political unrest.

No formally dedicated organization, public or private sector, has been set up to supply tractors, harvesters, water drilling machines, agro-processing and other machinery, suggesting a troubling complacency among all actors about the traditional system of agricultural production. Despite the activities of the Ministry of Agriculture, the Agricultural Transformation Agency (ATA) or the Ethiopian Agricultural Business Corporation (EABC), there is no single organization that is directly responsible for, or dedicated to, support agricultural mechanization, or indeed rural transformation. Bizarre as it may sound; Ethiopia seems to have accepted its traditional system of agricultural production as the best available. Ethiopia's leaders and practitioners in agriculture are certainly aware of highly advanced agricultural technologies. This raises broader political and policy questions as to why they are not seeking all ways to introduce and support the adoption of mechanization in agriculture. As we have emphasized, one does not need an extended statistical analysis nor elaborate data collection to establish that Ethiopia's agriculture is very old, relies on ox plow and rain-dependent techniques and has a negligible rate of mechanization. It is, in fact, an open museum of the Neolithic age. According to a recent study, the rate of

mechanization in agriculture in Ethiopia is estimated at 0.7% of land prepared by machine with no more 0.8% crops threshed by machine. Even these are only confined to areas of Arsi, Bale, Western Tigray and parts of Somali region (IFPRI, 2017)¹⁸.

The traditional systems of crop and livestock production may have served the nation for millennia but this was only with a smaller population and a largely unaffected environmental system. Today, the same traditional tools and activities are expected to cultivate extensive areas and feed over 100 million people. This is not only impractical, but it is also inducing human and environmental disaster. To continue to rely on the ard plow, or partial application of agricultural inputs, is simply inadequate to meet expectations of agricultural productivity or improvements in human condition. As a result of the absence of mechanization, labor productivity has remained exceptionally low, even in comparison to other developing economies. At best, household labor productivity, outside coffee or cash crop growing areas, amounts to 1,750 kg of cereal for cereal-dependent populations on an average 0.65 ha of land. In addition, youth unemployment has become a major political and policy challenge for both the Federal Government and the Regional States. Data on migration is hard to obtain, but it can be inferred from both pull and push factors at work in Ethiopia. On the one hand, declining land availability and absence of employment opportunities in rural area are pushing the youth to urban centers; on the other hand, government authorities, fearful of political implications, offer ‘promises of job creation’ pulling large numbers of rural youth into major urban centers, especially Addis Ababa. The significantly expanded primary, secondary and tertiary education levels are also creating extensive unmet job expectations outside the agricultural sector and rural areas. The educational system is not producing or encouraging talent and skills that help or prepare graduates to create jobs, nor is there sufficient private sector capacity to employ the tens of thousands of job seekers entering the labor market each year.

Fearful of the creative destruction

There is insufficient appreciation of the potential of a rural and agricultural transformation to generate employment on a sustainable and

¹⁸<http://essp.ifpri.info/2017/02/28/the-rapid-uptake-of-agricultural-mechanization-in-ethiopia-patterns-implications-and-challenges/>, accessed May 2019.

continual basis. This would include mechanized small, medium and large-scale farmers, tractor and combine harvester operators, rural transport operators, machinery repair technicians, agricultural extension officers, veterinary specialists, plant protection specialists, and other service providers. These services could be linked to rural urbanization, decentralized manufacturing and services. That is, when agriculture and rural economies are transformed, the role of agriculture is elevated, not diminished, taking the commanding role in the Ethiopian economy and national security. With the transformation of agriculture, and the factor of productivity being dramatically increased, agriculture would release surplus labor that would be transferred to agricultural product processing (such as cotton, oil presses, fruits and vegetable processing, food processing and packaging, food processing including sucrose extraction and others), transporting, trading, food catering and distribution (in small shops, hotels, restaurants, and others), storage, and add value and expanded services at different stages. For the foreseeable future, on the basis of Ethiopia's economy today, the dream of establishing heavy industries (for example, steel smelting or automatic manufacturing) is likely to be distant. Even if they were realized, agriculture would still remain the commanding height. A strategic linkage among the agriculture, manufacturing and service sectors and urbanization would offer extensive and inclusive development opportunities at scale and at speed. These actions would, however, require intergenerational political commitment, coherent policies, balanced investments across all sectors of the economy, and willingness to accept the forces of creative destruction.

The growing food deficit in the national food balance sheet, the increasing importation of cereals and vegetable oils, the continued and expanding food aid flows, the appearance of a chronic food insecure population, with large segments of the population living below the internationally determined poverty line, have all been accepted as 'normal'. Even as the international systems celebrate the avoidance of 'famine', that is absence of 'mass starvation' (de Waal 2018), existing conditions signal massive problems for the population, the environment and the national economy.

Continuation of the present system of agriculture will mean that food and other needs of the rural and urban poor have to be provided by the government and international charities. The Ethiopian economy cannot fully finance the number of the welfare dependent population, nor is feasible to expect indefinite foreign welfare assistance. Yet, despite all this, at the international level, Ethiopia is committed to achieving the Sustainable

Development Goals (SDG), which encapsulates “a plan of action for people, planet and prosperity. SDGs recognize that eradicating poverty in all its forms and dimensions is the greatest global challenge and an indispensable requirement for sustainable development. It is a universal resolve to free the human race from the tyranny of poverty and want and to heal and secure our planet. The 17 SDGs are integrated and indivisible and balance the three dimensions of sustainable development: the economic, social and environmental.” United Nations, the 2030 Agenda for Sustainable Development, 2015.

2.3 The Agriculture and the Environment Nexus

The most comprehensive review of the state of Ethiopia’s environment, its land, vegetation, forests, soils, water, and population was conducted by the FAO and the Ethiopian government in 1986 under the auspices of the Ethiopian Highlands Reclamation Study. The study, completed more than three decades ago, concluded that the increase in population had extended farming to increasingly vulnerable land areas and reduced available fallow periods. In fact, feudal and other forms of dependent land tenure, coupled with day-to-day preoccupations with survival, had, over the centuries, led the growing highland population to farm the land in ways inappropriate to its sustained use. This had inevitably led to land degradation, typified by excessive deforestation and soil erosion, and by worsening water storage and flow regimes, and reduced the potential productivity of land. It had become a spiral of degradation. The study estimated that over 1900 million tons of soil were lost from the highlands of Ethiopia annually. These were losses of productive top soil and for all practical purposes irreversible as it takes many years to generate a ton of top soil. Soil erosion was gradually undermining the natural agricultural heritage of the country, and as a result, the highlands of Ethiopia contained one of the largest areas of ecological degradation in Africa, if not in the world. Environmental conditions had worsened to such an extent that in some parts of the highlands, millions were now scarcely able to subsist even in years of good rainfall while years of poor rainfall threatened famines of increasing severity and extent. Other highland areas were being gradually degraded, and it was only a question of time before the degradation spiral threatened livelihoods in all these areas too. This process of degradation threatened millions of Ethiopians then and even

more in the future. It posed the greatest long-term threat to human survival, and the greatest challenges facing the Ethiopian people and Government.

These prognoses could hardly have been more apt drawing attention to urgent action. And since the study was conducted, Ethiopia's population has increased 2.6-fold putting massive pressure on the already degraded lands. No other in-depth study has been conducted, but it is quite evident that the situation of most watersheds and their surroundings have moved far beyond the picture painted more than three decades ago. There has been continued expansion of agriculture into marginal and high-risk areas, seriously increasing land fragmentation, declining land use per capita and a significant increase in virtual landlessness. There has, in effect, been no effort to reverse the dangerous trends observed thirty years ago. Outside of the highland areas, in pastoral and agro-pastoral areas of the country, an equally dangerous environmental deterioration is at work. Despite data scarcity, it is evident that crop production has expanded into the pastoral and agro-pastoral zones creating a perfect storm for environmental deterioration on the one hand, and conflict between livestock and crop production on the other.

2.4 Agricultural Growth without Transformation

In this section, we will review the performance of the agricultural sector, cereal crops, pulses, oilseeds and the livestock components.

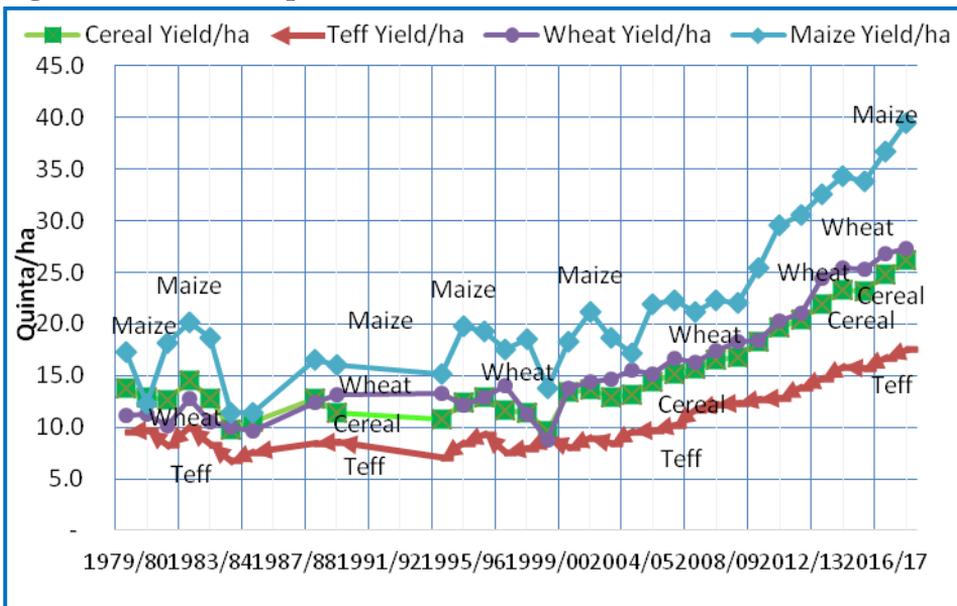
The crop sub-sector

Time series data is used here to examine performance and trends in crop production. This covers area cultivated, total production and yield per hectare from 1979/80 through 2017/18, over a period of 38 years. It is important to take a long-term trend because changes in the national economy such as crop performance only reveal themselves in time, and long-term data smooths out short-run fluctuations. During this period, as would be expected, aggregate national cereal production has increased considerably, by 4.2-fold, reflecting increases in the number of farming households, expanded area under crop cultivation, and utilization of chemical fertilizers, pesticides, and herbicides as well as other farm management practices. In spite of these quantitative increases, however, rural life has remained harsh, and production systems have continued to use antique techniques. Ethiopia's overall agricultural performance can be characterized as growth without structural transformation.

During this period, as depicted in Figure 3, the area under cereal crops grew at a rate of 2.13% per year, while yield increased at a rate of 1.7%, and cereal production grew by 3.87% per annum. Cereal yields increased from 1,379 kg/ha to 2,617 kg/ha in 2017/18, nearly double the productivity level of 1979/80 (Figure 3). Ethiopia’s cereal productivity of 2,617 kg/ha is far below 7,230 kg/ha in Egypt and 5,886 kg/ha in China (using FAO production data for 2017), indicating Ethiopia’s potential opportunity to expand production and productivity frontiers by more than double or triple its current levels.

The quantitative growth achievements in crop production are due to national efforts to increase cereal production to ameliorate national and household food deficits which would otherwise have spun out of control. This growth, however, came from the expanded area under cultivation, increases in the number of households participating in agriculture, and the use of chemical fertilizer and seeds. And any food security and national wellbeing implications of this supply side growth must also be considered in relation to the five key agriculture performance indicators: meeting consumption needs, meeting local and social obligations, investment in agriculture and replacement of tools, capacity to mitigate risk, and creation of wealth.

Figure 3: Selected Crop Yield/ha: 1979/80 - 2017/2018



Source: Author, based on the CSA data.

Principal cereal crop performance is highlighted below:

Teff: Consists of the largest area cultivated under all cereals, accounting for 29.5% of the total cultivated area and 19.7% of total cereal production. This area allocated to teff production is indicative of the high price of teff which fetches more than double the price of wheat and many times more for other cereal crops. It is the national food preference, especially among the middle class, and provides for the growing export market. The area under teff cultivation has been growing at a rate of 2% per annum; its total production has been growing at a rate of 3.65% though yields have only grown at a rate of 1.62% per annum over the past 38 years.

Maize: The area dedicated to maize production is the second largest, 20.8% of total cereal area with production accounting for 31.4% of total cereal output; nearly one third of cereal production in Ethiopia is maize. In terms of the volume of production, maize has the most impact on the national food equation, at least among the general population. Over the years, the area under maize cultivation has grown at 2.76% per annum, production by 5.0% and yield by 2.19%.

Sorghum: This accounts for 18.5% area under cereals and 19.3% of total cereal output. The area under sorghum has grown at an annual rate of 1.71%, total production at 3.11%, and yield by 1.37% per annum.

Wheat: Accounts for 16.6% of the area under cereal cultivation and 17.3% of total cereal production. The area for wheat has grown at 3.69% per annual, total wheat production¹⁹ at 6.18% and yield has remained at 2.4% per annum during the same period. Wheat is milled into flour for traditional bread, and use in bakeries, for pastries and pasta as well as being mixed with other cereals to make *enjera*. The growing number of milling companies in and around Addis Ababa, and in Arsi, Shewa and other regions, is a testimony of the growing demand for wheat. In addition, a significant quantity of wheat is imported each year to supply the national shortfall, accounting for 9% of national total cereal production (see Diriba 2018).

¹⁹ It is estimated that only 70-73% total volume of wheat enters consumption with 27-30% affected by impurities. These include desiccated grains, damaged grains by pests, grains in which the germ is discolored, sprouted grains, miscellaneous impurities such as extraneous seeds, extraneous matter, husks, ergots, decayed grains, dead insects, and other undesirable material.

Barley: Accounts for 9.3% of total cereal area and 7.7% of total cereal production. The area under barley has grown at a rate of 0.57%, total production by 2.19% and yield by 1.62% per annum.

Pulse crop production

Ethiopia has a rich heritage of pulses and oilseeds being one of the centers of origin of these crops. They represent the most important dietary composition of households, and are a major contributor to export earnings. Nevertheless, national policy and program priorities have not been commensurate with the importance of the pulses and oilseeds domestically or as export earners. Total pulse crop production grew at 2.75%, area at 1.56% and yields at 1.17% per annum between 1979/80 to 2017/18 (Figure 4).

Faba beans: Account for 29.8% of area and 33.2% of total pulse production in 2017/18. Annual growth has been 0.89% for area, 1.73% for production and 0.89% for yield over 38 years.

Haricot beans: Account for 20.8% area and 18.8% of production during the same period. Growth rate of area has been 7.7%, production at 8.28% and yield at 0.54% since 1979/80, indicating that most of the production increases have been due to area expansion.

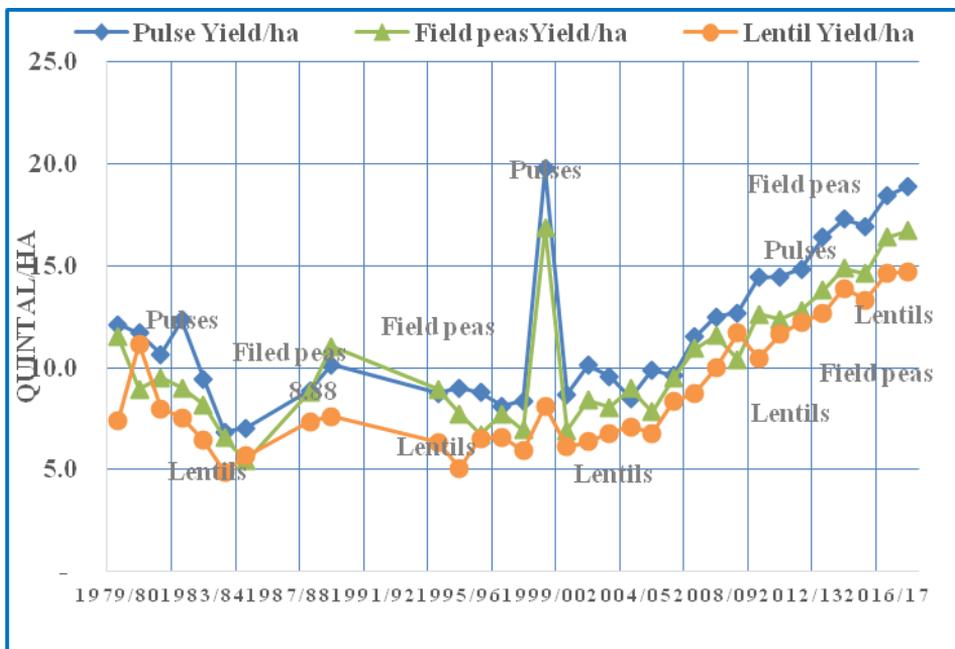
Chick pea: 16.5% of area and 18% of total production. Growth rates have been 1.02% for area, production 3.24%, and yield at 2.19%.

Grass pea: 9.7% of area and 10.3% of total pulse production output. Growth rates have been 1.74% for area, production 3.59% and yield 1.82% during the 38 years.

Lentils: 8.1% of area and 6.3% of total pulse production. Area, production and yield growth rates has been 2.89%, 4.76% and 1.82%, respectively.

In sum, Ethiopia has the potential to substantially increase pulse crop yields, and even in some cases at least double current yields.

Figure 4: Selected Pulse Crop Yield/ha: 1979/80 - 2017/18



Source: Author, based on the CSA data.

Oilseeds production (Graph 6)

Sesame: 39.4% of total area and 23.2% of the production of oilseeds. The area under sesame grew at 15.34%, production at 18.48% and yield at 2.72%.

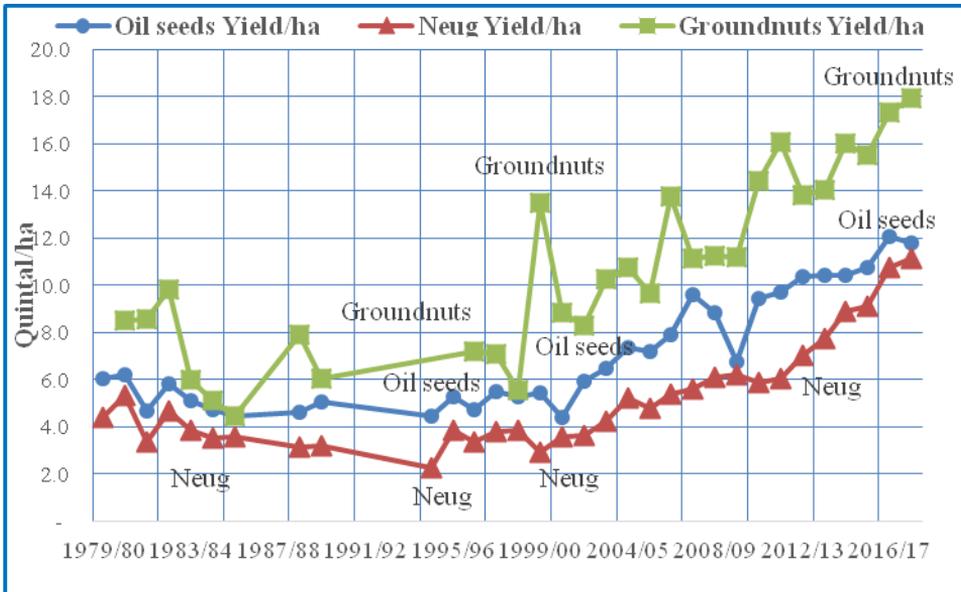
Neug (Niger seed): 31.1% of the total area dedicated to oilseeds and 29.3% of total production in 2017/18. Growth rates have been 2.62%, production 5.15% and yield 2.47% per annum.

Groundnuts (peanuts): 8.6% of area and 13.2% of total oilseeds production. Growth rates have been 11.22% for area, production 13.49% and yield 2.04%.

Linseed (flax): 8.5% of area and 8.0% of production. The area grew at 1.71%, production at 3.87% and yield at 2.12%.

Fenugreek: 3.5% area and 4.0% of total output of oilseeds. Area grew at a rate of 3.77%, production at 8.05% and yield at 4.12% per annum.

