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AGRICULTURAL TECHNOLOGY ADOPTION AND ITS DETERMINANTS IN ETHIOPIA: A REVIEWED PAPER

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ABSTRACT

The main objective of this paper is to review recent research works studied on agricultural technology adoption and its determinants in Ethiopia. In this paper, therefore, empirical studies done on the area were reviewed in terms of their publication year, the sources of data, methodology they employed and the results they obtained. Moreover, this paper has tried to assess secondary data collected from Central Statistical Agency (CSA) in order to get a more insight on the application rate of agricultural technologies by farm households. In Ethiopia, even though improvements have been seen over time, the use of agricultural technologies is found at its low level. Even though the results of studies conducted on the determinants of agricultural technology adoption were varied based on their study area and the type of technology they studied, variables such as accessibility of credit, farm size, distance from market, oxen ownership, and education were found to be the most common significant factors influencing adoption of agricultural technology in Ethiopia. .

Key words: Ethiopia, Agriculture, Technology, Determinant, Adoption rate.

1. Introduction

Technology can be described as the integration of people, knowledge, tools and systems with the objective to improve people's lives (Porter, 1985). According to Betz (1998), technology is always the means of creating new tools serving humans and their environment. Technology adoption refers to a decision to make full application of an innovation as the best course of action (Rogers, 2003)

Agricultural Transformation in many developing countries that led to a significant increase in agricultural productivity resulted from programmes of agricultural research, extension and infrastructural development occurred in the late 1960s, and this revolution was known as Green Revolution. According to Andersen and Hazell (1985) Green Revolution refers to a rapid increase in wheat and rice productivity resulted from the adoption of improved seed varieties, fertilizers and pesticides.

Technological change in agriculture comprises of introduction of high yielding variety of seeds, fertilizers, plant protection measures and irrigation. These changes in agricultural sector enhance the productivity per unit of land and bring about rapid increase in production.

Ethiopia is a country situated at the Eastern part of Africa with a population of more than 100 million (CSA, 2017). Agriculture is the backbone of the Ethiopian economy, playing a vital role in the country's economic development. The sector accounts for 36.7% of the GDP and generates 88.8% of export earnings. However, the Ethiopian agriculture is a rain feed which its growth depends on favorable climate among others things. For example, the agricultural sector exhibited the lower growth rate of 2.3% in 2015/16 largely on account of Elino effect (NBE, 2016).

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Out of the total crops produced in the country, grain crops took the lion share both in terms of the total area of land coverage and output production. From the total area of land 89.5% of it was covered by grains crops (cereals, pulses and oilseeds) which not only constituted the major food crops for the majority of the country's population but also served as a source of income at household level and a contributor for the country's foreign currency earnings, among others. Out of the total grain crop area, 79.88% hectare of land was covered by cereals where Teff, maize, sorghum and wheat took up 22.95%, 16.91%, 14.85 % and 13.33% of the grain crop area respectively. In terms of production, cereals constituted 86.68% grain production in which Maize, teff, wheat and sorghum 26.80%, 16.76%, 15.81% and 16.20% of the grain production respectively (CSA, 2017).

Since more than 80% of the population lives in the rural area where agriculture is the source of their livelihood, its growth is a major driver of poverty reduction in rural Ethiopia. As a result the government of Ethiopia has planned to increase agricultural productivity through the adoption of agricultural technologies among other strategies.

Even though the supply of improved seeds and fertilizer that help increase agricultural production and productivity has increased overtime, but still falls short of the target set in order to transform smallholder agriculture (MoFED, 2016).

The main objective of this paper is to review recent empirical research works on the rate of agricultural technology adoption and its determinants in Ethiopia. Moreover, this paper has tried to review the application of agricultural technologies based on secondary data collected from CSA Ethiopia.

