



# Technology Adoption and its Socio-Economic Correlates in Ethiopia: A Context-Level Approach

Dawit Yekoyesew<sup>1</sup> and Amare Bayissa<sup>2</sup>

<sup>1</sup>Addis Ababa University

<sup>2</sup>Arsi University

### ARTICLE INFO

#### Article history:

Received: 16 June 2017;

Received in revised form:  
6 October 2017;

Accepted: 16 October 2017;

#### Keywords

Socio-Economic,  
Correlate,  
Adoption,  
Technology,  
Context-Level,  
Approach,  
North Shoa,  
Zone,  
Ethiopia.

### ABSTRACT

Improved agricultural technologies are found to be important in improving the well-being of rural households in Ethiopia. However, the adoption of these technologies is low in the country. Thus, identifying factors that influences farmers' decisions to adopt in their geographical and social contexts is pertinent. The study was undertaken in three purposefully selected rural Kebeles of Tarmaber Woreda namely Koso-ber, Yitam-nakosta and Yizaba-na-woyin. Farm households categorized into worse-off/poor (41.5%), medium (52.2%) and better-off/rich (6.7%) based on such indicators as land size, livestock holdings (mainly oxen for plough), the number of times that a family feeds its members per day, housing conditions, land renting and/or sharecropping arrangement, household labour force availability, loan status, membership of cooperatives and ability to send children to school. Income loss, vulnerability to crop failure and asset depletion, alcoholism and social isolation are locally believed causes of poverty and extension input adoption. The survey result from cross-section sample of 125 farm households shows that educational status, availability of labour access to extension service, size of land holding, oxen possession, membership of cooperatives, and perceived distance of the market were found to be positive correlates of adoption of chemical fertilizers and improved seeds. The public services should reach poor households in remote area.

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### 1. Introduction

For most of rural households in Africa, agriculture is central to their livelihood. Similarly, in Ethiopia, where half of the population lives in poverty, agriculture is major means of livelihood. It is the base for industrial development and the means for overall economic development. To this end, the government has developed a strategy of "Agriculture Development Led Industrialization" (ADLI), which emphasizes improved productivity in smallholder agriculture and industrialization based on the use of domestic raw materials by adopting labor-intensive technologies.

Despite its key role as a leading sector for economic growth in Ethiopia, the agricultural sector over the years has performed poorly (Beyene Tadesse, 2004) and thus has been unable to produce sufficient amount of food to provide for the country's rapidly rising population. The poor performance of the sector is attributed to backwardness of the technology used in the production system and low rate of improved agricultural technologies adoption. This is because with the prevailing traditional agricultural technologies and farming practices it would be difficult to have more output from small farms. It is also characterized by traditional subsistence oriented farming, virtually small-scale, and entirely dependent on rainfall. More than 95 per cent of the country's agricultural output is generated by subsistence farmers who use traditional tools and farming practices (Beyene Tadesse, 2004).

It is noted that one of the ways to increase agricultural productivity is through the adoption of improved agricultural technologies (Doss 2003).

Adoption of modern agricultural technology is imperative to promote rural development and poverty reduction in Ethiopia. Without the development of the agricultural sector there would be fewer opportunities for reducing rural poverty in the country. Hence, the government of Ethiopia has increasingly sought to improve farmers' access to modern technologies and agricultural markets (Spielman 2007). However, despite the explicit efforts made by the government to promote agricultural innovation, evidence indicates that adoption rate of modern agricultural technologies in the country is very low (Kebede Yohannes et al. 1990). An agricultural extension service which fails to take local conditions into consideration (Abeje 2008) and lacks an understanding of the diverse agro- ecological and socio-economic environments can be considered at the root of the problem of this low level adoption of technology in the country.

Though studies (Grover and Antenh 2004) revealed the demographic and socio-economic factors affecting adoption of agricultural technologies at the household level in the country, identifying these factors with a clear understanding of the diverse agro- ecological and socio-economic environments where different social groups live has received limited attentions. This study, therefore, aimed at addressing this issue by looking at the experience of farm households in *Tarmaber<sup>1</sup> Woreda* of North Shoa regarding to adoption of improved seeds and chemical fertilizer.