Rapeseed accounts for 1.9% of area and 3% of oilseed production. Area grew at a rate of 0.52%, production at 2.2% and yield 1.67%

Figure 5: Selected Oil Seeds Yield/ha: 1979/80 - 2017/18

Source: Author, based on the CSA data.

The livestock sub-sector

The Ethiopian livestock sector is even more traditional than the crop subsector. Ownership and spatial distribution of livestock resources among the crop growing and pastoral areas is presented in Tables 2 and 3, respectively. Within the crop growing area, 3.7 million households (29.16%) are without cattle holdings, while over 11 million households (92.7% of cattle owning households) own between 1 to 9 head of cattle. In regional distribution, the Oromia State has the largest number (4.7 million cattle), followed by the Amhara State (3.8 million) and the SNNP Regional State (2.8 million). In terms of the equine population, a few Regional States stand out: a) Donkeys: Amhara State 1.878 million; Oromia 1.988 million; Tigray 521,928 and Gambela 496,226 account for 95.7% of the national donkey total. b) Horses: Tigray 2,983, Amhara 299,890 and Oromia 722,377.

Livestock resource distribution in pastoral area is presented in Table 3. Pastoral area accounts for 14% total cattle population, 19% sheep and 35% goats. This shows that 86% of cattle population is located in cereal producing areas with greater competition between crop and livestock over grazing and farm lands. The geographical concentration and specialization of animal

resources is an important context for any livestock sector transformation agenda as shown in Tables 2 and 3).

As Table 4 shows, there is a considerable livestock resource in Ethiopia disaggregated by regional States and combining livestock resources in crop growing, pastoral and agro-pastoral areas. There are more than 56.7 million cattle, 29.3 million sheep and 29.1 million goats. The potential to transform the sector as an economic engine for households and the nation is huge.

There have been a number of recent studies recommending modernization options for the livestock sub-sector (UNIDO 2013, ILRI 2017, FAO 2018/2019). The UNIDO study indicates that milk production in Ethiopia has remained relatively low in terms of productivity: 2,160 Hg/annum for an average cow milk, for the years 2000 - 2010 in Ethiopia; this compares with Kenya (5,500 Hg/An), Egypt (14,500 Hg/An) and South Africa (32,700 Hg/An), suggesting Ethiopia has considerable potential to increase milk production. Currently, 90% of milk production in Ethiopia is undertaken by smallholder farmers, depending almost entirely on natural grazing and most of the milk produced retained for household consumption. Another problem is the largely informal distribution and marketing system for milk and dairy products. There is only a limited formal commercial system in operation. This is characterized by the absence of licensing requirements, lack of regulation, low cost of operation and high producer price when compared to the formal market. The traditional processing and marketing of dairy products, especially of traditional soured butter, dominates the Ethiopian dairy sector, and the traditional, unreliable and unhygienic, processing methods contribute to poor product quality. The lack of chilling and cooling facilities during milk collection leads to deterioration of milk quality and high losses. Within the commercial sub-sector, problems of unreliable supply and the high cost of packaging materials continue to limit investment in processing and packaging technology. Most of the existing processing facilities lack state-of-the-art technology for manufacture of value-added dairy products such as UHT, yoghurt or ice-cream.

The UNIDO study also notes that despite the large number of dairy cows, both the volume and value of Ethiopian dairy exports remains low. Butter is exported to only a small number of countries including Djibouti, Somalia and South Africa and to the Ethiopian diaspora. The import of dairy products varies considerably year to year, but the value of imported dairy products is substantial enough to lead to a negative net trade balance, ranging from US\$ 5 million in 2007 to US\$16 million in 2010.

Table 2: Cattle Holding Size in Main Crop Growing Areas by Region, 2014-2015

Regions	Number of Households by Cattle Holding Size								total Owners
	not owners	1-2 Head	3-4 Head	5-9 Head	10-19 Head	20-49 Head	50-99 Head	100-199 Head	
Tigray	287,353	263,330	335,260	267,238	70,967	13,729	1,481	103	952,108
Afar	87,705	29,204	32,232	52,270	38,498	15,908	2,941		171,053
Amhara	1,003,187	1,387,062	1,349,692	953,993	132,376	11,283	1,389		3,835,795
Oromia	1,355,894	1,455,720	1,368,273	1,423,287	419,686	57,115	2,371	144	4,726,596
Somali	48,097	23,708	26,888	31,019	14,750	4,041	196		100,602
Benishangul-Gumuz	127,592	32,028	26,625	30,093	13,925	4,754	161		107,586
SNNP	772,980	1,105,073	979,778	634,189	90,814	22,156	4,574	1,339	2,837,923
Gambela	34,299	7,850	5,172	4,657	4,971	4,033	413	68	27,164
Harari	5,904	10,024	6,821	2,986	397				20,228
Dire Dawa	8,822	10,560	6,638	1,765	97				19,060
Ethiopia	3,731,833	4,324,559	4,137,379	3,401,497	786,481	133,019	13,526	1,654	12,798,115
% age	29.16	33.79	32.33	26.58	6.15	1.04	0.11	0.01	

Source: Based on the CSA data, CSA 2016

Table 3: Livestock ownership in Pastoral Areas, 2014/2015

Livestock number and ownership		Afar	Borana (Oromia)	Guji (Oromia)	Bale (Oromia)	Somali	South Omo (SNNP)	Total
Cattle	Number of	1,495,054	1,081,553	1,503,241	1,566,521	631,059	1,776,996	8,054,424
	Number of HH	156,239	134,459	268,668	280,022	97,836	110,123	1,047,347
	Average Holding	9.6	8.0	5.6	5.6	6.5	16.1	7.7
Sheep	Number of	1,732,090	343,674	567,042	298,293	1,308,309	1,243,506	5,492,914
	Number of HH	144,920	60,496	148,752	48,011	95,036	69,912	567,127
	Average Holding	12.0	5.7	3.8	6.2	13.8	17.8	9.7
Goat	Number of	3,301,056	876,139	423,698	726,394	1,835,811	3,084,232	10,247,330
	Number of HH	170,139	92,727	87,981	136,867	114,383	64,271	666,368
	Average Holding	19.4	9.4	4.8	5.3	16.0	48.0	15.4
Horse	Number of		874	168,299	90,685		21,109	280,967
	Number of HH		874	90,730	37,832		3,508	132,944
	Average Holding		1.0	1.9	2.4		6.0	2.1
Donkey	Number of	133,481	73,762	97,997	239,705	148,724	26,215	719,884
	Number of HH	98,659	46,753	65,726	156,190	91,791	11,453	470,572
	Average Holding	1.4	1.6	1.5	1.5	1.6	2.3	1.5
Mule	Number of	636	2,102	16,291	17,272	71	5,110	41,482
	Number of HH	636	1,915	13,141	15,354	71	3,639	34,756
	Average Holding	1.0	1.1	1.2	1.1	1.0	1.4	1.2
Camel	Number of	460,624	75,622	24,193	29,639	362,291		952,369
	Number of HH	78,463	17,464	7,608	10,961	42,247		156,743
	Average Holding	5.9	4.3	3.2	2.7	8.6		6.1
Poultry	Number of	106,355	689,154	914,064	710,593	177,300	1,218,629	3,816,095
	Number of HH	17,865	86,440	137,528	116,638	29,192	96,405	484,068
	Average Holding	6.0	8.0	6.6	6.1	6.1	12.6	7.9
Beehives		310	68,953	223,067	190,847	2,022	73,949	559,148

Source: Based on the CSA data, CSA 2016

Table 4: Total Livestock Resources of Ethiopia, 2014/15

	Cattle	Sheep	Goats	Horses	Mules	Donkeys	Camels	Poultry	Beehives
Tigray	4,578,181	1,817,305	4,255,290	3,543	3,754	753,450	55,921	6,189,848	250,598
Afar	1,580,313	1,665,727	3,149,351		377	124,787	434,291	132,215	2,360
Amhara	14,710,911	10,024,277	6,064,944	420,760	157,213	2,677,429	66,364	18,031,121	1,361,329
Oromia	22,925,730	9,715,587	7,849,924	1,222,760	156,331	3,007,027	239,357	20,076,129	2,864,320
Somali	645,166	1,296,412	1,903,891		221	136,159	353,124	162,884	1,351
Benishangul-Gumuz	659,587	104,547	440,719	1,672	1,936	67,702	1,151	1,375,326	218,616
SNNP	11,215,636	4,580,220	5,092,628	382,927	78,334	630,492	2,865	10,433,773	1,127,618
Gambela	278,584	35,476	88,610	683	25	846		307,387	55,502
Harari	62,401	6,287	57,624	773		11,445	4,363	71,419	1,291
Dire Dawa	49,880	86,545	209,982		137	18,699	6,670	86,617	2,278
	56,706,389	29,332,383	29,112,963	2,033,118	398,328	7,428,036	1,164,106	56,866,719	5,885,263

Source: CSA 2015, Agricultural Sample Survey, 2014/15

Animal feed is one of the defining challenges for both the traditional and the commercial livestock sector. The traditional open grazing system faces steep competition from crop production, and studies point out that the major constraints for the very low production and productivity of livestock in Ethiopia are the poor quality and inadequate quantity of available feed. The commercial sector lacks sufficient feed production, and FAO (2019) and Bediye et al (2018) have identified some of the challenges facing the commercial feed sector in Ethiopia.

The most common problems for animal feed production in Ethiopia can be summarized:

- a) Seasonality, shortage and high prices of feed ingredients that limit sustainability and affordability of compound feeds;
- b) The commercial feed sub-sector and livestock production face severe and unfair taxation. For example, a 15% value added tax (VAT) is charged on feed ingredients and on compound feeds, leading to double taxation for feed ingredients and formula/compound feeds for ruminants. For poultry, the government has recently taken the positive measure of removing VAT on poultry feed ingredients and formula feeds, as most of the feed supplements, especially premixes, are imported from abroad;
- c) Ensuring feed safety and quality is one of the key challenges in the commercial feed sector to avoid high aflatoxin levels in oilseed cakes and compound feeds;
- d) The response to the demand for compound feeds has not yet reached the desired level as most of the feed processing plants are operating below capacity;
- e) Capacity to manufacture remixes, minerals and vitamins remains low and importation is costly in terms of price and of foreign currency;
- f) Technical services, both in terms of research and extension facilities, for promotion of the commercial feed sector remain very weak or non-existent;
- g) Feed processing plants are currently facing serious challenges in lack of analytical services mainly because of high cost and inadequate service delivery; and
- h) The Ethiopian Animal Feed Industry Association (EAFIA), established in 2008, is still a young institution and it has not yet reached the desired

level of operation. It is facing technical, financial, and organizational challenges.

The FAO's study makes it clear that agro-industrial by-products could play a much more important role in meeting feed shortages in the country. It looks at all available agro-industrial by-products from flour millings, sugar factories, edible oil processing factories, breweries, and abattoirs as well as fishery by-products, slaughterhouse offal, bagasse, molasses, sugarcane tops and fruit peels. Molasses is used for ethanol production, but all the other by-products can play an important role in the feeding of livestock, mainly in urban and peri-urban livestock systems. There are around 300 wheat milling plants, of which 140 are located in and around Addis Ababa; and some 202,134 tons of oilseed cake, from niger seed (noug), groundnut, sesame, cotton, and safflower, are produced annually. A substantial quantity of oilseeds is exported without value addition, decreasing the availability of oilseed cakes for use for livestock. The offal produced in the Addis Ababa Abattoir is processed into meat meal and bone meal for poultry feed. Breweries produce useful by-products and the total from domestic and modern breweries amounts to 635,343 tons of which 515,097 tons comes from domestic brewing and distilling in the Oromia and Tigray States alone – details of the contribution of other regions was unavailable.

In total, agro-industrial by-products simply do not produce anywhere near the necessary quantity of feed. One reason is that most agro-industries are running below capacity, in part because of insufficient or intermittent availability of raw materials, including wheat, oilseeds etc., and water and/or power. In addition, there are problems of proper storage of by-products at the production site or on farms, of transport to users quickly enough and in proper containers, plastic or metal with a cover and without leakage, or of proper loading and unloading of by-products from vehicles. Linking the industries that produce by-products with the feed industries, without intermediaries, and the introduction of drying technologies at production sites to increase shelf-life, building the capacity to properly manage the storage and handling at the production sites and on-farm, would all help to reduce wastage. Equally important is enhancing awareness of the importance

of these by-products as animal feed, and inculcating the idea that these are valuable resources.

The FAO's study of feed availability and feed balance, which was conducted in 2018, the first of its kind for Ethiopia, also underscores that the main factors behind pastoral destitution in Ethiopia has been feed and water scarcity, as the natural resource base in the rangelands is shrinking fast. Institutionalization of a feed security system is therefore a necessity. It is needed to fully identify needs, resource availability, gaps, implications and ways to fill those both in Ethiopia and the region. This is required to make feed interventions in the country effective in immediate, medium and long-term as well as provide solutions for the region.

Another study, ILRI 2017, identified three key livestock commodity value chains – poultry for chicken meat and eggs, crossbred cattle mainly for milk, and red meat-milk from ruminants, indigenous cattle, sheep, goats, and camels. These comprised smallholder families and commercial production systems organized across lowland grazing, including both pastoral and agro-pastoral systems, and highland crop-livestock mixed systems, both rainfall deficient and rainfall sufficient.

Overall, a number of studies, including the ones just cited, concluded that despite the livestock sector's significant herd size, and its vast contributions to the national and household economy, it continues to be constrained by numerous factors:

- ✓ Poor market access and lack of infrastructure limits the value added of farm/herds to an estimated 31.5% compared to 100% in member countries of the Organization for Economic Co-operation and Development (OECD).
- ✓ Short supply channels lead to moderate post-harvest losses: in milk, these are estimated at 3.4 %, and in meat to between 11% and 24%.
- ✓ Constraints in land and credit discourage entry into meat and dairy markets despite the possibilities of a lucrative business environment in which there are few competitors. Unfavorable regulatory and fiscal frameworks for land allocation and feed production respectively, lead to a reluctance of private operators to invest.
- ✓ Feed supply, in particular grass and fodder, is the main physical constraint to further expansion of the livestock population.

- ✓ Animal disease constraints include Foot-and-Mouth disease, small ruminant pests, tsetse-borne trypanosomiasis, external parasites (*Ekek*), sheep and goat pox, and contagious bovine pleuropneumonia (CBPP).

3. Framing the Processes of Agricultural and Rural Transformation

3.1 Conceptualizing Agricultural and Rural Transformation

The way the vocabulary of ‘agricultural transformation’ is being used in policy and program documents, or in daily conversations within the diverse national languages such as Amharic, Oromifa and others lacks clarity about what it means, or what may be expected of it; nor is there agreement on how to commence the transformation processes. Even more disconcerting is the absence of ‘clarity’ of the concept of agricultural transformation within Ethiopia’s academic and policy discourse. Needless to say, concept of agricultural and rural transformation must be ‘clear’ and ‘objective’, that is, it must express, with precision, the underlying assumption about necessary and sufficient economic, social and technological changes, and offer unconstrained guidance for policy and program action. Furthermore, transformation is not only about the processes involved, it is also about the realization that it creates jobs, increase incomes, improves lives and livelihoods, and protect the natural resources.

As shown in section 2.4 above, there is also a considerable confusion and misunderstanding in comments about the state of Ethiopian agriculture. They all-too-often simply emphasize quantitative crop production growth and ignore the absence of any improvement in the conditions of life of millions of Ethiopians and the lack of structural change which might offer new economic, technological, organizational and production possibilities. The differing perceptions about transformation trajectories raise three basic questions: first, what ‘measures’ agricultural and rural transformation; that is, how do we know if ‘transformation is happening’? Second, are there verifiable efforts that link agriculture/rural transformation to the manufacturing, services and urbanization at a decentralized level? Thirdly, will Ethiopia be able to induce transformation at the necessary speed and scale to end hunger and poverty by 2030 as called

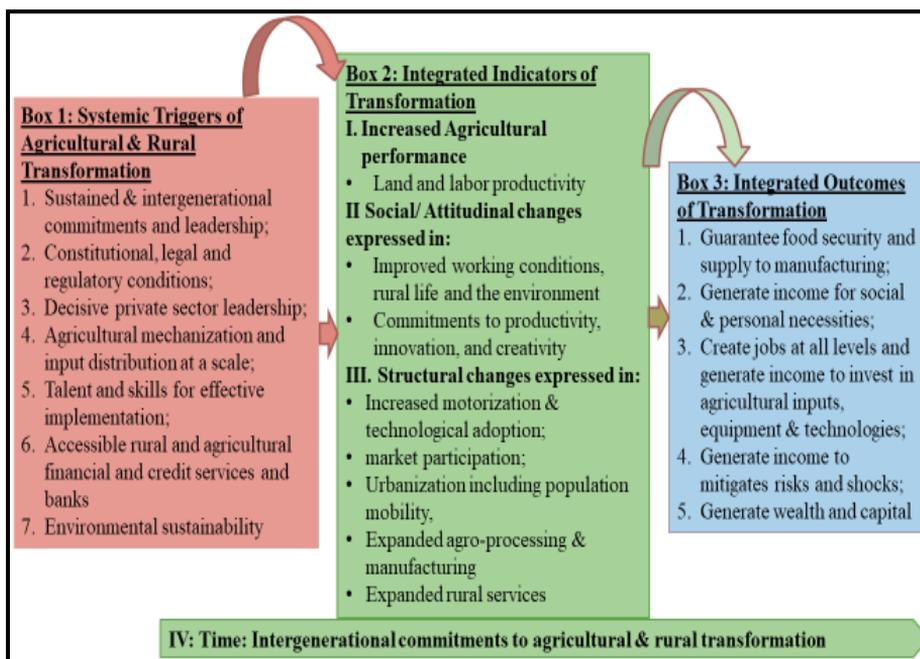
for in the Sustainable Development Goals (SDG) and save environmental catastrophe?

To be clear from the outset: agricultural and rural transformation is expressed here as the process of change from: a highly fragmented, risk and crisis-laden production system, rain-dependent, relying on traditional tools, with substandard conditions of life; to: one which is vibrant, wealth-creating, modern, system devoted to the improved wellbeing of the population, capable of producing for markets and supplying surplus for national demands for consumption, manufacturing and export earnings, by fully employing modern agricultural inputs, environmentally sustainable practices, and adopting farm machineries commensurate with the 21st century's technological and digital innovations. Implicit in agricultural and rural transformation is the desire and the necessity to improve human condition in all its forms, and at all times.

To clarify and depict this definition, four integrated processes are considered to trigger and measure progress towards agricultural and rural transformation: *performance, institution, structure, and time*, the period necessary for the evolution of Ethiopian agriculture (Figure 6, Box 2).

The starting point of agricultural and rural transformation in Ethiopia is to remove the many obstacles discussed above, herein referred to as systemic triggers (see Figure 6, Box 1). As has been discussed above, principal triggers include: i) sustained and intergeneration commitments and leadership, ii) continuously adapted constitutional, legal and regulatory conditions that facilitate the transformation processes at speed and scale; iii) shared responsibility between private sector and the State, with the state providing the means necessary for a decisive private sector leadership of the transformation process; iv) availability of a technological and innovation option that expands and delivers agricultural mechanization; v) commitment to the creation of human talent and skills to effectively and accountably implement agricultural and rural transformation; vi) facilitation and where necessary creation of rural and agricultural financial and credit services and banks, and vii) early and extensive work on environmental sustainability.

Figure 6: Processes of Agricultural & Rural Transformation: Triggers, Indicators & Outcomes



Source: Diriba, 2018. Overcoming Food and Agricultural Crises (and an expanded second edition, forthcoming).

Simultaneously, and as systemic triggers are acted upon, collective action is needed to induce social and attitudinal changes embodied in ‘institution’, that is totality of the norms, values and relationships that characterize Ethiopian society with a profound influence on agricultural performance, accepting, for example, as a way of life the substandard conditions of living of millions of rural households (see Figure 6, Box 2). ‘Institution ’includes political institutions, traditional and/or modern elements, family and community structures, religious bodies, ideologies, beliefs and values. It is about how a society perceives or recognizes the conditions of life, environmental changes, production systems, and interactions inside or outside an immediate community or societal structure. Seven characteristics of institutions need to be considered to unravel the puzzle of development and agricultural transformation in Ethiopia. These are: cultural and normative practices; religion and faith; functional and legal

practices; cognitive processes; organizational densities; persistence; and organizational manifestation. They offer an entry into and a deeper understanding about what holds back and/or prevents Ethiopia from innovations and embracing technologies to free millions of its citizens from chronic deprivation of food and basic necessities. As such, they provide a deeper understanding of structural change and equilibria within and among the factors that make up the national economy. These and additional elements discussed below will serve as integrated indicators of transformation.