2. Agricultural Technology Adoption In Ethiopia

The application of fertilizer to crop fields in Ethiopia is gathering momentum. The area covered by fertilizer used and the extent of area covered as a share of the total crop area has shown increment from 6.74 million hectare (50.48%) to 8.18 (57.06%) from 2010/11 to 2014/15. From the total fertilizers applied in Ethiopia, the area of land covered by both UREA and DAP took the largest share followed by DAP which constitutes 28.06% and 15.10 % in 2014/15.
Improved seeds are another important input that contributes to an increase in agricultural productivity. Even though its application has increased from 5.58% to 8.55% in terms of the area

Table 1 Agricultural Technologies Applied in Ethiopia from 2010/11-2014/15

Types of Agricultural Technologies	2010/11		2011/12		2012/13		2013/14		2014/15	
	Applied area in million hectare	Covered Area (%)	Applied area in million hectare	Covered Area (%)	Applied area in million hectare	Covered Area (%)	Applied area in million hectare	Covered Area (%)	Applied area in million hectare	Covered Area (%)
Fertilizer	6.74	50.48	6.80	49.70	7.44	53.41	7.43	52.56	8.18	57.06
Growth (% Change)	-	-	0.88	-1.55	9.42	7.46	-0.15	-1.59	9.98	8.57
Dap	2.11	15.78	20.48	14.96	2.27	16.25	2.03	14.38	2.16	15.10
Growth (% Change)	-	-	-2.86	-5.21	10.61	8.63	-10.22	-11.52	6.35	0.97
Urea	0.30	2.26	0.35	2.55	0.41	2.91	0.37	2.64	0.42	2.93
Growth (% Change)	-	-	15.75	12.95	16.34	14.25	-7.95	-9.28	12.49	11.05
Both Dap and Urea	2.43	18.16	2.56	18.68	3.10	22.23	3.40	24.03	4.02	28.06
Growth (% Change)	-	-	5.45	2.91	21.15	18.99	9.66	8.08	18.32	16.81
Natural	1.91	14.28	1.85	13.50	1.67	12.01	1.63	11.51	1.57	10.96
Growth (% Change)	-	-	-3.14	-5.48	-9.44	-11.06	-2.77	-4.17	-3.49	-4.72
Improved	0.75	5.58	0.86	6.29	0.83	5.97	1.04	7.33	1.23	8.55
Growth (% Change)	-	-	15.40	12.61	-3.27	-5.00	24.59	22.79	18.10	16.59
Pesticide	2.24	16.79	2.27	16.59	2.77	19.89	2.76	19.53	3.20	22.32
Growth (% Change)	-	-	1.20	-1.24	22.08	19.89	-0.34	-1.78	15.76	14.28
Irrigation	0.18	1.36	0.17	1.21	0.15	1.09	0.17	1.18	0.18	1.25
Growth (% Change)	-	-	-9.08	-11.28	-8.43	-10.07	9.72	8.14	7.52	6.15

Source: Own computation based on CSA

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covered on improved seeds between 2010/11 to 2014/15, still it is found at a very low level. When extensive pests and weeds damage crops the use of pesticides is indispensable. The total pesticide applied area reached 3.2 million hectares (22.32%) in 2014/15 which has increased over time. Even though irrigation enables to increase the frequency of crop production and alleviates water shortage caused by poor rains /dry seasons, the use of irrigation in Ethiopia is very low. In 2014/15 irrigation was practiced in only 0.18 million hectares (1.25%). Moreover, its application did not show a significant increment over time.

Now let us review recent studies done in Ethiopia which tried to assess the adoption rate of agricultural technologies by farm households based on survey data collected from different parts of Ethiopia.

As it is shown by table 2, most of the studies conducted in Ethiopia were concentrating on the adoption of fertilizer and improved seed varieties. However, regarding to the type of crops studied, while some of them tried to study the adoption of agricultural technologies on selected crops such as chickpea and maize (Asfaw et al. , 2011; Zeng et al., 2015; Verkaart et al., 2017; Tigist, 2017) other studies considered the adoption of technologies in either of the crops grown by farmers (Beshir et al., 2012; Berihun et.al, 2014; Gebregziabher et al., 2014; Abate et al., 2016; Husen et al., 2017) .

Studies indicated that the adoption status of households for improved agricultural technologies has shown tremendous change. In this regard Verkaart et.al (2017), found that the percentage of improved chickpea adopters in Ethiopia has increased over time. According to this study, there were only 31.2% adopters in 2006/07 while this rate has been increased to 63.0% and 79.0% in 2009/10 and 2013/14 respectively. In line with the above result, Asfaw et al. (2011) revealed that 32% of the farm households adopt improved seed variety of Chickpea.