Another indicator of transformation is structural change (see Figure 6, Box 2) which measures progress towards agricultural transformation; it measures changes from the traditional systems of production, relying on arid-plow and rainfall, to modern production systems that utilize mechanized practices, allows significantly enhanced land and labor productivity, and offers a shift in the relative proportion of agriculture within the broader national economy, as well as changes in the living standards of the population. In a broad sense, structure is the most important input of social and economic transformation. For this reason, structural change is complex and it is central to accelerating and/or constraining agricultural transformation over time.

The third process is about measuring outcomes of agricultural transformation, that is 'performance', being measured in terms of improvements in the wellbeing of the population, and it is assessed in the following five ways, which characterizes their definition of food security for Ethiopia (see Figure 6, Box 3).

- ✓ First, agricultural performance must be evaluated in terms of its capacity to provide food security, at the most basic level, for human nutrition and survival requirements for producing and consuming units. Nutritional requirements can be met directly from farm products and/or from markets in exchange for farm /labor income.
- ✓ Second, agricultural performance must also be assessed in terms of its capacity to meet the social, personal and communal, and economic necessities of life such as shelter, clothing, medical, educational and locally determined communal expenses including the capacity to pay for leisure activities, even if these are rare for most Ethiopians. In other words, agricultural performance assessment must be expressed in terms of

cash income that can pay for health, educational and other related social obligations for the participants in the sector.

- ✓ Third, agricultural performance must go beyond the maintenance of life; it must serve as a business enterprise where farmers invest in innovation and technological change to enhance land and labor productivity. Agricultural performance should be measured in terms of its capacity to afford producers the ability to purchase farm inputs and tools including fertilizer, seeds, pesticides, and the replacement of tools including *maresha*, hoes, racks, and investments in mechanization, hay-making, milk-processing and beef production, afford agricultural machine rental or purchase investment in irrigation to reduce the risks of dependence on rainfall as well as investment in modern livestock rearing and animal product processing.
- ✓ Fourth, agricultural performance must also be assessed by capacity of households, the producing units, to mitigate risk in the event of crop failure or animal deaths. Risk can be mitigated by savings put aside from agricultural produce either in-kind or in cash or through purchase of risk insurance, if such schemes are available. Agriculture should also provide a cushion for shocks and provide for ‘risk management’ either in direct savings from crops or animals or in cash. Although agricultural risk management and/or ‘risk insurance’ is a modern concept to most Ethiopian farmers, the concept is as old as the emergence of agriculture which has developed a built-in traditional system to provide a cushion in times of need in the form of grain saving, borrowing, reciprocity, migration, crop diversification, dispersion of farm plots in different locations or differing agro-ecological zones, and other ways.
- ✓ Fifth, agriculture performance also includes saving beyond year-on-year consumption and expenditure, and must be able to contribute to creation of wealth, guaranteeing pensions or social insurance. Implicit in the performance matrix is the extent to which Ethiopia’s agriculture is open to and utilizes mechanization options that could have profound impact on performance of the agricultural sector as well as improve the wellbeing of the population.

Finally, it is important to be mindful of the time it takes to fully rollout agricultural and rural transformation. This refers to the evolution and temporal changes in agriculture, and it explains the sequence of events that

influence the structure and performance of agriculture over a sustained period of time. Individuals, societies and governments often become pre-occupied with on-going and current events, ignoring the sum total of changes over a long period of time, generally referred to as economic or social history. History, however, is not just the record of events from the past but is also the science and action of human societies as they happen. It is important that we understand the social, economic and technological changes of a society through the lens of time. That is, ‘time’ as expressed in a single cropping season, a program or project period, a particular event such as a revolution, the duration a government stays in power, a generation, centuries or even millennia. It is important to observe what may have happened in successive cropping seasons, or during a series of program cycles, over the period of successive governments, or even over centuries or millennia. Without this, Ethiopia misses the effect, the impact of cumulative change over time.

3.2. Agricultural and Rural Transformation in Development Literature

The most widely accepted characterization of agricultural transformation is one that describes the shift from highly diversified, subsistence-oriented farms towards more specialized production, and market supply. Delgado (1995:3) further expands agricultural transformation as offering ‘specialization in production, greater use of purchased inputs, greater resource flows to farming, and substantial cuts in unit costs of production from technological changes.’ In fact, numerous characterizations and descriptions of agricultural transformation abound: agricultural populations move out of farming, becoming dependent on the market, rising ratio of agribusiness value added as part of rural-centered agricultural transformation, aggregation of small farms, technologies responding to factor prices (land, labor and capital), increased infrastructure, higher information/communication penetration, and integration of agriculture into a wider economy (Timmer 1998, FAO 2017, Naseem 2017). These characterizations of agricultural transformation in international literature are important, but they do not tell us what actually triggers the transformation

processes, whether they need accidental or deliberate political action, or what conditions must be put in place for agricultural transformation to happen or to be rolled out on a large scale. They do not suggest what performance matrix should be deployed to understand and measure if a transformation is taking place at the desired speed and scale. And most markedly, international transformation literature does not focus on the quality of lives of the agricultural population or on changes in their wellbeing, except through implicit assumption about ending hunger and poverty.

Historically, when agricultural transformation started in Europe, the principal motivation was to reduce the price of food in order to allow for cheaper wage labor. Lewis: “If the capitalist sector produces no food, its expansion increases the demand for food, raises the price of food in terms of capitalist products, and so reduces profits. This is one of the senses in which industrialization is dependent upon agricultural improvement; it is not profitable to produce a growing volume of manufactures unless agricultural production is growing simultaneously. This is also why industrial and agrarian revolutions always go together, and why economies in which agriculture is stagnant do not show industrial development” (quoted in Timmer 1998).

A number of other objectives for agricultural transformation have been shown in development literature, especially since the mid-20th century. The more immediate and primary objectives of investing in agricultural transformation is “to reduce hunger and poverty”, that is provide an agricultural-led development strategy that would produce more food, and generate more employment in the short-run, as has been the case with Ethiopia’s policy guidance of the Agricultural Development Led Industrialization (ADLI). The hunger and poverty reduction objectives are important for developing countries such as Ethiopia; but they should not be the ultimate goal of agricultural transformation. This must be modernizing the agricultural sector for the long-term, and improving the rural living conditions of the population, thereby reducing poverty and hunger.

Releasing surplus labor in agriculture long with the rising land and labor productivity is not an end in itself for Ethiopia or for many developing economies of Africa. In fact, in Ethiopia, numerous factors are pushing out the agricultural labor force without there being sufficient and necessary

conditions to absorb it in the manufacturing and service sectors. Surplus labor must serve for the gradual emergence and expansion of the manufacturing and service sectors, the later motivating the former. Another objective of agricultural transformation in international development literature is to decrease the relative role of agriculture in the economy²⁰. Such views continue to influence scholars and politicians alike. In a recent literature on Ethiopia, the Prime Minister of Ethiopia Abiy Ahmed, reflects a similar sentiment of agriculture as ‘dying as it is growing—‘ዓዳጊሟች’’, and he states that “ግብርናዉ የፈለገ እድገት ቢያሳይ የአንዲትን ሀገር አዳጊ ፍላጎቶች እስከ መጨረሻ ይዞ መጓዝ ያጠያይቃል። ለዚህም ነዉ አንዳንድ ምሁራን ግብርናን “አዳጊሟች” ሲሉ የሚገልጹት” (መደመር: 2012: 218)። The persistent views of ‘dying agriculture’ is far from the reality in Ethiopia. Agriculture has been and will continue to be the most important sector with an undiminished role in the national food and economic security objectives. What has happened in historical processes, and can be expected to happen in Ethiopia, is the ratio of *agriculture’s primary value will decrease* (expressed in crop and animal production, that is without considering agricultural derivatives). This is, however, an inadequate measure of the role of agriculture, and as discussed above, when agriculture and rural economies are transformed, the role of agriculture is elevated, not diminished, as the commanding element in the Ethiopian economy and peace and security; surplus labor will be transferred to agricultural product processing. Heavy industrial development remains a long-term prospect, and initial investible surplus, income and capital, has to be generated in agriculture in order for growth to occur broadly in the national economy. In fact, of course, agriculture adds significant value to other sectors such as the manufacturing and service sectors, in the form of agro-processing. Certainly, given the dominant²¹ size of agriculture in Ethiopia, it will remain the most vital sector of the national economy. The non-agricultural sectors, without agricultural product derivatives, will be smaller relative to agriculture and its allied economic benefits.

²⁰ See Staatz, 1994. The Strategic Role of Food and Agricultural Systems in Fighting Hunger Through Fostering Sustainable Economic Growth. See also Timmer 2007 in Handbook of Development Economics, Volume 1.

²¹ Dominance of agriculture is expressed in the number of people it employs, geographical dispersion, number of households, and as the principal supplier of national consumption, manufacturing and export earnings.

The challenge for Ethiopia and other developing countries in Africa is to balance resource allocation judiciously among agriculture, manufacturing and services sectors and offer equitable incentives to develop urban and rural infrastructure. Withholding resources too soon, or withdrawing them from agriculture to finance expansion in other sectors will have a dual impact, delaying agricultural transformation and limiting supplies of food and raw material, such as cotton, oil seeds, or grain for the manufacturing and the service sectors. The service sector will also suffer from dampened demands as a result of high food commodity prices, having massive effects on urban consumers as well as the wage-dependent rural population. These are, indeed, the precise conditions playing out in contemporary Ethiopia.

To deal with the effects of agricultural production deficits, national policies are often geared towards importing agricultural commodities to curb price rises and limit potential social unrest. This policy option may be necessary to address the short-term supply deficits. In the medium and long-term, however, it can only further exacerbate a downward spiral of agricultural growth as domestic producers are unable to compete with the highly productive farms of developed economies. As is the present case in Ethiopia today, domestic wheat prices are nearly three times higher than imported wheat. The low price of imported wheat, combined with periodic peaks in food aid deliveries, often undercuts possible price incentives that could have facilitated investment and innovation for domestic producers. On a recent visit²² to Arsi in Oromia Regional State, the author saw conflicting responses to the low price of imported wheat and vegetable oil. Producers of wheat were strongly critical of the lower price of imported wheat; consumers in both urban and rural areas expressed approval.

Policies advocated in the international development literature, to “squeeze agriculture on behalf of the more dynamic sectors of the economy”, are highly damaging to any possible transformation of the sector, especially in countries where agriculture is the principal source of food and income. The context of Ethiopia is vastly different from the European and American transformation processes that have largely informed the scholarship of much

²² A field visit to Arsi and the adjoining areas is a regular exercise of the author in part to inform the write up of this discussion paper and preparation of the second edition of his “Overcoming Food and Agricultural Crises in Ethiopia”.

of the writings and conceptual underpinnings of agricultural and economic transformation. Contrary to the “squeezing out” hypothesis, agriculture and the rural sectors have to be transformed and be modernized to allow for any expectation of economic equilibrium. If and when land and labor productivity increases are comparable to the globally motorized farms, then it may be feasible to anticipate transmission of the productivity gains in agriculture to other sectors of the national economy in the form of savings, lowered price of agricultural and manufactured commodities for consumers, and capital flows from agriculture to urban areas for investment in services or manufacturing sectors without being “squeezed”. In an economic equilibrium, the value of the agricultural surplus is capitalized in and outside agriculture; and land is capitalized as agricultural land, through aggregation and consolidation, with expanding urbanization offering lucrative land values. This also assumes State facilitation of decentralized urbanization, rural industrialization, agro-processing, technical assistance for skills development, credit and financing arrangements, property rights, and national educational systems that can respond to emerging talent demands across all sectors. These natural process of capital flows, from agriculture into the manufacturing and service sectors, cannot however occur if the agricultural sector remains traditional, with low productivity, and living standards of the population near or below subsistence as is the case in Ethiopia. If agriculture is forcibly “squeezed” by State intervention, it creates stagnation, not transformation.

Implicit in the processes of agricultural transformation are greater performance of institutional and structural changes through time that will bring about resolution of national food concerns, induce voluntary resource outflows from agriculture, and bring about the adoption of technologies without passing through the historically costly processes of technological invention. Agricultural and rural transformation induce quantitative, structural and technological transformation of largely traditional and subsistence agriculture, and can be expected to improve living conditions. Indeed, Ethiopia has sought for this, in policy terms, as when the EPRDF administration introduced the Agricultural-Development-Led-Industrialization (ADLI) policy to provide an underpinning for developmental architecture. The ADLI has, however, had difficulty in getting off the ground in the spirit expressed by its designers; it is now necessary to revamp an integrative framework of transformation in the

light of Ethiopia's present context offered in the concluding section of this discussion paper.

It is important to keep in mind that rural and agricultural transformation are inseparable and they offer inclusive development opportunities for all Ethiopians. As important, in the short and medium term, is the fact that most growth opportunities will continue to come from agriculture: food production, employment in agriculture and allied sub-sectors, food manufacturing, food services, and agriculturally based trade. These can and will make significant contributions to the non-agricultural growth processes including employment generation.

3.3 Triggers of Agricultural and Rural Transformation

The question of *what actually triggers and drives agricultural transformation* is an important one and often neglected in development literature as well as in development discourse. There are no clear-cut theoretical models nor any uniform procedures to guide countries in starting or sustaining agricultural and rural transformation processes. Responses to and guidance of transformation can only be found in broader social, technological and modernization theories, and most of the suggested options are dependent on country and context-specific political and policy commitments to transformation. Within broader development processes, countries can consider streams of technical changes and complementary reforms (see Figure 6). These can include the too-often neglected roles of institutions, the relevance of legal systems, organizational capacity, cognition and leadership capacities, social norms and values, and commitments to change, as well as recognizing the many facets of the problems of traditional agricultural and rural development. Ethiopia's commitments, for example, must include ways to unravel the legal constraints, and provide for universal property rights permitting land consolidation to facilitate mechanization and durable investment to improve the land, enhance organizational efficiencies and accountabilities, lower costs of agricultural inputs, reduce high transaction costs, and deliver investment in infrastructure. Additional triggers include accessing the knowledge and skills embodied in technologies and management practices, and the provision of an organizational system that recognizes and motivates

citizenry, especially youth, to participate and invest in agriculture. In a 21st century context, economic growth and social changes depend increasingly on embodied knowledge and self-learning. A critical task is to identify the most effective mechanisms to transfer knowledge and skills to agricultural households and assure them of an inclusive and equitable share of the benefits. In this context, the traditional extension system will continue to be needed but its efficacy will have to be complemented or even replaced by online learning and private sector agricultural extension services.

Agricultural transformation is contingent on organizational, social and technological adaptation, commitments to modernization and improvements in the living conditions of the farming population. The 20th century scholarship that continues to influence the development agenda in Africa, and certainly in Ethiopia, is now facing vastly different forms and processes in the 21st century. Naseem et al (2017) has rightly noted, “the characterization of contemporary structural transformation primarily in terms of productivity, employment, and migration seems unsatisfactory. Other attributes need to be considered that may affect the process of structural transformation. There are considerable differences in the initial conditions and the global economic environment in which today’s agriculturally-based economies find themselves in, that the process of structural transformation is likely to be different in the coming decades.” The study points out that new opportunities may create an environment that is more conducive to a rural centered agricultural transformation, with, for example, new agricultural value-added products and services closer to farms allowing households to generate incomes through non-farm activities, often enabled by information and communication technologies and other technical advances. Diriba (2018) has emphasized that the holy-grail of agricultural transformation is to be found in institutional changes that will facilitate and capture economies of scale in the provision of services such as mechanization, delivery of inputs, financial services, and transmission of skills and know-how to the farming population. It should also be noted that the increased competition for export-based markets, a major element in the Asian structural transformation experience, is largely inapplicable for Ethiopia, due to the paucity of technological openings, lack of financial services, and limitations of talents and skills.

Sustaining agricultural transformation has to look to important policymaking and programming activities including: a) provision of a quantifiable vision and strategy for agricultural transformation (Mellor 1973); b) sustained and verifiable inter-generational commitments over an extended period of time (Diriba 2018); c) sustained resource allocation to the rural and agricultural development, providing for example, 10% of national expenditure to agriculture (AU/NEPAD 2010); and d) a carefully balanced prioritization of agricultural and rural transformation with other sectors of the economy including manufacturing, services, urbanization and infrastructural expansion.

It is important to emphasize the inseparable linkage between agriculture and rural transformation. The links are not imaginary; rather policymakers and development practitioners must be guided by pragmatic resource allocation for inclusive and decentralized development opportunities. There are three major considerations.

- First, at the most general level, to achieve the ambition of transforming agriculture from subsistence production to one of technology-employing agriculture, Ethiopia must induce technical change. This must cover policies, investment, and an enabling environment focusing on the removal of organizational and legal constraints for all sectors. It must facilitate and ease a greater use of agricultural input supplies, increased land and labor productivity, the use of fertilizers, pesticides, seeds, and irrigation, as well as the expansion of manufacturing and service industries, all of which will result in structural transformation. In Ethiopia, no sector can be transformed in isolation. The relative shift of the ratio between agriculture, manufacturing and services should not be used as a tool for resource-allocation decisions nor should it be relevant as an indicator of transformation.
- At a sector level, within agriculture itself, crop productivity increase is certainly necessary but this is insufficient to produce all-inclusive agricultural transformation. As we have seen, partial and low-level utilization of agricultural inputs has tended to increase crop productivity per hectare of land. Combined with the expansion in the area of land usage arising from population increases and utilization of agricultural inputs, this has led to increased quantitative crop production at an aggregate national level. This has provided a temporary respite to poverty

and hunger, but in spite of crop productivity gains, the organizational, structural and technological constraints have remained. Agricultural and rural transformation have not been taking place at the scale and speed they ought to be in Ethiopia. The apparent relative ‘decline in poverty and hunger’, in monetary average, is not a signal of agricultural and rural transformation; millions of Ethiopians continue to suffer from substandard living conditions including hunger and income poverty.

- Rural transformation is often assumed to occur as part of an agricultural transformation process, or as an outcome of other economic processes²³. For a comprehensive transformation to take place on a scale that is sustainable and inclusive of the people’s conditions, the rural areas must become an integral part of the political and programmatic choices that make up the transformation agenda. Rural transformation means creation of an ecosystem in which the transformation of agriculture takes place, improved human wellbeing is provided, environmental protection is ensured, changes in the mindset of the population commence, rural services are provided, conditions of life for the rural population significantly improved with resulting market participation, and the availability of a large proportion of home consumed commodities.

²³ Ethiopia’s rural development policy document was developed in 2004, There has not, however, been any meaningful or practical action to realize it.

4. A Call to Action: Incentives and Reform Considerations

4.1 Quadruple Sector Approach to Transformation

Implementing agricultural and rural transformation cannot take place without an integrated and synergistic linkage with other sectors of the economy. In context of Ethiopia, there are four interlinked sectors: agriculture along with its rural environs, manufacturing, services, and urbanization. Each of these are expanded further below. The context and developmental stage of Ethiopia demands recognition that agricultural and rural transformation are intrinsically linked; the one cannot transform without the corresponding transformation of the other. Nor can agriculture, manufacturing, services and urbanization succeed in isolation of each other.

The starting point for decisive and urgent agricultural and rural transformation is the recognition that Ethiopia's smallholder agriculture is faced with severe challenges that have been accumulating for many decades. Ethiopia has now put in place a number of building blocks to rollout an economy-wide transformation at speed and scale. These building blocks include many decades of experience across different sectors and the economy, allowing for expanded infrastructure and services, the conception and construction of industrial parks at strategic locations, expansion of primary, secondary and tertiary educational opportunities, and the achievement of quantitative production increases in agriculture. Equally, in implementing agricultural and rural transformation, Ethiopia must climb new heights of economic and social transformation, building on the gains and experiences of the past, and committing itself to a long-term, inter-generational, and sustainable transformation of agriculture. These long-term commitments will require continuous adaptation of programs and strategies within and across each of the principal sectors.

The quadruple sector approach offers an inclusive platform of development that can dramatically improve the conditions of Ethiopia's population, especially those in rural areas. Unquestionably, rolling out an economy-wide transformation with agriculture as a lead sector demands bold commitments and tangible actions by all Ethiopians and its leadership at all levels. It involves creating sufficient and necessary conditions to trigger and sustain agricultural and rural transformation.

Firstly, *agriculture and rural transformation* must remain central and serve as the precondition for the transformation of the other principal sectors. For this reason, Federal and Regional State guidance is critical to establish linkages among the principal sectors and placing agriculture as *primus inter pares*, first among equals.

Secondly, the development of *rural industrialization and expanded manufacturing* capacities must be supported, initially focusing on agro-processing including production of poultry, dairy, beef cattle and oilseeds, and flour mills just to mention a few areas. The very foundation of rural industrialization is enhanced productivity and a gradual move to specialization in specific products. A comprehensive list of realistic and locally viable rural industrialization opportunities and options must be worked out at *Kebele* and *Woreda* level. Rural industrialization must be conceived strategically, and it must reflect the condition of Ethiopian smallholder farmers. In this way, rural industrialization can serve as an inclusive development opportunity.

Third: *Decentralized urbanization*. Urbanization typically accompanies rapid progress of agricultural and rural transformation, which in turn can be fueled by expanded urbanization, especially in the growth of manufacturing and services. As agricultural transformation takes off, and as a result of rises labor productivity, increasing numbers of people will be compelled to leave the rural areas. These people will be required to either sell or mortgage their land and move to urban centers to establish themselves as wage laborers or traders. A decentralized urban development strategy commensurate with strategic urban planning must be considered, providing services such as land valuation and designation of urban sites, water supply, electricity, educational and health facilities, housing designs including affordable building material, among others. The key is to ensure that there is a sufficient pull factor at the *Kebele* and *Woreda* level for urbanization so that all surplus labor does not try to move into Federal or Regional capital cities. While some migration is unavoidable, sufficient urban service delivery incentives and policy instruments must first be put in place at a decentralized level, focusing on small towns. This must include the provision of rural housing, including key facilities such as rural electrification, water and rural transportation systems. Rural transportation systems permit farmers to

commute to and from their farms should they decide to retain a dualistic economic model.

Finally, there's the need for *social, physical, digital and market infrastructure and services* as these will increase dramatically as the productive sectors of the economy transform.

In summary and as already presented earlier, the quadruple sector transformation framework replaces the ADLI framework, and a major task will be to balance resource allocation judiciously among the principal sectors. To reiterate: withholding resources too soon, or withdrawing them from agriculture to finance expansion in other sectors will delay agricultural transformation and limit supplies of food and raw material, such as cotton, oil seeds, or grain to the manufacturing and service sectors. It would also undermine the national and household wealth creation that can be reinvested in infrastructure and technology generation. The service sector would also suffer from dampened demands following high food commodity prices, and have massive effects on consumers as well as wage-dependent population in both rural and urban areas. These are, in fact, the precise conditions playing out in contemporary Ethiopia.

This four sector transformation agenda must now be supported by homegrown and Ethiopia-specific scholarly researches focusing on the transformation processes, triggers and indicators. These studies must offer a realistic assessment of options, and provide practical and policy relevant recommendations. While lessons from successful transformation elsewhere in the world are useful to suggest, inspire and motivate ideas and actions, it is also important to recognize that past experiences, especially agriculture, in Europe, North America and elsewhere, cannot be transferred *in toto*. They do not correspond to 21st century Ethiopia. Ethiopia has to identify transformation pathways that reflect its own cultural, institutional and domestic capacities.

A number of incentives and reform priorities are suggested here as a basis for enacting agricultural and rural transformation in the light of the 'systemic triggers, integrated processes and integrated outcomes' detailed in the previous sections (see Figure 6), and expanded below.

4.2 Sustained and Intergenerational Commitments to Transformation

The starting point for Federal and State leaders is to commit to and lead the agricultural and rural transformation with vision and tenacity, with all the political capital they can command, mobilizing the public at large, and inducing the necessary technological and social changes. There can be no illusions about the complex processes of social, economic, technological and legal processes needed to enact agricultural and rural transformation. It will take generational commitments to fully achieve them. Without the visible commitment of the highest authority in the land, transformation will not take off. Ethiopia's agricultural and rural conditions cannot compare with modern agricultural practices elsewhere in the world, nor does the current stage of agricultural development offer any respite for social and economic malaise affecting millions of Ethiopians today. Ethiopia cannot afford to postpone agricultural and rural transformation as it did in the 1960s. Ethiopia has ignored the signals of the devastating famines in 1973/74 and 1983/85. Since then, nearly all parts of the country have been engulfed by food shortages of various magnitude. The absence of episodes of famine or of famine mortality, thanks to continuous foreign aid and the work of humanitarian workers, must not be mistaken for any normal agricultural economic situation. It is anything but that.

It is similarly important to underline that a reduced ratio of agriculture relative to the overall economy should not be mistaken for the commencement of agricultural transformation. The key determinants of transformation are increasing labor and land productivity, gradual and expanded utilization of mechanization, reduced food insecurity and vulnerability, and visible evidence of agricultural wealth creation that can be invested within and outside agriculture. Agriculture and its twin, rural transformation, must be supported by efficient organizational arrangements including agricultural banks and rural financial services, skills and technology delivery systems. Beyond mere policy intent, agriculture and rural transformation must be demonstrably linked with manufacturing industries, developments in the service sector and decentralized urbanization. For Ethiopia, agriculture will certainly continue to play an undiminished role in food security and provide essential economic functions. To fully appreciate the commanding heights of agriculture, it is necessary to calculate

the value of textiles, leather products, flour mills, oil presses, restaurant services, bakeries and others. In effect, there is essentially very little manufacturing or services without contributions from the agricultural sector.

The Federal Government and the Regional States must craft a carefully thought-through division of labor to avoid duplication of functions regarding the agricultural and rural transformation processes. There are a number of ambiguities regarding the economy to be seen in the constitution. The Federal Government and Regional States must prioritize and invest in infrastructure to support urbanization and rural industrialization. Prioritized, strategic centers for agricultural and rural transformation must be identified to serve for a decentralized urbanization strategy as well as supporting transformation initiatives across all sectors of the economy, including manufacturing, services, agriculture and rural livelihood improvement. This can be achieved by investing in rural roads, housing, electrification, and expanded digital services, both Internet and telephone, and enacting social change. With economic opportunities, and improved living standards for both rural and urban populations, it is feasible to anticipate gradually increasing household participation in markets, a gradual shift from utilizing home processed supplies to market supplied processed goods and services.

Together with the private sector, it is important that the Federal Government and Regional States work in tandem to develop a coherent political and policy for decentralized urbanization, for population migration including property rights that will facilitate and support urbanization strategies and programs. Urbanization will also serve to create transmission centers of competitive market prices. Competitive markets are usually characterized by prices being near to the marginal cost of production and an absence of rent seeking behavior. They facilitate efficient allocation of scarce resources. One way to measure market efficiency is to see how large the price gaps are between domestic prices and border prices. Market price gaps result from poor infrastructure, high processing costs, obsolete technology, government taxes and fees, high profit margins captured by various marketing agents, illegal bribes and other informal costs.

Government guidance is critical to establish linkages among sectors. During the initial period, agriculture and rural sectors must be treated *primus inter pares*, first among equals, vis-a-vis other sectors of the economy in order to put agriculture firmly on the path of transformation. Cereals, pulses,

and oilseed production must be linked to agro-processing manufacturing and value adding activities such as flour mills, biscuits, oil presses, and increasing national production to meet demands and reducing prices to consumers. Similarly, livestock production must aim at increased milk processing and packaging, meat processing and value addition activities. Cotton production should be fully linked to textile manufacturing.

A decline in the share of primary agricultural products will occur gradually as modernization and mechanization become firmly rooted, as farm sizes begin to consolidate, as land and labor productivities significantly increase, and manufacturing and processing industries expand. So, in order for agricultural transformation to be sustainable, it must be pragmatically but firmly linked to developments in the manufacturing and service sectors of the economy. Finding an equilibrium between the agricultural, manufacturing and service sectors is the most important political and technical decision Ethiopia will have to make. It is important to keep in mind that owners of manufacturing and service sector industries, the elite, have proximity to the political power that can influence policy choices and other decisions in their favor. This might lead to the withdrawal or significant reduction in investment in agriculture and rural areas, so undermining and/or delaying agricultural and rural transformation. This possibility calls for serious political arbitrage through, for example, exemplary and dedicated governance to support a transformation agenda, both at federal and regional state levels, private sector and active civil society voice. An economy-wide structural transformation can manifestly lead to greater employment across all sectors, especially in agriculture and allied rural activities, at least initially. It will also lead to improved incomes, especially as the price of food drops following surplus production that exceeds domestic demands, coupled with better and expanded services for housing, water and electricity as well as educational and health facilities.

4.3 Legal and Regulatory Environment to Facilitate Transformation

To realize agricultural and rural transformation, requires thoughtful and boldly considered land consolidation and property rights arrangements. The question of land consolidation needs to be defined within a broader property rights policy that embraces leasing, mortgaging, and facilitating

long-term strategic investment on the land. Land property rights should be considered from the point of view of output growth and the welfare of the smallholder farmers. They should not be seen through the prism of politics and ideology as in the past, but rather, aligned to allow for the basic sustenance of life when cultivated, and offer a legal means to mortgage, lease, or liquidate when appropriate. They should also facilitate utilization of agricultural mechanization and rural industrialization. Land rights should be properly and pragmatically considered so that land size does not continue to be the breeding ground of an interminable food crisis. Land ownership or entitlement, in fact, must allow farmers to either stay on the farm or move to urban areas where he/she might invest in business activities using the income from land liquidation. The liquidation process, with appropriate valuation, must offer access to capital and the opportunity for consolidating fragmented land holdings. Land property rights is one of the transformative areas of institutional change that can spur agricultural growth and develop other sectors by turning “dead capital” into investible and transformative funds.

Importantly, the consolidation process must also protect smallholder farmers from the greed of the elites and rent-seekers, as well as from eviction by creating a legal mechanism for equity, and the determination of a ‘fairer land value’ system based on its relative location. It must consider the specific context of land within pastoral areas under special arrangements and facilitate investment in water drilling and pasture land management, as well as the clearing of bushes to minimize and reverse desertification. It should classify land in crop areas keeping in mind commercial and irrigation potential and feasibilities for expansion; and differentiate land in suburban areas and areas of urban expansion with the highest land value.

Policies and programs for land property rights must help reverse declining land availability, fragmentation, and land degradation. A crucial element for land consolidation must be to ensure farmers’ access to and ability to employ technology to enhance productivity. The debate about farm-size, of small versus commercial farms, is based broadly on ideological rather than practical considerations. Farm size aggregation will pave the way to link the development of agriculture, manufacturing, services and urbanization and the accompanying investment in infrastructural development. If legal and constitutional conditions are met, farm size aggregation becomes a matter of individual choice rather than elite-

motivated political calculation. It also helps eliminate duality of land system between rural and urban populations. Overall, land property rights can facilitate the emergence of small and medium scale investments in agricultural activities by providing the legal means for land transfer on a long-term basis (whether by lease, sale, mortgage, or rent). This calls for amending the constitution, as well as the provision of an acceptable legal and regulatory environment.

No one can foretell how farm households will respond to full ownership rights, and meaningless pontification is of no help. Nevertheless, farm size aggregation will certainly pave the way to link the development of agriculture, manufacturing, services and urbanization and the accompanying investment in infrastructural development.

4.4 Decisive Agricultural Mechanization and Access to Inputs

The immediate and supreme priority for the 21st century Ethiopian is adoption of agricultural mechanization and involvement in the ‘creative destruction’ of technology. *Maresha* and hoe cultivation system must gradually be replaced with mechanized crop and livestock husbandry. Agricultural transformation entails a transition that links smallholder farmers to a progressive adoption of technologies, improving on/off-farm transportation, storage systems and the increased use of irrigation as well as the development of high yielding crop varieties and animal species.

Agricultural mechanization demands the creation of new institutions to support mechanization and technological innovation to accelerate the transformation drive. Mechanization also requires the educational system to be technically oriented; universities, technical schools and specifically dedicated training centers must become focused on skills creation. It is imperative to establish Centers of Excellence and demonstration centers for agricultural mechanization, for example, starting in Arsi and Bale where already farmers are using tractors and combine harvesters. The Government must increase Research and Development (R&D) funds significantly at all levels.

The Federal and Regional institutions must collaborate to train a new generation of farmers who will be instrumental in rolling out agricultural transformation. These trained farmers will perform a number of functions.

They will serve as technology-model farmers and provide advisory service to both skilled and unskilled farmers, demonstrating that innovations are compatible with farmers' existing pool of knowledge. They can also provide agricultural education to the youth at agricultural demonstration stations, possibly established in each *kebele* farmers' association area. They will in fact become agricultural trainers and teachers.

Youth must be the major force of mechanization in agriculture, participating in farming, being tractor operators, workshop service providers and ensuring diligence and work preparedness. There is a need for mechanisms under which existing farming populations can progressively improve their skills. It is necessary to create a conducive environment for technical schools to produce a skilled and industrious young workforce with a desire to work diligently in agriculture.

Replacing the ox-plow and manual agricultural production practices with mechanized systems is the *sine qua non* of agricultural transformation. The experiences that we have referred to in the case of Bale, Arsi and other locations where some mechanized agriculture has been employed must be expanded. The first order of business of the Federal Government and Regional States, jointly with private and in joint public-private partnerships, must be to identify where tractor/harvester assembly plants and accessories, can be strategically located in Ethiopia suitable to the soils and the terrain. During the initial period, however, importing tractors and accessories, combine harvesters, milking machines, hatcheries and incubators, enhanced storage systems, and other innovations must be prioritized. Demonstration centers for agricultural mechanization, tractor and combine harvester hiring stations should be established throughout the country.

All the stages of agricultural and rural transformation involve structural changes, increases in household income and reduction in poverty. Transformation in the agricultural sector has been recognized as having one of the largest impacts on reducing poverty. In China, transformation in the agricultural sector is estimated to have been 3.5 times more effective in reducing poverty than anything else. In Latin America, the figure is 2.7 times. Successful rural transformation is, therefore, the key to reducing poverty as a majority of the poor are to be found in rural areas. Building on the successful experience of a quantitative growth of crops, and the opportunities to expand the potential of the livestock sector, Ethiopia must now aim to double, triple or

even quadruple its present productivity levels by introducing mechanization and other actions that will facilitate structural transformation. Labor and land productivity, if combined with increasing utilization of mechanization and other agricultural inputs, are the proven indicators of agricultural transformation. In this sense, labor productivity is closely linked with household income and poverty reduction.

4.5 Decisive Private Sector Lead in Agricultural and Rural Transformation

Ethiopia's smallholder farmers, and the private sector in agriculture, have not been able to challenge heavy-handed Government interventions, especially the legal and constitutional constraints and organizational inefficiencies. With deregulation and explicit encouragement of the private sector in input and technology supplies, supporting, for example, meat, milk and poultry value-addition, it is feasible to transform the livestock sub-sector at scale and at speed, making good use of the readily available information and in-depth analyses of the sector.

Smallholder and new entrant private sector elements, can participate in the production of national priority consumption crops, oilseeds, cotton, and pulse crops. As incomes increase and wealth is created, farmers and private sector investors will acquire the necessary financial means to invest in long-term measures including mechanization, irrigation, afforestation and related activities. There will be major opportunities for Ethiopia's livestock transformation for private sector and pastoralists benefitting from improved feed and veterinary services as well as improved breeds. Improved networks of milk production and collection systems will encourage smallholders in particular and ensure quality in supplying commercial milk processing plants. There is an urgent need to modernize the milk and meat processing technologies and increase the number of skilled dairy processing and meat hygiene professionals and technicians. Incentives to encourage investment in animal production and meat processing will go a long way to meet increasing domestic demand for meat and milk, as well for to encourage export promotion. Improvements in animal health services and animal genetics that takes into account Ethiopia's indigenous breeds, including Borana, Horo and other breeds suitable for beef, should be put to work, offering immediate

economic gains for livestock owners and specialty markets. Animal feed industries must be supported and expanded, commensurate with the growing demands for animal protein and animal products.

4.6 Effective and Accountable Organizational Capacity

An immediate priority for organizational reform must be deregulation of the prevailing systems of agricultural input supplies, especially seeds, fertilizers, pesticides, herbicides, supplies of tractors and accessories, combine harvesters, and others. The roles of the federal government and regional states must be clearly defined. Motivating youth with skills training, providing start-up capital and similar steps, will serve the dual objectives of employment creation and nurturing mechanization service centers. Equally important is to consider a rollout for application of Internet and big data, based on a system that was developed to report tree planting in July 2019, to allow for accurate estimate of the demands for agricultural inputs, spatially and temporally.

It is important to put in place governance arrangements to harness synergies among government institutions, private sector actors, technologists, farmers and research institutions. Effective and accountable institutional rules and regulations, policies, programs and financial arrangements are necessary to support agricultural transformation as well as a dedicated organization to spearhead the transformation agenda. A structure of governance for transformation must be organized at Federal and Regional State level - consisting of politicians, policymakers, relevant ministries including agricultural, technologists, business partners, investors and others with interests and expertise in agricultural transformation. This governance structure must oversee conflict between traditional elements and the emerging, and progressive, institutions which will provide a transformational force. The key task is managing the paradoxes between the old and the new, and supporting innovative ways of doing business. Most importantly, one must be aware of the emergence and empowerment of diverse interest groups. One example of this was the elite elements who promoted the land grab around Addis Ababa and other major cities without adequately or proportionately compensating farmers. This underlines the necessity of

having a legal mechanism in place for land valuation and to protect farmers from forced eviction.

4.7 Accessible Rural and Agricultural Financial, Credit Services and Incentives

Another priority function of the Federal and Regional States must be the creation of decentralized agricultural and rural credit banks and financial services. For policy changes to be effective and deliver on the promises of the transformation agenda, it is critical to put in place effective and decentralized financial structures in the form of agricultural and rural development banks.

Smart subsidies and price incentives should be directed to strategic commodities that meet federal and regional priorities. These are preconditions for meeting food, manufacturing and service sector demands. They may also include cereal crops, maize, sorghum, wheat, *teff*, or barley, and pulses and oilseeds, aiming to satisfy domestic consumption as well as replace imports. Equally important, incentive systems must also prioritize the needs of the manufacturing sector, especially the principal commodities needed by the Industrial Parks and agro-processing plants. Those include cotton production for textiles, the livestock sector for meat and milk production, and hides and skin to supply leather manufacturing.

It is also important to reconsider the effect of the current imported wheat subsidy. Subsidizing wheat millers has been acting as price disincentive to local producers. An alternative subsidy approach could be to target bread consumers using income thresholds. Similarly, incentives for the production of oilseed crops would help to encourage greater domestic production of oilseeds and replace imported vegetable oils. Special and preferential price incentives must be considered to encourage the production of high-value nutrition crops and import-substitution crops, for example for wheat, oilseeds, and cotton.

Another step would be to sequence and prioritize incentives for agricultural and rural transformation by using farmers who have shown themselves ready to innovate. This could include selective incentive schemes that motivate existing capacities, individuals and farm household decisions to invest in modernization of agriculture and rural life. For example, there

are a number of farmers, especially in Arsi and Bale areas, who have already accumulated experience in using tractors and combine harvesters and have started land aggregation. With targeted and sufficient incentives, they could quickly become agents of agricultural and rural transformation. New entrants to agriculture and rurally based agro-processing enterprises could also be prioritized through credit systems, technical training/ assistance, subsidies and tax exemption.