From the existing studies done in Ethiopia, the adoption of fertilizers by farmers has increased over time. For instance, Beshir et al. (2012) and Berihun et al. (2014) have found the adoption rate at fertilizers at 17.8% and 26.67% respectively where as more recent studies such as Husen et al. (2017) and Tigist (2017) have got the adoption rate of 56.8% and 63% respectively.

Table 2 Summary of studies conducted on the rate of Agricultural Technology Adoption in Ethiopia

Author /s	Study Area	Type of adopted technology	Rate of Adoption
Asfaw et al. (2011)	Central highlands of the Ethiopia	improved Seed varieties of Chickpea	32%
Beshir et al. (2012)	North East Ethiopia	Fertilizer adoption in at least one of the crops	17.8%
Berihun et.al (2014)	Northern Ethiopia	Fertilizer adoption in at least one of the crops	26.67%
		Improved seed varieties in at least one of the crops	34.44%
Gebregziabher et al. (2014)	Four major Regions (Amhara, Oromia, SNNP and Tigray)	Motor Pumps adoption in at least one of the crops	33.5%
Zeng et al. (2015)	Four major Regions (Amhara, Oromia, SNNP and Tigray)	improved seed varieties of Maize	46.3%
Abate et al. (2016)	It covered all areas of Ethiopia	Fertilizer in at least one of the crops	85.5%
		Improved seed varieties in at least one of the crops	51.7%
Husen et al. (2017)	SNNP	fertilizers or improved seed varieties in at least one of the crops	56.8%
Verkaart et.al (2017)	Central highlands of the Ethiopia	Improved Seed varieties of Chickpea	79.0%
Tigist (2017)	Four Regions (Amhara, Oromia, SNNP and Tigray	Improved seed varieties of Wheat, Maize, Teff, Sorghum, and Barley	18%
		Fertilizer adoption in Wheat, Maize, Teff, Sorghum, and Barley	63%

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3. Determinants of Agricultural Technology Adoption in Ethiopia

The adoption of agricultural technologies depends on different demographic and socio-economic factors. In this section recent studies conducted on factors influencing adoption of agricultural technologies in Ethiopia are reviewed. Hence, the data they used, their method of estimation and results obtained are presented. For the purpose of convenience, the reviewed studies are presented chronologically.

Croppenstedt et al. (2003) studied on determinants of fertilizer adoption in Ethiopia based on a survey covered 6147 cereal households from four regions. By applying double-hurdle model, they found that access of fertilizer, availability of credit, household size; formal education and value-to-cost ratio are the major factors that affect households' decision for fertilizer adoption.

Dadi et al. (2004) studied on the duration analysis of technological adoption in Ethiopian Agriculture by using accelerated lifetime model. The estimated models suggest that economic incentives such as prices are appear to be the most important determinants for the speed of adopting new technologies followed by oxen ownership and infrastructural factors.

Admassie and Ayele (2010) conducted a study on adoption of improved technology in Ethiopia based on 1920 farm household heads drawn from four national regional states. The results of the logit and probit model identified that farm size and extension service affects technology adoption positively where as distance to market and age of the household head affects it negatively. Moreover, they employed tobit model to analyze factors influencing the intensity of fertilizer use and found that while farm size, family size, literacy and extension contact affect positively, age and distance affects intensity of fertilizer use negatively and significantly.

Yesuf and Kohlin (2008) employed probit model to examine the effect of market and institutional imperfections on technology adoption (fertilizer use and soil conservation) in Ethiopia based on survey data collected from 202 farm households in five districts of Amhara region. The study found that while household's decision to adopt fertilizer depends negatively on whether the same household adopts soil conservation, the reverse was not found significant. Moreover, access to credit, plot size, risk considerations, and rates-of-time preference, were significant factors influencing technology adoption decision.

Asfaw et al. (2011) examined the determinants of agricultural technology adoption and their impact on farmers' integration into output market in Ethiopia based on cross-section sample of 700 farmers. The Double-Hurdle model results show that knowledge of existing varieties, perception about the attributes of improved varieties, household wealth (livestock and land) and availability of active labor force are major determinants for adoption of improved technologies.