4.8 Environmental Sustainability

The most critical element of property rights discussed above is to ensure and enact legal basis to delineate and protect the natural environment, highly degraded areas, and the critical watersheds that feed into Ethiopia's numerous hydro-power plants, including the river basins that are severely endangered. The reservoir of Ethiopia's watershed and environmental systems is close to being broken irreparably. Farm size aggregation and employment of technology can finally start to slow down, and turn around, the current and continuing human-induced environmental deterioration, destruction of soils and vegetation....But urgent action is needed to prevent crossing the threshold beyond which lies the collapse of the country's very structure and civilization.

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The Impact of Micro-Credit Intervention on Female Labor Force Participation in Income-Generating Activities in Rural Households of North Wollo, Ethiopia

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Abstract

We examined the impact of micro-credit on female labor participation in income-generating activities in rural households of North Wollo, Ethiopia. The study employed selection and average treatment effect models to determine the effect and impact of credit intervention on the decision of women to participate in income-generating activities and their level of engagement. A total of 460 households, participants and nonparticipants of the credit scheme, from three woredas of North Wollo Administrative zone was selected using systematic random sampling. Using the primary data, the study found that micro-credit has positive and significant effect both on women's decisions to participate in income-generating activities, and the magnitude of time spent on such activities. In particular, the study showed that, on average, women who had access to credit facilities spent 4.45 more hours of time on income-generating activities than the control group. The average time spent by women in the control group in income-generating activities was 1.39 hours. The average treatment effect (ATE) was found to be considerably greater than the average treatment effect among the treated (ATET) implying that poor women with less entrepreneurial capabilities had been targeted for credit participation. Future policies in micro-credit should consider targeting women with better potential for succeeding in business despite their initial income status. The majority of credit participant women

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were found to be engaged in better and newly developed income-generating activities such as animal fattening and rearing, poultry, bee-keeping, vegetable cultivation and business-related activities. However, a considerable number of women were also engaged in traditional activities such as fire-wood collection and weeding to generate income. Such activities are borderline cases to influence the status of women in intra-household resource allocation: the study noted that where women engage the choice of economic activities needs consideration.

Key Words: women labor, micro-credit, income-generating activities, Ethiopia

JEL Classification: J22

1. Introduction

International comparisons reveal that women take on a disproportionate share of unpaid work at home. In some developing countries, they spend five additional hours per day on unpaid work activities than men while the average gender gap has been narrowed to three hours of unpaid work per day in most developed countries (Gauthier et al., 2004; Antonopoulos, 2007). In rural economies which are strongly characterized by distinct gender roles, those roles which are typically designated as female roles are reproductive and almost invariably less valued than those designated as male roles which are productive. Empirical studies show that in a number of African countries, women are less likely to be in paid jobs, they are disproportionately concentrated in informal and precarious employment, and they are paid less (Appleton et al., 1999; ILO, 2002; Fafchamps et al., 2006; Nordman and Wolff, 2009).

One of the segregation of work in developing countries is reflected in the form of gender division of labor in which women are confined to unproductive activities. This traditional segregation of jobs by gender hides women's talents and potentially leads to misallocation of resources, in turn resulting in a sub-optimal level of output and household welfare. One line of argument for the apparent lack of appreciable participation of women in income-generating activities (IGAs) in developing countries is the limited access to investable resources of the household (Jones et al., 2010; Stokes et

al., 2015). This has much to do with the long-held belief that male members of a household, most importantly, the male head of the household, are the breadwinners of the household and therefore investable resources are exclusively controlled by them (Fafchamps and Quisumbing, 2005; Shambel, 2012; Bekele et al., 2013).

The traditional division of labor between partners may serve as an explanation for the existing differences in income earning opportunities between men and women. Literature on women in agricultural societies generally exhibits wide-ranging gender inequalities in terms of possession of key resources and factor inputs, which limit women's opportunities to generate income (Blackden and Bhanu, 1999). Women are restricted in their access to productive resources such as land, agricultural inputs, credit and extension services (Agarwal, 1994; Deere and Leon, 2001; Quisumbing et al., 2004). Limited access to investable resources is thus the major constraint of rural women to participate in IGAs and to generate their own income.

Similar to other developing countries, the historical segregation of men and women in their activities in Ethiopia has had a long-lasting effect on the participation of women in the market-oriented labor market. Rural employment opportunities in Ethiopia range from household-based farm and non-farm activities to participating in the labor market as a wage laborer or through self-employment-based activities. However, in the absence of access to institutional capital, the labor market in rural Ethiopia seems to be segmented across gender lines. Women's activities tend to be limited to home-based agricultural or other traditional works, while men mostly get involved in on-farm or other off-farm income-generating activities. Even when women are willing to participate in off-farm non-agricultural activities, the opportunities are limited due to the socio-cultural barriers that dictate their inheritance and participation in the labor market. Women in this male-dominated society are excluded from inheriting the family's productive assets, mainly arable land, and as such accessing credit from formal institutions without providing credible material possessions as collateral is difficult for them. Socially secluded and culturally separated, they have been restricted to household-based agricultural work, therefore naturally playing a "secondary role" in the household decision making.

Though gender division of labor in rural Ethiopia varies in terms of farming systems, cultural settings, location, ethnicity, income and the

different wealth categories (Mollel and Mtenga, 2000), women are invariably responsible for reproductive tasks and household activities such as gathering fuelwood and fetching water, cooking, washing and cleaning (Frank, 1999; Gemechu et al., 2009). Men are the key players in crop and livestock production, and are, therefore, the principal decision makers and beneficiaries in terms of control over the income generated from the sale of produce (Gemechu et al., 2009; Lemlem et al., 2010).

This article examines the impact of micro-credit intervention on gender division of labor in income-generating activities vis-à-vis traditional household activities in rural households of North Wollo Administrative Zone of Amhara Regional State. Women in this Zone and in the Amhara Region at large, though not acknowledged, primarily participate in agricultural activities such as land preparation, weeding, harvesting, threshing and storing, and in livestock production such as herding, tending sick animals, watering, milking and milk processing in addition to in-house routine activities (Frank, 1999). The major argument of this study is that augmenting investable resources of rural households using micro-credit intervention would enhance women's decisions to participate in, and increase time spent on, income-generating activities.

Like many developing countries, Ethiopian rural households, especially women, have been suffering from lack of access to capital. While Ethiopia is one of the biggest countries in terms of the rural women population in Africa, previous studies have not focused on the impact of micro-credit on rural household gender division of labor in the form of female labor force participation in income-generating activities. There are related empirical studies on Asian countries, where microfinance flourishes, which have analyzed the impact of micro-credit on creating opportunities to women to start up self-employment (Bennett, 1992; Menon and Rodgers, 2009, 2011) and diversify their economic activities (Hashemi et al., 1996; Lanjouw and Murgai, 2009). Similarly, studies focused on Ethiopia also deals with the impact of micro-credit to enhance women's self-employment (Asmamaw, 2014), creation of non-farm business (Tarozzi et al. 2015) and capitalization of women's existing businesses (Belwal et al., 2012). However, these studies have not addressed the impact of micro-credit on women's decisions to participate in income-generating activities nor the time spent on such activities.

To fill the gap, using survey data, this study has examined the impact of micro-credit on women's participation in income-generating activities. A total of 460 sample households from 3 woredas of North Wollo Administrative Zone have been considered using systematic random sampling techniques. This paper consists of five sections with the remaining parts organized as follows: Section two provides theoretical perspectives and covers related empirical literature; section three deals with the data and methodology, and section four reveals the results of the study and our accompanying discussion. The final section presents conclusions and implications.

2. Theoretical Perspectives and Related Empirical Literature

Modern labor economics argues that individuals are endowed with their own specific talents which usually are revealed through education and job participation. According to Becker's theory of the allocation of time (Becker, 1965), such specialization of the partners within one household is efficient, as private households represent economic institutions that maximize their utility by optimizing the members' time of allocation to market and household production. Hence, the household's decision about its members' time in paid and unpaid work is defined taking the relative productivity of the household members into account, i.e. the partner that can offer a higher potential income specializes in market work, while the partner with a lower potential income specializes in non-market work. The implication of this theory on traditional household gender division of labor is however debatable. In the structure of the traditional gender division of labor, men (the husband) are pre-assigned to most of the paid work and women (the wife) to most of the unpaid housework, thus leaving no opportunity for women to specialize in market work. In such a context, Becker's theory would thus be consistent only if the husband and wife persist in their pre-existing gender-based tasks resulting in household efficiency in terms of increased household output.

However, feminist economists such as Boserup (1970) did not agree with Becker's argument of household efficiency in division of labor by gender, because they believed that it implies exploitation of women. Their main argument is that although such specialization based on gender might be

efficient for the household as a whole, the partner who specializes in non-market work may suffer from a disadvantage in terms of future labor market opportunities. In most instances, it will be the wife who specializes in housework and child care, while the husband concentrates on market work. While withdrawing from the labor market and specializing in housework, the wife's marketable human capital stays constant or even decreases, so that her chances to get back into the labor market are reduced. Hence, this traditional division of labor between partners may serve as an explanation for remaining differences in labor market opportunities and wages between men and women. The consequences of such specialization of the partners with women withdrawing from the labor market become even more serious if the household breaks apart at any time, necessitating the wife making a living from being gainfully employed. This, indeed, might be one of the reasons why women are affected by old-age poverty more than men (Bredtmann, 2011).

There are also numerous reasons why female specialization in unpaid domestic work may be the subject of concern in a gender equity sense. For example, domestic human capital may be of little value relative to market human capital outside a specific relationship, and so lead to less bargaining power within the relationship (via a lower external threat point) and poorer outcomes in the event of relationship breakdown. Moreover, women's education, employment, and earnings are essential in the fight against poverty, not only because of the direct and interrelated contribution they make to household welfare, but also because of the personal power they provide for women in shaping and making family decisions and in redirecting household spending on essential needs, especially in favor of children's health and education (UNICEF, 1999; Gichuru et al., 2019). This suggests, firstly, men and women have systematically differing preferences over the way in which household income should be allocated, and secondly, that an individual's income contribution to the household plays a role in family bargaining, over and above its implications for external threat points (Washbrook, 2007).

As much as a lack of education hides potential talents within a population, traditional segregation of jobs by gender can equally disguise talents and potentially lead to misallocation of resources. The segregation of work in the form of gender division of labor forces women to be confined

with some ‘unproductive’ activities (Sen, 1990) which are not regarded as contributing to output and are often classified as ‘unproductive’ labor. An important economic outcome of such traditional division of labor is thus a lower output and less favorable level of welfare of a household.

The type of activities members of the household is involved in has impacts on their decision-making participation and contribution to household welfare. Change in traditional gender division of labor through involvement in activities that confer more income earning power on women tend to increase their participation in decision-making (Ngome, 2003) and increase their contribution to welfare within the household (Sikod, 2007). Related to this, Gichuru et al. (2019) state that a source of income can increase woman’s bargaining power in household decisions if it is available primarily to the woman. Literature on intra-household allocation of time has established that men's work is highly associated with paid market work while women devote the majority of their time performing unpaid work (Gershuny, 2000; Beneria, 2003). Gender differences in allocation of time between paid and unpaid work have important implications in terms of well-being (Floro, 1995; Antonopoulos and Hirway, 2010). Increased segregation of unpaid work and paid work by sex pushes women particularly into social and income poverty (Elson and Cagatay, 2000), as well as, time poverty (Folbre and Bittman, 2004; Antonopoulos and Memis, 2010).

The argument of the present study is that reorienting the traditional gender division of household labor in the way it provides opportunities to women to participate in paid/ market work could increase women’s time spent on income-generating activities over household routines.

The perspectives of gender based inequalities and differences in task allocation and in task type have been outlined in a number of studies covering the relative resources perspective (Mannino and Deutsch, 2007; Knudsen and Warness, 2008; Brines, 1994), time availability perspective (Davis et al., 2007; Artis and Pavalko, 2003) and gender ideological perspective (Arrighi and Maume, 2000; Fuwa, 2004; Parkman, 2004; Davis et al., 2007; Knudsen and Warness, 2008). These make it clear that women in developing countries are most likely exposed to undesirable housework. In Ethiopia, relative to men (husbands), rural women (wives) are less educated (CSA, 2012a) and do not have access to, or control over, resources (Frank, 1999; Jones et al., 2010), resulting in less power to bargain their

(her) way out of routine housework. Their time is also considered as available for house work and child caring activities because most of the women do not participate in paid/market work (Ferrant and Thim, 2010; CSA, 2012b). Moreover, as members of a male dominated society, women in Ethiopia who hold more traditional attitudes behave in a more traditional manner and spend almost all of their time on housework (Bekele et al, 2013). On the basis of all these perspectives, there is no favorable socio-economic background for rural women to participate in paid/ market work or to reduce the time spend on housework. The stagnant structure of the traditional division of labor in rural households in effect demands a positive shock to provide women with the possibility of participation in income-generating activities.

The representative (sampled) woman in a typical agricultural household faces a number of activities. Arising from the inseparability of production and consumption decisions in agricultural households (Singh et al., 1986), the woman's choice of economic activities is simultaneously made with maximization of the utility of the household (assuming that overall welfare of the household can be represented by a joint utility), and is subject to different constraints. One such constraint in the production process is the traditional restriction of women to participate in particular economic activities (henceforth activity constraint). It can be hypothesized that relaxing the resource constraint faced by women through availability of micro-credit would at the same time relax the activity constraint.

As noted in Bennett (1992), credit is the gateway to productive self-employment for women. Access to micro-credit can provide the opportunity for women to start up self-employment activities and undertake more profitable work, thus facilitating moves toward poverty reduction. According to Menon and Rodgers (2011), the targeted use of small loans can support and incentivize women's labor market activities and promote economic welfare. In another study, Menon and Rodgers (2009) state that women's likelihood of engaging in self-employment is substantially stronger than men in response to a loan. Regarding women's activities, Hashemi et al. (1996) suggested that loan recipients in Bangladesh used credit primarily for self-employment in small-scale activities ranging from animal husbandry to artisan crafts.

Evidence in Menon and Rodgers (2011) indicated that India's rural banking reform program increased the likelihood of women to engage in

gainful self-employment beyond unpaid family work. Moreover, an increase in women's self-employment in India's rural sector appeared to have occurred in more productive economic activities. The same study reported that increased access to credit facilitated the shift of women workers out of cultivation into other entrepreneurial activities, including more capital-intensive livestock and dairy farming. More broadly, the move into more productive economic activities was one possible channel through which India's social banking program worked to reduce poverty. In support of this argument, Lanjouw and Murgai (2009) found that diversification of economic activities in India's rural sector, and the growth of non-farm employment including other types of self-employment endeavors, contributed to poverty reduction. Asmamaw (2014) stated that in Ethiopia small loans provided by micro-finance programs were enhancing self-employment projects generating income to improve the living conditions of the poor and alleviate poverty. Similar evidence in Tarozzi et al. (2015) indicates that the micro-credit treatment has increased the prevalence of new non-farm business creation for both men and women program participants in Ethiopia. Additionally, Belwal et al. (2012) noted that micro-credit helps women small-scale entrepreneurs to finance and maintain established businesses in Addis Ababa, implying that the credit incentivized women to stay in income-generating activities.

This paper has the aim of investigating the impact of augmenting the investable resources of households, using micro-credit intervention, on gender division of labor, targeting the typical treatment of women in rural Ethiopia. Employing standard treatment effect models, the study examines the effect of micro-credit on women's decision to participate on income-generating activities and the impact on the time they spent on such activities. Given the fact that there are limited or non-existent sources of capital to create and start up new economic activities for rural women, it should be expected that micro-credit would have a positive impact on women's participation and time spent in income-generating activities.

3. Data and Methodology

3.1 Data

This study utilized data from a household survey, collected from November to December 2017, of 460 households drawn from three woredas of North Wollo Administrative Zone (NWAZ) through a systematic random sampling technique. North Wollo is one of the 11 administrative zones of Amhara Regional State of Ethiopia. In the 2007 population and housing census, it had a total population of 1,500,303 persons in an area of 12,172.50 km² (CSA, 2007). The larger portion of the Zone is mountainous and characterized by steep slopes which are unsuitable for agriculture. This severely limits the cultivated area. According to the World Bank (2004), the average rural household has 0.7 hectare of land (compared to the national average of 1.01 hectare of land and a regional average of 0.75 for the Amhara Region), and the equivalent of 0.7 head of livestock. About 13.2% of the population are involved in non-farm related jobs, compared to the national average of 25% and a regional average of 21%. The Zone also has a high drought risk and all of its rural woredas are included in the 48 woredas identified as the most drought prone and food insecure in the Amhara Region.

A number of governmental and nongovernmental organizations based in the zone have been making different interventions to tackle the above mentioned problems. Of which the Amhara Credit and Saving Institution (ACSI) provides micro-credit services to alleviate financial constraint both at zonal and regional level. Credit services of this institution have reached rural households in all North Wollo woreda administrations, targeting 60% participation of women clients. So, to examine the impact of credit schemes on women labor force participation in NWAZ, clients of the Amhara Credit and Saving Institution (ACSI) have been considered as treatment group.

Multi-stage sampling procedures were employed to draw up the target sample households of the study. In the first stage, North Wollo Administrative Zone (NWAZ) was selected deliberately for the reasons of the zonal background mentioned above and the authors' familiarity with the area. In the second stage, to capture women's different working cultures

existing in NWAZ, all districts of the zone were classified into three strata along the existing major agro-ecological zones (dega (highland), woina dega (temperate zone) and kolla (lowland)). Three districts, one from each stratum, were selected using a random selection method. In the third stage, seven kebeles, two kebeles each from the dega and woina dega strata, and three from the kolla, were selected randomly. In the fourth stage, households in each kebele were stratified into two groups based on wives' involvement in microcredit programs. Sample households of microcredit participants (wife participation) and non-participants (wife non-participation) in each kebele were identified using random sampling with probability proportional to sample size.

All respondents were women, and among them 172 were credit participants and 288 were non-participants. Interviews were conducted with each respondent woman to gather time use-data using semi-structured questionnaires. Activity-specific recall questions were designed to list the daily activities of women and the time spent on each activity. Women's daily activities, were categorized into six groups: income-generating activities, household routine activities, traditional agricultural activities (helping in agriculture), social activities, community activities and personal care. The total time to perform all of these activities was calculated at fourteen hours. Finally, one-week (the last seven days from the interview day) time-data was collected from each woman through diary method. Women noted the time spent for all their daily activities over the total of 14 hours. In addition to the time use-data, household demographics, credit participation, household income, land and livestock holding data were also collected. The authors initiated, organized and supervised the collection of the data.

3.2 Methods of Analysis

The study employs descriptive statistics and econometric models to analyze the impact of micro-credit provision on women's labor force participation in income-generating activities. Descriptive statistics were applied to characterize the sample households' social, economic, demographic and institutional factors. The Heckman selection model was employed to identify the determinants of women's participation in income-generating activities. The presence of a considerable number of women who

had never spent time in income-generated activities might suggest using corner solution outcome models (Tobit) over Ordinary Least Squares (OLS) but the expectation, verified by tests, that selection bias would threaten the validity of the Tobit model as a result of women's self-selection into the participation in IGAs, encouraged the use of the Heckman procedure. Standard average treatment effect models were used to analyze the impact of credit schemes on women's participation decisions and level of engagement in income-generating activities. Tests on selection bias for participation in the credit scheme or on the endogeneity of credit participation required the use of a control function approach that took account of the endogeneity problem. Other methods, including Propensity Score Matching (PSM), Augmented Inverse Probability Weights (AIPW) and Inverse Probability Weighted Regression Adjustment (IPWRA) estimation, are utilized for comparison purpose.

The Model

A woman is assumed to participate in income-generating activities when she is convinced that spending additional time in such activities pays off more in return in the form of welfare as compared to the status quo. The status quo in this context is that a woman is traditionally assigned to perform unproductive and reproductive activities such as household chores and childcare which are not acknowledged as economic activities and are not considered in measurements of household economic welfare. Let the return from participation of a woman in income-generating activity requiring a certain level of time spent on such activity be denoted by L_i . As expected, and observed in the data there are women who never spent time in income-generating activities, and the decision of participation of women in income-generating activities is one of a corner solution outcome. Let L_i^* represent the time that would have been spent in the continuous net benefit of participating in the program of IGAs. With no self-selection problem, the model of female labor participation on income-generating activities would be given by:

$$L_i = x_i' \beta + \epsilon \quad (1)$$

where

$$L_i = \begin{cases} L_i^* & \text{if } L_i^* > 0 \\ 0 & \text{if } L_i^* \leq 0 \end{cases} \quad (2)$$

x = vector of covariates including a dummy for credit participation, β = parameters, and ϵ = error term.