Beshir et al. (2012), by employing Double hurdle approach studied determinants of chemical fertilizer technology adoption in north eastern highlands of Ethiopia. The study found that distance from farmers' home to markets, Distance to input supply, Extension service access and credit supply affects the adoption of inorganic fertilizer.

A study by Berihun et al. (2014) has employed both probit model and OLS to identify factors influencing technology adoption and their impact on Farm Income based on cross-sectional study in Southern Tigray Zone of Northern Ethiopia. The result stated that sex, irrigation use, off-farm income, plot distance and distance to market affects adoption of chemical fertilizer whereas age, irrigation use, access to credit and distance to market were found as determinants of high yield variety in Ethiopia. Moreover, the OLS result revealed that agricultural technology adoption has a positive and significant effect on farm income by which adopters are better-offs than non-adopters.

Gebregziabher et al. (2014), using probit model found that gender, age, oxen ownership, access to extension, access to surface & ground water, social capital and region of residence influence farmers' decision of motor pump adoption in Ethiopia.

Zeng et al. (2015) studied the impacts of improved maize varieties on poverty in rural Ethiopia by using propensity score matching (PSM) and revealed that improved maize varieties have led to a 0.8–1.3 percentage drop of poverty headcount ratio and relative reductions of poverty depth and severity.

Abate et al. (2016) estimated the effect of Rural Finance on agricultural technology adoption in Ethiopia using 817 household survey data and a propensity-score-matching technique. The results suggest that access to institutional finance has a significant positive impact on both the adoption and extent of technology use. It revealed that in the absence of financial institutions, both adoption and application rates of fertilizer and modern seeds would have been significantly lower by 11% and 32%, respectively.

A study by Verkaart et al. (2017) done on welfare impacts of improved chickpea adoption in Ethiopia based on three years panel data from 606 randomly selected households by using double-hurdle model. The study reported that improved chickpea adoption significantly increases household income and reducing household poverty.

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Tigist (2017) studied productivity and welfare impact of technology adoption in Ethiopia based on survey data collected from 1500 rural households drawn from four regions. The estimation of endogenous treatment effect model indicate that there is positive and significant effect of improved technology adoption (HYVs and inorganic fertilizer) on the rural households' crop productivity and welfare (Real per capita consumption expenditure) in Ethiopia.

A study by Husen et al. (2017), employed probit model to analyzed the impact of social capital on Agricultural Technology Adoption among Ethiopian Farmers using socio-economic data of 398 farming households. The estimated probit model revealed that being members of *Jarsumma* (informal conflict resolution) increased the likelihood of soil and water conservation practices and productivity enhancing technologies such as fertilizers and improved high yielding seed varieties adoption by 12.87% and 17.8%, respectively. It also found that while members of *Iddir* (informal funeral group) were 18.2% more likely to adopt soil and water conservation practices, *Iddir* members were 12.8% less likely to adopt productivity enhancing technologies.

4. Conclusion

Literatures on the area observed the significant impact of modern agricultural technologies such as fertilizers, improved seeds, pesticides and irrigation for the growth of the agricultural productivity. This paper reviewed the rate of agricultural technology adoption and its determinants in Ethiopia based on secondary data collected from CSA and empirical studies conducted in the area. In Ethiopia, even though improvements have been observed, the use of agricultural technologies is appeared to be low. From the total crop area, on average nearly 50% and 20% of the land is covered by fertilizers and pesticides where as the area covered by improved seed and irrigation is less than 10% and nearly 1% respectively. Empirical studies on adoption of agricultural technologies in Ethiopia were concentrating on the adoption of fertilizer and improved seed varieties. However, the adoption rate of technologies by farm household is varied based on the type of technology and the time of study. Reviewed studies revealed that farm households were adopt more of chemical fertilizers than improved seeds and their adoption rate increases for more recent studies. Studies conducted on the determinants of agricultural technology adoption identified different variables depending on their study area and the type of technology they studied. However, in most of the studies variables such as accessibility of credit, farm size, distance from market, oxen ownership, and level education were found to be significant determinants for agricultural technology adoption in Ethiopia.

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