This model would be estimated using Tobit. Nevertheless, there is good reason to believe that participation of women in income-generating activities in rural Ethiopia is also the result of self-selection. In a culture dominated by decisions of labor participation with gender segregation between income activities and traditional household activities, it takes extra inherent courage for a woman to break the inertia of segregation. A decision to participate in income-generating activities by women is assumed to be affected by an intrinsic factor other than observed variables and the failure to account for any such unobserved variable leads to an error term correlated with important covariates in the model. In such circumstances, estimation of the corner solution outcome model using Tobit would result in inconsistent estimates of the major covariates in particular credit participation (Wooldridge, 2002). The alternative for this is the selection model which accounts for problems of incidental truncation as one cannot observe the level of time that would have been spent on income-generating activities had they decided to participate.

Let M be a binary choice representing women's participation decision in income-generating activities, taking on **1** if a woman participates and **0** otherwise. The regression and selection models are, respectively, given by:

$$L_i = x' \beta + \epsilon \quad (3)$$

$$M_i = z' \delta + v \quad (4)$$

where z = a set of instruments in such a way that $x \subset z$ and $cov(\epsilon, v) \neq 0$.

This model can be estimated using the Heckman procedure (Heckit) or the full information maximum likelihood estimation technique.

The standard regression model or the more advanced selection model is employed to capture the effect of credit on the level of time spent on income-generating activities by women along with other covariates. The model can be specified to identify the determinants of time spent on income-generating activities by women and seen as a simple average treatment effect model under an ignorability assumption accounting for possible selection problem in the outcome variable.

Nevertheless, the impact of credit participation needs to be determined in a more formal way. In principle, there are three cases under which average treatment effect can be estimated for cross-sectional data: difference in mean estimator, OLS estimation under ignorability or unconfoundedness assumption, and instrumental variable estimation.

Let L_i represent time spent on income-generating activities, and w_i represent participation in a credit program. The generic model for the outcome is given by:

$$L = (1 - w)L_0 + wL_1 = L_0 + w(L_1 - L_0) \quad (5)$$

Where L_0 is the time spent by women in income-generating activities if they were not in general to participate in credit program ($w = 0$) and L_1 is the amount of time spent by women if they were to participate in credit program ($w = 1$).

Assuming that participation in the credit program is random so that w is not in any way related to the expected outcome of participation in the credit programs, $L_1 - L_0$, the average treatment effect (ATE), and the average treatment effect on the treated (ATET) can be estimated using difference-in-mean method:

$$ATE = ATET = E(L_1 - L_0) = E(L_1 - L_0 | w = 1) \quad (6)$$

Under the assumption of randomness in participation, a difference-in-mean estimator of the difference in time spent on income-generating activities between the participants and non-participants in micro-credit

schemes would be unbiased and consistent. This can econometrically be estimated by running a regression of time spent on income-generating activities on the dummy of credit participation:

$$E(L_i|w_i) = \gamma + \alpha w_i + \epsilon \quad (7)$$

Here, α measures the difference in average time spent on income-generating activities between participants and non-participants in the population and $\hat{\alpha}$ is the difference-in-mean estimator.

It is generally believed that neither eligibility nor participation in a credit program can be randomized as potential credit participants are usually targeted resulting in systematic selection of participants in a program. The ACSI credit program targets poor women for participation and initially the criterion for admission into the program was that woman should be in a household having either none or owning only one ox. In recent years, this criterion has become less binding as women in some households who owned more than one ox have had access to credit. Women might also self-select themselves to participate in the credit scheme. Women who had applied to participate but failed would be an ideal control for the study. However, there is no information available for unsuccessful women applicants for the credit program. Invoking from Wooldridge (2010), let in Equation (5), $L_0 = E(L_0) + v_0$ and $L_1 = E(L_1) + v_1$, where v_1 and v_0 are random individual specific attributes under the two states (states of participation and non-participation), Equation (5) can be rewritten as:

$$L_i = E(L_0) + (E(L_1) - E(L_0))w + v_0 + w(v_1 - v_0) \quad (8)$$

The case that participation depends on (L_0, L_1) implies that v_0 and v_1 are not mean independent of participation in credit activity (w). Under such cases the difference-in-mean estimator does not yield a consistent estimate of the ATE and ATET, and the ATE and ATET differ by the magnitude of $(v_1 - v_0)$.

There are two major frameworks under which Equation (8) can be estimated. The first framework assumes that participation may depend on

observables in which case ignorability assumption (confoundedness or conditional independence assumption) would lead to estimation of the average treatment effect by controlling for observable covariates (Wooldridge, 2010). The more common propensity score matching method falls in this category.

Given that L_0 and L_1 represent outcomes (time spent on income-generating activities) without and within participation in a credit program, respectively, let x represent a set of observable covariates which help control dependence of the outcome and participation variables, L_i and w_i . According to Rosenbaum and Rubin (1983), the correlation between the outcome and participation variables depends on a set of observables x and controlling the latter would help estimate ATE appropriately. The population is thus defined by (L_0, L_1, w, x) ; average treatment effect can be estimated by using regression adjustment methods or propensity score matching methods using sample data.

There is however a possibility that selection for participation into the credit scheme depends on an unobservable factor such as ability or the special courage of women, among those targeted for participation, or alternatively, women with less abilities might be pushed into a credit program. That is, the outcome variable (time spent on income-generating activities) and participation in credit are jointly determined so that the latter becomes endogenous. Statistically, the error term of the outcome regression model and the decision regression model should be correlated. In such cases, instrumental variable estimation would be appropriate (Wooldridge, 2010).

There are a variety of approaches of estimation to address the selection issue based on the assumptions of Equation (8). If there is a good reason to believe that $v_1 = v_0$, the instrument exogeneity or exclusion assumption holds i.e. $L(v_0|x, z) = L(v_0|x)$, and the instrument relevance condition holds i.e. $L(w|x, z) \neq L(w|x)$, where z stands for a set of instruments in addition to covariates x , Equation (8) can be rewritten as:

$$L_i = \delta_0 + \tau w + u_0 \tag{9}$$

where $\tau = ATE$, $u_0 = v_0 - L(v_0|x,z)$. Even though the interaction of participation w and $(v_1 - v_0)$ vanishes following the assumption, w is still correlated with u_0 through the stochastic component of L_0 which is v_0 .

In this case, standard 2SLS can be used to consistently estimate ATE and ATET. With stronger assumptions on the functional form of instrument relevance, a non-linear prediction of the participation equation such as fitted values of a probit model can be used as an instrument to consistently estimate the ATE and ATET.

If $v_1 \neq v_0$, the IV estimator using the standard instruments (z) or predicted values of the participation model cannot consistently estimate the ATE and ATET.

Two competing methods of estimating the ATE and ATET in this case are the correction functions and control function approaches suggested by Wooldridge (2008).

The correction function approaches estimate the model:

$$L = \gamma + \tau w + x\beta + w[x - E(x)]\delta + \varphi\phi(\theta_0 + x\theta_1 + z\theta_2) + error \quad (10)$$

using the predicted cumulative density function of a probit model of participation ($\widehat{\Phi}$), the interaction term $\widehat{\Phi}_i(x_i - E(x))$, the estimated probability density function $\widehat{\phi}_i$ and covariates x , as instruments. According to Wooldridge (2008), the extra term $\widehat{\phi}_i = \phi(\widehat{\theta}_0 + x\widehat{\theta}_1 + z\widehat{\theta}_2)$ is a correction function that directly accounts for the distribution of part of the error terms v_0 and v_1 instead of assuming they do not cause inconsistency. The control function estimates the model:

$$E(L_i/W, X, Z) = \gamma + \alpha w + x\beta_0 + w(X - E(x))\delta + \rho_1 w[\phi(q\theta)/\Phi(q\theta)] + \rho_2(1-w)\{\phi(q\theta)/[1 - \Phi(q\theta)]\} \quad (11)$$

where $q\theta \equiv \theta_0 + x\theta_1 + z\theta_2 + \dots$, and $\widehat{\rho}_1$ and $\widehat{\rho}_2$ are parameters that can be used to directly test for the existence of endogeneity caused by self-selection.

Test results showed that this last model is appropriate in this study while estimates using other methods discussed are reported for comparison purpose.

3.3 Definition and Description of Variables

The major dependent variable in this study is the average time spent by women on income-generating activities, measured by hours spent on specific activities categorized as income-generating. With a total daily time for all activities of 14 hours, the time spent on IGAs had a range of 0 to 14 hours. As indicated in Table 1, the mean time spent is 1.54 hours per day. Another related variable used in the model is participation decision variable which takes on 1 if a woman participates in income-generating activity and 0 otherwise.

The major target variable for this study is credit participation. The variable takes on 1 if a woman participates in ACSI credit program, 0 otherwise. There is no alternative micro-credit or other form of institutional credit service in the study area. Other covariates included can be described shortly. Household land holding refers to total land size currently possessed by households including rented-in and shared or other land use arrangements by household. Household livestock holding refers to the total number of animals possessed by the household measured in tropical livestock units (TLU). Household total income is the total earning of the household from both farm and non-farm activities through self-employment and wage labor, and includes all transfers including aid and credit. On the other side, remittance refers to the amount of money in birr transferred to a given household from another person, household or institutions; if the source of the money is a person, she/he should not be a member of a currently sampled household. Dependency ratio refers to the ratio between the number of household members who do not work and the total household size. As it happened that all respondents in the sample were either Orthodox Christians or Muslims, the “religion of respondent” has a value of 1 if a woman was Muslim and 0 if Orthodox Christian. Extent of micro-credit clients in the village indicates the proportion of women clients in the microcredit program in a given village. Other control variables indicated in Table 1 are straight forward and need no further description.

Table 1: Definition and description of variables used in analysis

Variables	Mean	Standard deviation	minimum	maximum
Average time of women spent on IGAs per a day in hour	1.54	1.6	0	8.13
Age of the respondent (years)	37.20	10.98	18	70
Dependency ratio	0.35	0.24	0.00	1.00
Total income of the household in Birr	35139	33560	0.00	273990
Landholding size of the household in hectare	0.59	0.50	0.00	3.25
Number of livestock of the household in TLU	2.14	2.22	0	21.43
Remittance in Birr	3124	16849	0	250000
Distance to the nearest market in kms	10.44	6.32	2	23
Distance to the nearest micro-credit office in kms	13.47	4.8	6	23
			Proportions (%)	
Woman's participation in IGAs (= 1 if woman participate)			67.6	
Credit participation (= 1 if woman borrowed money)			37.39	
Level of education of the woman (class years)				
Woman has no education /illiterate/			63.9	
Woman has basic education			4.2	
Woman has primary education			19	
Woman has secondary education			12	
Woman has tertiary education			0.9	
Respondent/ woman is Orthodox Christian			94.35	
Respondent/ woman is Muslim			5.65	
Marital status of the respondent (=0 if married)			79.35	
Dummy kolla (=1 if kolla)			76.30	
Dummy dega (=1 if dega)				
Extent of micro-credit client in the village				

4. Results and Discussion

4.1 Descriptive Analysis

A total of 460 sample households were selected through a systematic random sampling technique for this study. All respondents in the sampled households were women, with 172 (37.39%) participating in a credit scheme, and 288 (62.61%) being non-credit participants. Among all respondents 365 (79%) were married and the rest, 95 (21%), divorced and/or widowed. Of the 172 credit participants, 131 (76%) were married and 41(24%) divorced and/or widowed. The average and median ages of all respondents were 37.2 and 35 years respectively. The average and median ages of women who participated in the credit scheme were 37.44 and 36 respectively. The minimum and maximum ages of the participants were 19 and 70 years, respectively. The majority, 64%, of respondents were uneducated and another 23% only attended primary education. Of the 172 credit participants 63.74% were uneducated and 25.73% had attended primary education. In terms of religion, the majority of the respondents (94.35%) were Orthodox Christians and the rest, 5.65%, Muslims. About 51% of the Orthodox Christians and 11.54% of Muslims in the sample were credit participants.

Time spent on income-generating activities across credit participation, marital status of women and agro-ecological zone is shown in Table 2. Among women who participated in the credit scheme, 77% participated in income-generating activities with an average participation time of 2 hours and 31 minutes (2.52 hours) a day. On the other hand, 62% of non-participant women respondents participated in income-generating activities with an average time of 2 hours and 5 minutes (2.08 hours) per day. As it stands, the less than an hour difference in time spent on income-generating activities between participants and non-participants in credit program appears to be small. Nevertheless, this figure is likely to be biased as participation in credit program is not expected to be random, implying that time spent on income-generating activities by women and decision to participate in credit programs could be endogenous. Econometric analysis in the next section will address the issues of selection and endogeneity to estimate a plausible figure.

Given the cultural inertia that segregates activities between men and women in rural communities of Ethiopia such as those considered by this study, the amount of time women spent on income-generating activities with respect to their marital status deserves investigation once the decision of women to participate in such activities had been made. Accordingly, the average time of women of different marital status spent on income-generating activities was computed. In general, it was found that participation in micro-credit program positively affected the average time women spent on IGAs irrespective of their marital status. Married credit participant women spent 25 minutes more per day than non-client married women. Similarly, under the widowed/divorced women category, credit participant women spent 30 minutes more on IGAs than non-credit participants.

Participation of women in IGAs also tends to vary across agro-ecological Zones. The rate of participation in income-generating activities for credit client women in kolla, woina dega and dega zones were 75%, 87% and 74% respectively; and the average time of participation in IGAs by the respondents in these zones was 2.07, 3.51 and 2.43 hours per day respectively. However, the daily average time of non-credit participant women in IGAs across the agro-ecological zones was 1.99, 2.03 and 2.26 hours per day in the kolla, woina dega and dega woredas respectively; and their rate of participation in IGAs was 55%, 70% and 65%. The result revealed that irrespective of differences in agro-ecological zones both the proportion of participants in IGAs and the amount of time spent on such activities was higher for credit participants than for non-participants. The highest proportion of IGA participants (87%), with the longest time spent on IGAs (3.51 hours per day), was recorded for credit participants in woina dega areas. One possible explanation for this is the fact that there are more choices of economic activities in this agro-ecological zone.

Table 2: Participation on credit scheme and Income-generating activities

Women's participation in microcredit and time spent on IGAs		Credit Participant (observation = 172)			Noncredit participant (observation = 288)		
		Participants in IGAs (%)	Time spent on IGAs		Participants in IGAs (%)	Time spent on IGAs	
			Mean	Std. dev		Mean	Std. dev
Proportion of women participate in IGAs and time spent	Both Married and Widowed/divorced women	77	2.52	1.59	62	2.08	1.33
	Married women	78	2.49	1.42	62	2.07	1.29
	Widowed/divorced women	76	2.62	2.06	63	2.12	1.49
	Women in kolla/Raya Kobo	75	2.07	1.11	55	1.99	1.27
	Women in woina dega/Lasta	87	3.51	2.15	70	2.03	1.26
	Women in dega/Wadela	74	2.43	1.33	65	2.26	1.47

Source: Author's computation from sample survey data (2017).

Women in the research area are used to participation in some types of traditional economic activities such as collection of firewood and weeding for the purpose of both house consumption and to generate income. However, such activities are no more than borderline cases to influence the status of women in intra-household resource allocation and women empowerment. In contrast, engagement of women in economic activities such as animal fattening and raising, growing vegetables for market and other business-related activities, are recent developments. As Table 3 indicates, 54.35 % of credit participant women were engaged in such new economic activity ventures compared to only 42.34% of non-credit participants. By contrast, only 9.78% credit participants (compared to 17.12 % of non-credit participants) were engaged in more traditional economic activities such as firewood collection. Table 3 gives a list of categories of IGAs based on their economic importance, with the least valued at the top. The proportion of women credit participants engaged in high valued IGAs is higher than non-credit participants, implying the credit scheme might help its clients to become involved in high valued IGAs.

Table 3: Categories of income-generating activities and women participation

Categories of Income-generating activities	Participation of women in IGAs in percent	
	Credit participant women (observation = 172)	Credit non-participant women (observation = 288)
Daily labor, fire wood collection, safety- net, hairdressing	9.78	17.12
Local drink and food, small shops	15.22	20.72
Handicrafts and cloth making	2.17	1.80
Animal fattening and rearing, poultry, bee keeping, vegetable cultivation	54.35	42.34
Trade and other professional work	18.48	18.02
Total	100	100

Source: Author's computations based on own survey data (2017)

4.2 Econometric Analysis

4.2.1 Modeling determinants of time spent by women on income generating activities

The main purpose of this subsection is to empirically verify that access to credit increases the time spent by women on income-generating activities. A significant number of women respondents did not spend time on IGAs. While the Tobit estimation methods would be appropriate to handle such a corner solution outcome model, the suspicion that participation in the IGAs could be a result of self-selection leads to a need to address such issues.

The regression model of interest relates time spent in hours by women in IGAs with the dummy of credit participation along with other control variables. The unobserved factor that might have led some women to decide to participate in the IGAs was found in the decision model or selection equation where the dependent variable is binary (taking on 1 if a woman spent time in IGAs) and a set of explanatory variables. It is required that all covariates which appear in the regression equation should also appear in the selection model while the later model should include at least one variable which does not appear in the regression equation (Wooldridge, 2010).

The Heckman method estimates both the regression and selection models simultaneously. Testing for the correlation of the error terms of the two equations (regression and selection equations) indicates whether there is a selection bias if the model was estimated using other standard models such as Tobit.

Table 4 shows results of Heckman estimation of both regression and selection models. The STATA output also reports the result for the test of selection bias. The null hypothesis that the regression and selection equations are independent or that the correlation coefficient between the error terms of the two equations (ρ) is zero, is rejected at 1% level of significance. This justifies the appropriateness of the use of the Heckman procedure instead of other standard models such as the corner solution outcome model (Tobit model).

The result shows that credit participation was significant at 1% significance level and had positive impact on the amount of time spent by women in income-generating activities. Size of land owned by the household, dependency ratio and the agro-ecological zones (kolla and dega) were statistically significant in affecting women's time spent on IGAs at 1% significance level. The implication of the negative relationship between kolla and dega agro-ecological zone with IGAs was that women living in these agro-ecological zones spent less time on IGAs than those living in the third agro-ecological zone (woina dega). Another variable that had significant effect on the amount of time spent by women in IGAs was age of the respondent. Other control variables were not statistically significant.

On a passing note, religion as an instrument in the selection equation significantly affecting women's decision to participate in IGAs, was assumed to affect participation directly but only affect the amount of time spent indirectly.

Table 4: Heckman selection model estimation of hours spent on Income-generating activities by women

	Regression Model		Selection Model	
	Dependent Variable: Hours spent M = 1 if a woman participated on income-generating activities			
	Coefficient	Std. Err.	Coefficient	Std. Err.
Dummy women credit participation (= 1 if participated)	0.944	(0.200)***	0.393	(0.131)***
Age of the respondent	-0.0002	(0.0001)**	0.0002	(0.000)***
Level of education of the respondent	0.006	(0.031)	-0.033	(0.019)*
Marital status of the respondent (=1 if single)	-0.369	(0.441)	0.238	(0.286)
Sex of the household head (=1 if female)	0.201	(0.409)	-0.045	(0.257)
Dependency ratio	-1.080	(0.398)***	-0.288	(0.257)
Religion (=1 if Muslim)			-1.000	(0.350)***
Size of landholding of the household	-0.130	(0.043)***	0.009	(0.032)
Number of livestock of the household in TLU			-0.029	(0.031)
Remittance in Birr	-0.004	(0.006)	-0.003	(0.003)
Distance to the nearest micro-credit office			0.0004	(0.012)
Extent of micro-credit client in the village			-0.291	(1.536)
Dummy kolla (=1 if kolla)	-0.668	(0.267)***	-0.446	(0.202)**
Dummy dega (=1 if dega)	-0.810	(0.264)***	-0.380	(0.452)
Constant	2.847	(0.367)***	1.282	(0.299)***
/athrho			2.281	(0.480)***
Lnσ			0.566	(0.057)***

Number of observations: 403

Test of independent equations ($\rho = 0$): $\chi^2(1) = 51.71$, P-value $> \chi^2 = 0.0000$

Note: Robust standard errors in parentheses; the signs ***, ** and * indicate level significance at 1%, 5% and 10% respectively

4.2.2 Measuring the impact of credit on women's time spent on income-generating activities: the average treatment effect

A more formal method of estimation of the impact of participation in credit programs by women on the amount of time spent in income-generating activities is an average treatment effect. As noted above, subsection 3.2, there are at least three issues under which average treatment effect is estimated. Under ideal circumstances, an assumption of random selection of women into the credit program would entail comparing the mean time spent in income-generating activities by women who participated in credit schemes and those who do not. The average treatment effect can be estimated under the assumption that participation in the credit scheme by women may not be random but can depend on factors that are observable. In this case, providing controls for the direct and indirect effect of such variables in the average treatment effect model would allow estimation of the impact of credit participation on time spent in IGAs by women. The third fact is that participation in the credit scheme could be a result of self-selection where such selection depended on factors that are not observable; that is, the outcome and selection model might not be independent. In this case, instrumental variable estimation becomes relevant to deal with the risk of inconsistency in the results (Wooldridge, 2010).

In this particular study, women's participation in the credit program was not expected to be random for two reasons: first there was targeting by credit facility officers or operators where poverty was considered as one criterion. Second, in a society where segregation of activities by gender is rife, participation in the credit program by women might well be the result of special attributes of some women. This would justify the relevance of testing for the existence of selection bias in the model of the average treatment effect.

Estimation showed the null hypothesis, that outcome and participation equations were independent, was rejected at 1% level of significance. As a result, instrumental variable estimation was used to estimate the impact of credit participation by women on the time spent on income-generating activities. A STATA output of the estimation of Equation 11 is shown in Table 5. Results under the assumption of ignorability (standard estimates and PSM) are reported for comparison. Under

ignorability assumptions, regression adjustment (RA) estimators, inverse probability weights (IPW) estimators, augmented inverse probability weights (AIPW) estimators, and inverse probability weighted regression adjustment (IPWRA) estimators, give a variety of options to estimate ATE, ATET, and potential outcome means (POMs). The AIPW and IPWRA estimators have efficiency advantages over RA and IPW estimators because they combine the models for both outcome and treatment probability and have a double robust property (it requires that only one of the two models - the outcome and treatment probability – needs to be correctly specified) (StataCorp., 2015).

The method that accounts for the endogeneity problem extends the regression adjustment estimator under the ignorability assumption. In this case, the outcome model is assumed to be linear and the treatment follows a probit model (results are indicated on the last column and row of Table 5).

In augmented inverse probability weights (AIPW) estimation, level of education of the respondent, size of landholding of the household, remittances in thousand Birr, age of the respondent, dependency ratio, dummy kolla and dummy dega variables are, used in regression model. On the other hand; the number of livestock of the household in TLU, distance to the nearest micro-credit office in kms, extent of micro-credit clients in the village, marital status and age of the respondent are used in the participation model. Except for dependency ratio, included in the participation model of the inverse probability weighted regression adjustment (IPWRA) estimation, similar variables are used both in AIPW and IPWRA. The covariates used in propensity-score matching (PSM) are dummy credit, remittances in thousand Birr, level of education of the respondent, size of landholding of the household, age of the respondent, gender of the household head, and dummy kolla and dummy dega. In the endogenous treatment-effects estimation (IV estimation) control variables are level of education of the respondent, size of landholding of the household, age and marital status of the respondent, remittances in thousand Birr, distance to the nearest market in kms, dependency ratio, dummy kolla, and dummy dega; and religion as an instrumental variable.

Table 5: Treatment effects estimation of hours spent on Income-generating activities by women

	Hours spent on Income-generating Activities							
	augmented IPW		IPW regression adjustment		propensity-score matching		Endogenous treatment-effects estimation	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
ATE								
Credit participation (1 vs 0)	0.750	(0.158)***	0.752	(0.158)***	0.919	(0.189)***	4.445	(1.098)***
Potential outcome means								
Credit participation 0	1.270	(0.093)***	1.271	(0.093)***	-	-	1.394	(0.445)***
ATET								
Credit participation (1 vs 0)	-	-	0.711	(0.156)***	0.902	(0.187)***	0.420	(1.013)
Potential outcome means								
Credit participation 0	-	-	1.247	(0.096)***	-	-	1.539	(1.006)
Observations	403		403		403		403	
Outcome model	linear by ML		linear		matching		linear	
Treatment model	Logit		logit		logit		probit	
Test of endogeneity	Ho: treatment and outcome unobservables are uncorrelated							
	$\chi^2(2) = 16.37 [0.0003]$							

Note: Robust standard errors in parentheses; the signs ***, ** and * indicate level significance at 1% , 5% and 10% respectively

As it can be seen from Table 5, the coefficients of ATE and POMs of credit participation in AIPW estimates are statistically significant at 1% level. The result shows that the identified group (participant women in credit programs) spend 0.75 hours or about 45 minutes longer in income-generating activities than the non-participant group. The average time spent by women who did not participate in credit program is 1.27 hours or an hour and 16 minutes. So, the average time spent on IGAs, if all women were participated in micro-credit, would be 45 minutes greater than the average of an hour and 16 minutes that would be spent on income-generating activities if none of the women had participated in micro-credit. The results of the IPWRA estimators are similar to that of AIPW, and the result of the PSM estimator is not significantly different from these, showing that credit participant women spent more than 0.92 hours or 55 minutes per day on IGAs than non-participant women.

At the same time, the rejection of the test for independent outcome and treatment models imply biased and inconsistent AIPW, IPWRA and PSM estimates. The alternative model that accounts for the endogeneity (selection) problem is the instrumental variable estimation. In this case, the control function approach which is suggested by Wooldridge (2007, 2010) is employed. That is, the residual in the treatment model is included in the potential outcome models to estimate the ATE. The results of this later method of estimation show a significant coefficient for both ATE and POMs, and the coefficient is much improved compared to the results under the previous three estimates. According to the estimate using the control function approach, on average, treated women (women who participated in credit program) spend 4 hours and 28 minutes more than the untreated women on credit. This is a quite significant difference given the 1 hour and 23 minutes average time spent in IGAs by women who did not participate in IGAs. In other words, the average time spent on IGAs if all women were to participate in micro-credit would be 4.45 hours (or 4 hours and 28 minutes) substantially greater than the average of 1.39 hours (an hour and 23 minutes) time that would be spent if none of the women had participated in micro-credit program.

Results in ATET estimation revealed that the effect of credit among the credit participants is very low, even insignificant in the control function estimation where endogeneity due to selection bias is not an issue. Based on

the second model in Table 5, when all women in the sub-population (credit participants only) participated, the average time spent on IGAs per day is estimated to be 0.71 hour (45 minutes), more than when no women in the sub-population of interest participated. If no women in the sub-population of interest participated, the average time spent in IGAs amounted to 1.25 hours (an hour and 15 minutes) per day.

Despite the fact that the alternative average treatment effect models showed that the impact of women credit participation result in different magnitudes of time spent on income-generating activities, they invariably confirmed the positive impact of credit schemes. The implication of these results is that micro-credit intervention in rural Ethiopia can be seen as one of economic versus gender development strategy through reorienting the traditional gender division of labor in rural households.

5. Conclusion and Implications

Using primary data, the study has investigated the impact of participation in micro-credit on women's engagement in income-generating activities, and also identified other important factors which determine the time spent by women on such activities. To examine the issue, 460 households, drawn from 3 woredas of North Wollo Administrative Zone, were chosen, using a systematic random sampling method. All respondents in the sampled households were women, of which 172 participated in a credit scheme and 288 were non-credit participants.

The impact of participation in credit schemes on women's time spent on IGAs was assessed by using average treatment methods considering women who participated in activities financed by Amhara Credit and Saving Institution (ACSI) as a treated group and other women who did not participate as a control group. The statistical methodology used for this assessment was chosen on the basis of the high likelihood of prevalence of self-selection or targeted selection in a credit program resulting in an endogeneity problem. While the most appropriate and robust model was employed to account for selection problems on the basis of unobserved heterogeneity, other intermediate models, such as AIPW, IPWRA and PSM,

which assume selection to depend on observables were employed to estimate the treatment effect for comparison purposes.

The study found that women's participation in IGAs had a positively significant effect on the time women spent on income-generating activities. Based on estimates of the control function approach of Wooldridge, it was found that women who participated in credit schemes spent 4 hours and 28 minutes (4.45 hours) longer per day than non-participants. In addition, a large number of participant women spent their time on more productive and formal economic activities in comparison with non-participants who tend to engage in less formal economic activities. The more formal activities include animal fattening and rearing, poultry, bee keeping and vegetable cultivation. The descriptive analysis also found that irrespective of the marital status of women, micro-credit had a positive impact on the time women spent on IGAs.

The study identified important factors which determine women's participation in IGAs other than access to credit. Age and dependency ratio were consistent demographic factors which negatively affected women's IGAs time. The most important economic variable which affected women's participation in IGAs was the size of landholding of the household. Households which own more land resource (farm land) were expected to spend their time on farming activities, and thus women's time spent on IGAs, as a member of the household, tended to be low. Agro-ecology was another factor which determined the amount of time spent on income-generating activity by women. Among the three agro-ecological zones, women who lived in the woina dega (temperate) zone tended to spend more time on IGAs. One possible reason could be the fact that the temperate climate is suitable for many alternative IGAs; dega and kolla zones offer more limited opportunities for rural-related economic activities.

Empirical findings suggest that Ethiopia can promote women's self-employment in productive activities using intervention that can enhance and improve women labor force participation in IGAs. This study concluded that rural women's participation in micro-credit schemes has a significant impact on women's participation on IGAs and the time spent on such activities. It is, therefore, possible to reallocate rural women's labor from traditional household activities with low returns to productive activities through various policy interventions that target reducing women's financial constraints. To

this end, policies and interventions of development agencies should consider strategies of expanding micro-credit schemes focusing on the self-employment of women. The fact that the average treatment effect (ATE) was found to be higher than the average treatment effect among the treated (ATET) is consistent with targeting of women for credit participation based on their level of poverty. There is the possibility to enhance rural women labor force participation in IGAs through properly designed policy interventions that can target more productive women despite their initial income status.

This study offers conclusive additional evidence to the existing literature on the role of micro-credit in improving women's economic participation in the form of labor force participation in rural settings.

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Technical Inefficiency of Smallholder Wheat Production System: Empirical Study from Northern Ethiopia

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Abstract

This paper estimates the level and determinants of technical inefficiency of wheat producers based on data collected from 320 randomly selected wheat-producing farm households in four districts of Tigray regional state, Northern Ethiopia. Technical efficiency in wheat production was estimated using Cobb-Douglas stochastic production frontier model while a technical inefficiency model was estimated to identify sources of inefficiency. The mean technical efficiency of wheat producers was estimated to be only 57%. Given the present state of technology and input level, the result suggests that there is plenty of scope to increase wheat output (efficiency). The technical inefficiency model results suggest that there is an opportunity to reduce inefficiency in wheat production; and in this regard, farmer education, livestock size, and access to market information were found to have a counter effect on inefficiency. These factors represent human capital, production assets and improved information access for enhanced decision-making capabilities as important areas of intervention to reduce inefficiency. Overall, the results indicate the important role that sources of information and knowledge play in reducing technical inefficiency.

Keywords: Wheat producers, technical inefficiency, Cobb–Douglas, stochastic frontier function

JEL Codes: Q12

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Acknowledgements

This study was conducted through the support of the Regional Universities Forum of “Wheat Value Chain project” (RUFORUM)” with grant number (RU 2014 CARP-05).

1. Introduction

Cereal production and marketing are the single largest agricultural sub-sector in Ethiopia's economy, providing livelihood means for millions of smallholder households. In Ethiopia, cereals account for roughly 60% of rural employment, 73% of the total cultivated land, more than 40% of a typical household's food expenditure, and more than 60% of total caloric intake (Rashid and Negassa, 2012). Among cereals, wheat is one of the main staple crops in Ethiopia in terms of both production and consumption, which makes the country the second largest producer of wheat in sub-Saharan Africa. At national level, 1.63 million ha of cultivated land was used for wheat production by about 4.84 million smallholder farmers (CSA, 2013).

In Ethiopia, wheat is grown mainly in the highland areas of Oromia, Amhara, Southern Nations, Nationalities and Peoples (SNNP) and Tigray regions (CSA, 2013). Currently, wheat production and marketing has received higher attention by the Government of Ethiopia (GoE) as well as by Non-governmental organizations (NGOs) (EAAPP, 2009). Government support for wheat production and marketing is especially channeled through research and extension on new and improved wheat technologies. As part of this, the country has become a center of research excellence for wheat research in Eastern Africa (EAAPP, 2009).

However, wheat production systems in Ethiopia are riddled with several problems leading to inefficiencies in wheat production and marketing. Among the major problems, significant imperfections in wheat input and output markets, traditional technologies, low labor and land productivity and limited management capability of producers, are particularly recognized (Rashid and Negassa, 2012; Gebreselassie et al., 2017). Despite the wide-ranging obstacles, the most important problem in wheat production systems in Ethiopia is the limited use of improved production technology and the ensuing technical inefficiency (Rashid and Negassa, 2012; Gebreselassie et al., 2017).

In this regard, several studies were conducted to estimate the level of technical efficiency of smallholder farmers in Ethiopia (such as Asmare, 1998; Seyoum et al., 1998; Mohammad et al., 2000; Temesgen and Ayalneh, 2005). These studies showed that there are wide efficiency differences among small-scale farmers in Ethiopia, ranging from 0.39 to about 0.95 (see

also Mesay et al., 2013). Such results need to be looked at within the production contexts that may be unique and more localized.

While poorly-functioning wheat markets, use of traditional technologies, low labour and land productivity and poor management capability also characterize dryland wheat production systems in northern Ethiopia, the effect of erratic rainfall in relatively dry and highland areas on wheat production and efficiency may be more pronounced. This is especially true for wheat producing highland but moisture stressed areas in the Tigray Regional State, which is the focus of this study. The study area is characterized by low rainfall, high climatic variability (rainfall and temperature). In a similar context to this, Gebregziabher et al. (2016) argue that farmers in arid and semi-arid highland areas of Amhara Regional State in northern Ethiopia are already experiencing moisture stress leading to shorter growing seasons, lower yields and reduced suitable land for agriculture. Technical efficiency studies in such wheat production contexts are limited. With this in the hindsight, this study aims at contributing to the limited knowledge on production efficiency of smallholder farmers in a such a difficult production environment.

More specifically, this paper contributes to the literature on technical efficiency in two respects. One, this study was based on wheat production systems in moisture stressed highland areas of Ethiopia where unique and localized attributes affect efficiency of wheat production. Wheat production in the dryland parts of Ethiopia involve production systems under water-deficient and less favorable climatic, agro-ecological and bio-physical conditions that are in stark contrast to the production systems considered by previous studies conducted in high rainfall and favorable environmental conditions. Secondly, unlike many previous studies that adopted either parametric or non-parametric approaches, this paper combined parametric with non-parametric methods to assess the robustness of the results. Specific sources of inefficiency that contribute to loss in wheat production in the drylands of northern Ethiopia have been analyzed in this paper.

2. Theoretical Framework and Methods

The main motivation of this study was to measure the technical efficiency of wheat production and explore the responsiveness of wheat yield

to different inputs. The observed variations in this responsiveness are modeled from the perspective of differences in the production technology and inputs that are used by farms, differences in the levels of efficiency of the production processes and differences in the context in which production takes place. We describe this responsiveness of wheat yield to inputs and efficiency as follows.

2.1 Stochastic Production Frontier Model and Method

To study efficiency (and from there inefficiency), one of the most widely applied parametric approaches is Stochastic Frontier Analysis (SFA) that follows a defined production function. The model involves a composite error term that accounts both for the statistical noise in the data as well as the inefficiency in production (Coelli, 1995). Any deviation from the efficient frontier (ideal outputs from a given input set at given level of technology) is attributed to both the stochastic disturbance such as errors in measurement, topography, weather and effects of other unobserved and uncontrollable variables, as well as the individual-specific factors that affect inefficiency (Coelli, 1995).

Once the individual inefficiency levels are estimated, the major factors causing the inefficiency can easily be identified from the model. One of the limitations of this parametric method is the imposition of restrictive assumptions about the functional forms of the production function and the distribution of random errors. Nonetheless, SFA has been commonly used for analyzing agricultural efficiency both in developed and developing countries. Greene (2008) provides a detailed and comprehensive discussion of different variants of SFA models.

In this study, a stochastic frontier production function was used to model the efficiency in wheat production. The stochastic frontier production function is specified as:

$$\ln y_i = \beta_0 + \sum_{k=1}^k \beta'_k \ln \mathbf{I}_k + v_i - u_i \quad (1)$$

Where y_i represents the yield of the i th wheat producer, \mathbf{I}_k is the vector of inputs, and the $\mathbf{\beta}$ is the vector of parameters that must be estimated. Following this, the model estimated has the following form:

$$\ln yield_i = \beta_0 + \beta_1 \ln (land_i) + \beta_2 \ln (DAP_i) + \beta_3 \ln (UREA_i) + \beta_4 \ln (seed_i) + \beta_5 \ln (ploughing_i) + \beta_6 \ln (weeding_i) + v_i - u_i \quad (2)$$

where $\ln yield_i$ is the log of the amount of wheat that is produced in kilograms per tsimad⁴; $\ln (land_i)$ is the log of the area of land in tsimad used for wheat production, $\ln (DAP_i)$ and $\ln (UREA_i)$ represent the log of DAP and UREA applied in kilogram on wheat production; $\ln (seed_i)$ is the log of the amount of wheat seeds in kilogram used per tsimad; $\ln (ploughing_i)$ is the log of the number of workers per day working on ploughing and $\ln (weeding_i)$ is the log of the number of workers per day working on weeding for wheat production. Whereas the values of v_i represent the occurrences that cannot be controlled by the farmer, the values of u_i represent the technical efficiency of wheat production and composed of a mean and a variance with normal distribution truncated at zero (Juan and Wilman, 2014).

Each individual farm's technical efficiency performance is then compared with the estimated frontier. The level of technical efficiency of each farm is then given by:

$$TE_i = \frac{y_i}{y_i^*} = f(x_i; \beta) \exp(v_i - u_i) / f(x_i; \beta) \exp(v_i) = \exp(-u_i) \quad (3)$$

where $\exp(-u_i)$ ranges between zero and one and is inversely related to the level of the technical efficiency effect. Based on this, maximum likelihood was used to estimate the parameters of the stochastic frontier production function. The random effect dominates the variation between the frontier output level and the actually obtained output level. If y_i is close to zero, it implies that the random effect dominates the variation between the frontier output level (y_i^*) and the actually obtained output level (y_i) . Conversely, if

⁴ *Tsimad* is a local unit used to measure land size and equivalent to 0.25 hectare (2500m²).

y_i is close to one, it can be assumed that the variations in outputs are determined by technical efficiencies (Abate and Kebebew, 2011).

Equation 3, which is used to estimate technical efficiency, can indirectly be used to generate values for inefficiency. Given these data, the inefficiency model can be specified generically as;

$$TIE_i = \mathbf{X}'_i \boldsymbol{\theta} + \varepsilon_i \quad (4)$$

where TIE denotes technical inefficiency, and \mathbf{X} is the vector of variables that are hypothesized to be sources of technical inefficiency with their corresponding vector of estimates, $\boldsymbol{\theta}$. The error term is assumed to be normally distributed with zero mean and constant variance. Equation 4 was then estimated using OLS⁵.

The technical efficiency estimated using stochastic frontier model gives information mainly on the efficiency level of the average farmer (i.e., average efficiency in wheat production). Sometimes, additional insight can be obtained by computing technical efficiency estimate that captures an efficiency frontier based on which all other wheat producing farmers can be compare to (Ruggiero, 2007). The method that allows such comparison is the Data Envelopment Analysis (DEA), which is non-parametric model and does not require prior functional specification and distributional assumptions. In this study, we used this model to further examine the technical efficiency of white producers relative to the most efficient producer. In the end, we used the results from DEA for comparison with the results of the stochastic frontier we used for interpretation purposes.

⁵ The technical inefficiency model estimated using OLS was subjected to omitted variable bias test and heteroskedasticity test. The null hypothesis of no omitted variable bias [F(3, 302) = 1.94; Prob > F = 0.1227] and no heteroskedasticity [chi2(1) = 0.1; Prob > chi2 = 0.7537] could not be rejected.

3. Data

The wheat growing areas in Tigray vary in agroecology (climatic and biophysical conditions), market access and land-related endowments, all of which may influence wheat production and efficiency. To account for these differences and select a representative sample, multi-stage sampling procedure was used. In the first stage, potential wheat growing districts and peasant associations (PAs) within these districts were selected purposively. As the interest was to study technical inefficiency variations among wheat producing farm households, there was a need to concentrate on those districts that focus on wheat production. In the second stage, households were stratified into groups of farm households (based on the strata of income/wealth: better off, medium and poor) in order to select representative sample of all income groups. In the third stage, a sample of 320 wheat producing farm households were randomly selected based on probability to proportional size (PPS) sampling method. Proportional sampling was made possible by obtaining population data from each of the selected peasant associations. For data collection, five enumerators were selected and trained on the purpose and contents of the questionnaire. The questionnaire was pre-tested on 12 farm households. Once useful feedback from the pre-test was incorporated in the questionnaire, the main household survey was carried out during June to August 2016⁶ in the 4 districts and 8 kebele's covered by the study. The study districts included are Degua-Temben, Ganta-Afeshum, Emba-Alaje and Ofla, which constitute the major wheat producing areas in the Tigray Regional State. Crop production is the main sources of income in the study areas. The major crops grown are wheat, barley, teff, beans, peas, lentil, sorghum and maize. However, wheat is the dominant crop in the highlands of Tigray Regional State in general and in the study areas in particular. Almost all farm households in the study areas grow wheat. Data collected included, among others, socio-economic and demographic characteristics, farm and production data related to yield and input use, farm

⁶Although the survey was conducted during the cropping season of the 2016 period (June to August), data about production, inputs and related information were from the previous cropping calendar.

management, physical features such as arable land quality and major challenges of technology adoption, and market problems.

Based on theoretical suggestions and previous studies, the variables that are often considered to be sources of inefficiency are related to household and farm-specific characteristics, including age, education level, gender, family size, access to credit, extension contact, membership in cooperatives, market information and livestock ownership. Age and educational level of household head are often used as proxy for experience in farming that could be correlated with efficiency. Age of household head is expected to be negatively correlated with inefficiency as farmers would develop their experience and learning from the experience with age (Coelli and Battese, 1996; Rahman, 2002). The positive relationship may, however, not be linear in the sense that after a certain age level, the inefficiency would increase again (Liewelyn and Williams, 1996), and hence the inclusion of age squared that will show whether the relationship with age is quadratic. Education in terms of years of schooling is expected to be negatively correlated with inefficiency. Farmers with higher education tend to learn the skills and develop the knowledge to manage factors of production better and process information more effectively for production purposes, which in turn may reduce inefficiency in production. It is hypothesized that there may exist differences in technical inefficiency among male and female-headed households. Differences in resources ownership and the control over production inputs and management of these inputs, which the female-headed households are worse off might lead female-headed households being more technically inefficient. With household size, it is hypothesized that technical inefficiency decreases. More household members may translate into pooling labor for production, and the sheer size in household is expected to contribute to efficiency (inefficiency).

Access to credit was hypothesized to negatively correlate with technical inefficiency. Technical inefficiency of wheat production is decreases with the increase in farmers' access to credit. Most subsistence farmers are poor and experience credit constraints and subsequently may not be in a position to increase agricultural productivity significantly. Extension contact was hypothesized to be negatively correlated to technical inefficiency. Farmers who have readily accessible extension education are presumed to acquire relevant and up-to-date knowledge and skills as well as

information regarding wheat production, input supply and management, marketing and other aspects that may reduce technical inefficiency. Membership of multi-purpose cooperatives was another factor that was hypothesized to reduce technical inefficiency by facilitating farmers' access to essential information, such as new production techniques, market, credit facilities, and also training related to wheat production. This eventually would enhance farmers' ability to apply innovation, manage their production resources more effectively and reduce inefficiency. Access to market information is an important factor that was hypothesized to be negatively correlated with technical inefficiency. Market information is crucial for decision making on how, when and where to purchase inputs used for wheat production and sell wheat products. Livestock ownership is a proxy for wealth status and was hypothesized to be negatively correlated with technical inefficiency. Livestock as key assets can serve as sources of liquidity to purchase agricultural inputs and equipment used for wheat production. This in turn is expected to increase productivity and efficiency and by translation reduce technical inefficiency.

4. Results and Discussion

Given the difficult climatic and agro-ecological conditions of wheat production in the study area, wheat productivity was found to be low. The average wheat productivity was 7.59 quintal per tsimad (equivalent to 3.04 tons per hectare). This is similar to the average productivity of wheat farmer in Kenya, India and Bangladesh. This average wheat yield was obtained by using 37.2 kg/tsimad (148.8kg/ha) of seed, 29.6 kg/tsimad (118.4kg/ha) of DAP, 30.1 kg/tsimad (120.4kg/ha) of UREA, an average of 3.6 times of ploughing and an average of 30.1 labor days.

On average farm households allocate about 1.43 tsimad (0.36 ha) of their land for wheat production. This is a high proportion of land allocated for wheat given the small average land holding of about 0.75 ha in the Tigray region. Households owned an average of 3.22 tropical livestock unit (TLU) of livestock. This livestock size, key resource for wheat farming (through services to ploughing, threshing and manuring) is also similar to the national (Ethiopia) average. Only about 119 (37%) of households obtained credit during the study period. This, however, does not necessarily indicate

lack of access. Many households may not have been interested in obtaining credit in the first place.

The average number of contacts made by extension staff with wheat producing households for wheat crop-related information per year was 7. This is not sufficient compared to what is required. The common practice is also that information about wheat is discussed when extension agents meet farmers to discuss other issues. So, the actual period of time may be longer. About 233 (72.8%) households were members of multi-purpose cooperatives. Many farmers were organized through cooperatives both for input and wheat output marketing related benefits. Access to markets does not come easy as, on average, a household spends about 60 minutes (1hr) traveling on foot to reach the nearest market from their residence.

Table 1: Summary statistics of variables used in the stochastic frontier and inefficiency models

Continuous variables	Unit	Mean	Std. Dev.	Minimum	Maximum
Age	Years	48.2	13.6	18	83
Family size	Number	5.34	1.97	1	11
Education level	Years of schooling	2.51	3.16	0	10
Yield	Kg per tsimad	759.1	636.4	100	4500
Wheat land size	Tsimad	1.43	0.99	0.08	6
Amount of improved seed used	Kg per tsimad	37.2	8.8	12.5	50
DAP used	Kg per tsimad	29.6	12.7	10	50
UREA used	Kg per tsimad	30.1	12.7	12.5	50
Ploughing frequency	Number	3.60	0.65	2	7
No. of labor used for weeding	Number per tsimad	30.1	23.8	3	180
Extension advice frequency	Number	7.79	9.38	0	60
Livestock ownership	Tropical Livestock Unit (TLU)	3.22	2.63	0	22.9
Distance to the nearest market	Minutes	60.9	39.23	5	240
Dummy variables					
Gender (1=male-head; 0=female-head)		0.734	0.44	0	1
Credit for wheat production (1=access; 0=otherwise)		0.372	0.48	0	1
Membership of MP-cooperative (1=member; 0=non-member)		0.728	0.45	0	1
Market information (1=have access; 0=otherwise)		0.531	0.50	0	1

Source: Own computation, 2016

4.1 Technical Efficiency

First, the robustness of results was tested using likelihood ratio test. The test result ($\chi^2(1) = 1.64$) indicated the constant elasticity assumption of the Cobb-Douglas yield function could not be rejected at the 5% significance level, based on which we interpreted yield results in response to production inputs. Following this, efficiency model was estimated. The average technical efficiency of the farm households was estimated to be only 57%, with household-level technical efficiencies ranging from 20% to 97%, indicating that farmers are only producing on average 57% percent of the maximum possible output level, given the state of technology (Table 2). The variations in technical efficiency among farmers indicate the sub-optimal use of production inputs by wheat producers. Farmers vary in their endowment and use of land, labor, seed, and soil fertility enhancing inputs for wheat production, which were found to be significantly correlated with yield. Optimal combination of these inputs in this case would enable the most technically inefficient farmer to enhance wheat yield by 79 per cent [i.e., $1 - (20/97) = 0.7938$]. Moreover, optimal combination of these inputs would enable the average farmer to increase wheat yield by 41 per cent [i.e., $1 - (57/97) = 0.4124$] to achieve the technical efficacy level of its most efficient counterpart. Overall, results show significant inefficiency, demonstrating the opportunity for farmers to increase productivity depending on their specific observable and unobservable characteristics.

The stochastic frontier analysis helps shade light into the average technical efficiency of the sample of farms when examined from the perspective of production (output-oriented efficiency). To get a different perspective on the variations in technical efficiency of different farms as compared to the most efficient farm in the sample, data envelopment analysis that focuses on input use results was used. Results from input-oriented two-stage DEA show that the efficiency score (theta) of all the DMUs (wheat producers) ranged between 65.6 to 1%. This range for instance indicates that the least efficient farm (with efficiency score of 65.6%) would need to reduce overall input use by 34.4% to become efficient. The mean efficiency from DEA was estimated to be 88.7%, indicating that on average the farms would need to reduce aggregate input use by 11.3% to achieve efficiency. These results suggest the existence of

significant inefficiency in the use of inputs by farms, which in turn point out the possibility for increasing wheat output with improved use and management of production inputs.

Table 2: Technical efficiency and distribution of wheat producers at different efficiency levels

Variable	No. of observations	Mean	Std. Dev.	Min	Max
Efficiency	316	0.569	0.171	0.205	0.969
Range of technical efficiency		Frequency		Percent	
0- 0.25		5		1.58	
0.251- 0.50		120		37.97	
0.51- 0.75		135		42.72	
> 0.75		56		17.72	
Total		316		100.00	

Source: Own computation, 2016

Technical efficiency estimate from Data Envelopment Analysis

Variable	No. of observations	Mean	Std. Dev.	Min	Max
Efficiency (theta)	316	0.887	0.085	0.656	1

Source: Own computation, 2016

Districts vary in different agro-ecological and socioeconomic characteristics, which may exhibit variations in technical efficiency. Comparison of the mean technical efficiency across districts was made using ANOVA and results show that there is no statistically significant difference in mean technical efficiency among districts (0.553 for Degua-temben, 0.473 for Ganta-afeshum, 0.686 for Emba-alaje and 0.564 for Ofla). Classifications of technical efficiency levels were also made and results show significant variation among different groups of households. A significant number of the farm households (close to 40%) operate at half of their production potential or lower. The indication is that a large number of wheat producer farmers faced worse inefficiency problems, where they could not even produce half of their potential. This clearly shows the possibility of increasing productivity and efficiency among large number of farm households. Only about 17.7% of wheat producer farmers operated at efficiency levels of

greater than 75% (Table 2). Even for these groups of farmers, there is a great deal of room to increase efficiency.

4.2 Inputs' Role on Wheat Yield

In the stochastic frontier and efficiency models for wheat producers, the maximum likelihood estimates were defined by equations 1 and 3 as presented in Table 3 above. As expected, the major inputs are found to be key means of production that could increase efficiency. Land size, UREA fertilizer, amount of different improved seeds, ploughing frequency and weeding frequency for wheat production were found to have statistically significant positive effect on wheat yield. The coefficient of wheat land size was significant and positive, implying that an increase in land allocation for wheat would increase the wheat output. Though the result related to land shows the potential contribution of land to production, increasing land size would not be easy in the study area. Land rental and lease are allowed which offer potential to increase land size, which could be attractive to more efficient farmers (Almeida and Buainain, 2016, Kemper et al., 2018).

As an important factor of production, improved wheat seeds play key role in improving productivity. The marginal elasticity of 0.10% related to wheat seeds might look very small (Table 3). It nonetheless underlines the importance of improved seeds. Shiferaw et al. (2008) and Qian and Zhao (2017) in this regard underline the role of improved seed varieties who found that on average farmers who used improved seeds obtained more yield than farmers who did not use improved seeds. The scale of production and seed quality emanating from such improved seeds cannot be overemphasized as the supply of wheat seed with the reasonable price to the farmers would increase wheat production. In this regard, the wider scale expansion of formal and informal seed exchange system of seed distribution by research centers for demonstration and pre-scaling up activities needs to be continued for serving the smallholder wheat seed demands. This needs to be complemented by enhancing the multiplier effects of revolving seed model in increasing improved seed to poor smallholder farmers.

Table 3: Technical efficiency and inefficiency determinants

Variables	Coefficient	t-statistic
Output model		
Constant	4.427***	14.5 (0.306)
Land size per tsimad (Inland)	0.420***	5.28 (0.080)
Improved seed per tsimad (Inimpsedamt)	0.102**	2.12 (0.048)
DAP used in kg per tsimad (InfertiDAP)	0.030	0.56 (0.054)
UREA used in kg per tsimad (InfertUREA)	0.189***	2.63 (0.072)
Ploughing frequency per tsimad (Inplougnum)	0.703***	5.00 (0.141)
Labour used for weeding per tsimad (InNumlab_weed)	0.008***	5.31 (0.002)
σ_v	0.326	(0.035)
σ_u	0.448	(0.075)
Likelihood ratio test for $\sigma_u = 0$; $\chi^2(1) = 4.99$ Prob $\geq \chi^2 = 0.013$		
Inefficiency model		
Constant	0.630 ***	4.96 (0.127)
Age	-0.004	-0.70 (0.005)
Age-squared	0.001	0.66 (0.001)
Education level	-0.007**	-1.92 (0.003)
Gender	-0.014	-0.57 (0.024)
Family size	0.004	0.67 (0.006)
Credit access	-0.015	-0.73 (0.020)
Extension contact	-0.000	-0.80 (0.001)
Membership in MP-cooperative	-0.017	-0.75 (0.023)
Market information	-0.054***	-2.77 (0.019)
Livestock ownership	-0.014***	-3.48 (0.004)

Source: Own computation, 2016 Note: ** and *** indicate significance at 5 and 1% levels of significance respectively. Values in parentheses are standard errors.

Further, results emphasize the role of land preparation, management and soil fertility enhancing methods and inputs in increasing productivity. Ploughing and weeding frequency as land preparation and management activities play positive roles in increasing output. Optimal land preparation has the potential to increase yield. The largest effect of ploughing on yield may be attributed to creating an enabling soil and soil microbes for wheat production. While increased ploughing frequency beyond the optimum level would disturb soil structure and might cause negative consequences on

wheat production, it nonetheless emphasizes the importance of repeated (3–4 times) ploughing. As expected, labor input in terms of weeding positively contributes to wheat yield. Every labor man-day per tsimad invested in weeding wheat farmlands helps eliminate competition for key soil nutrients (such as water and nutrients). The access created to more nutrients and water by as much weeding frequency as possible would eventually lead to an increase in wheat productivity.

As it is commonly the case, UREA fertilizer was found to have a positive and significant effect on yield. This is true although farmers often fail to use the recommended rate of UREA fertilizer, which would have further increased wheat yield. On the other hand, DAP fertilizer was found to have no statistically significant effect on wheat yield. While there could be several explanations for this, one thing that caught our imagination is that most of Tigray and the specific districts where the study took place have shortage of phosphorus while nitrogen endowment is relatively good (ATA, 2014). Farmers failure to apply recommended rate of fertilizer (including DAP fertilizer) may be one important reason for why DAP fertilizer did not have effect on wheat yield.

4.3 Determinants of Technical Inefficiency

The likelihood ratio test for the significance of the inefficiency parameter is found to be statistically significant at 1% level (with $\text{Prob}(\chi^2) = 0.005$), which indicates that the variation in wheat yield, in addition to variations in input use, was probably due to the inefficiency effects of farmers' specific attributes. Out of the ten variables used, three variables (education level, access market information and total livestock ownership) were found to have a negative and statistically significant effect on technical inefficiency of wheat farmers (Table 3).

The coefficient of education level in years of schooling has a negative effect on technical inefficiency. This means inefficiency is likely to decrease with education, *ceteris paribus*. This may be because education improves the ability of farm households to make informed decision about the use of production inputs and increase their access to information. Moreover, with education, farm households are likely to build management capabilities

and systems; and hence implement such skills for better use of resources and inputs while producing wheat (Geta et al., 2013; Berhanu et al., 2015). This is expected to reduce inefficiencies, and by implication can lead to higher wheat yield. In relation to this, Asogwa et al. (2012), Geta et al. (2013) and Mesay et al. (2013) argue that education reduced inefficiency as it increased access to agricultural information and encouraged farmers to adopt and utilize improved inputs (such as fertilizers and crop varieties) which in turn enabled higher production.

Results further indicate that farmers who readily access market information are likely to be less inefficient as compared to those who do not have access to market information. This market information can be useful in helping farmers assess the market and locate demand bases to sell their wheat with reasonable price. If farmers have access to market information, they would reasonably know where, when and by how much to sell their wheat. If farmers have access to market information, they would be highly encouraged to allocate additional farmland to wheat as they have the confidence of earning reasonably higher price, for example; by selling their wheat to multipurpose cooperatives and flour factories, which fetch higher returns than individually selling to outlets in the local market.

Livestock size was the other variable that was found to have statistically significant at 1% significance level and negative effect on technical inefficiency. This result implies more livestock brings lower technical inefficiency of wheat production. This might be because livestock provide drought power, cash to finance input expenses; and manure as fertilizer, all of which can enhance production. Furthermore, possession of large number of livestock indicated greater overall wealth and capacity. This in turn may create capacity to reduce inefficiency. For example, livestock in a mixed farming system, are also used for ploughing and threshing, both of which play significant roles in reducing inefficiency (see also Mohammed et al., 2000; Beshir et al., 2012). Therefore, governmental strategies that enable farmers to own such kind of productive assets (livestock namely Oxen) using different methods; for instance, arranging oxen purchased by credit would have a positive effect in reducing farmers inefficiency or enhancing their efficiency so that they can produce wheat on time at a maximum possible frontier using the same level of resources (inputs) that they are currently using.

5. Concluding Remarks

This paper assessed technical efficiency and determinant factors of inefficiency among wheat-producing farm households in four districts of Tigray Regional State in northern Ethiopia. Data on wheat yield, inputs and socioeconomic characteristics were collected from wheat growing farm households for this purpose. A Cobb-Douglas stochastic frontier production function was estimated and used to investigate relationship between yield and production inputs. In addition, an inefficiency model was estimated to identify the sources of inefficiency in the wheat production system.

As it appears, level of technical efficiency in the wheat production systems is significantly lower. The mean technical efficiency was estimated to be only 57%, indicating significant loss in the wheat production systems. There are even wheat-growing farm households whose technical efficiency is as low as 20%, showing considerable potential to increase the production and productivity of wheat. As it turns out, efficiency of the wheat production system can be improved depending on the sources of the inefficiencies, such as addressing the sources of inefficiency or effective supply and management of production inputs (like fertilizer and land preparation or ploughing).

Technical inefficiency is pervasive and some of the most important household-specific attributes that govern technical inefficiency were educational achievement, access to market information and livestock size. These key features play mitigating roles in countering technical inefficiency as they represent human capital, production capabilities, and information. These household-level attributes may be key to pooling production resources and building economies of scale and improved production management capability that helps reduce inefficiency. This depicts the picture that if the necessary technical and managerial skills are not in place, smallholder wheat production systems would continue to be riddled with inefficiencies in production. This is because farm households would continue to have limitations in the key skills and capabilities that embolden them to counter inefficiencies. In this regard, the role of education and information cannot be overemphasized in countering inefficiency. Hence, the current rural adult education programs which are practical oriented, need special attention and be strengthened, although this affects not only wheat production systems but also important to improve agricultural efficiency in general.

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