<sup>1</sup> *Tarmaber Woreda (district)* is located in eastern edge of the Ethiopian highlands.

Since poverty is a multidimensional and socially and geographically configured (Mullen 1999b) assets and wellbeing vary along with time and across societies capturing local realities is imperative. Thus, in order to describe the characteristics of the poor across sub-social groups and explore the socio-economic and ecological constraints of the adoption of seeds and chemical fertilizers at household level peoples' perspectives were used.

## 2. Research Designs and Methods

In order to contextualize the factors in diverse agro-ecological zones sample households were purposefully selected from three traditional agro-climatic zones namely *Kola* (hot zone), *Woyina dega* (warm zone) and *Dega* (cold zone). Accordingly, *Koso-ber* from *Dega* (cold zone), *Yitam-na-kosta* from *Woyina dega* (warm zone) and *Yizaba-na-woyin* from *Kola* (hot zone).

Then, well-being rankings were conducted in these sampled *Kebeles* to identify indicators of poverty in the study area and to categorize sampled households into different socio-economic strata. These helped to capture variations in terms of asset possession across farm households and to examine the socio-economic factors responsible for lack of adoption of extension inputs. A community group of key informants from each *Kebele* were asked to propose lists of criteria defining different levels of well-being in the community. Farm households were stratified into such wealth ranks as poor, medium and better-off. Using stratified sampling design in each wealth rank households were also categorized in to female-headed and male-headed households. To see adoption status of farmers across social groups, a total of 125 households were randomly selected from *Koso-ber* (26), *Yitam-na-kosta* (21) and *Yizaba-na-woyin* (78) *Kebeles* using Probability Proportion to Size.

Focus group discussions were conducted with group of farmers in each selected rural *Kebele* the stratified groups to share their thoughts, feelings, attitudes and ideas on poverty and factors affecting use and non-use of extension inputs.

Survey in selected *Kebeles* was conducted using semi-structured questionnaire containing both open-ended and closed-ended questions after well-being rankings and focus group discussions. It allowed to identifying the profile of the rural households and their asset endowment position as well as correlate with adoption decision of farmers at household level.

To supplement the primary data such secondary sources of data as *Tarmaber Woreda* Agricultural and Rural Development offices annual report, Books, Periodicals, seminar papers, conference proceedings were reviewed.

In order to measure statistical significance of continuous and discrete variables (and independent and dependent variables), descriptive statistics such as percentages, frequencies, mean and standard deviations, T-test, Chi-square and Multiple Correlations were utilized with the help of Statistical Package for Social Sciences (SPSS) version 13.

## 3. Results and Discussions

### 3.1. Local Conceptions of Poverty: A Classification of Farm Households

Farm households were classified into worse-off/“*chegetegna*<sup>2</sup>”, medium and better-off based on indicators such as

<sup>2</sup> In *Yizaba-na-woyin* and *Yitam-na-kosta* *Kebeles* they have slightly different name which is “*mecheresha deha*” (completely poor). They have also categorized those who have nothing under “*minim yelelew menati deha*” or “*tsom adari*”.

land size, livestock holdings (mainly oxen for plough), the number of times that a family feeds its members per day, housing conditions (e.g. type of roof, other materials by which houses were constructed and number of huts), land renting and/or sharecropping arrangement, household labour force availability (hired-in or hired-out of labour by the household), loan status, membership of cooperatives and ability to send children to school.

#### 3.1.1. Worse-off/Poor Households

These are households (mainly female-headed) with no animals, mainly ox for farming activities. Lack of farming oxen made them to serve better-off farm households with their labour to get oxen in return. Having no oxen to plough the land at the time of rainy season created a problem in the production of crops of the season. They own land ranging from 0.25 to 0.375 hectare. They own small huts (“*dasasa gojjo*”) constructed using such as grass, stone, and sludge.

Female headed households of this category are mainly unable to send their children to school. Focus group informants noted that “*When we cannot find food to feed them twice a day, schooling is not possible to think about.*” They could not provide them with food and thus were forced to give them to better-off farm households where they have been exchanging their labour for food. Households in this category eat food which is low in content-“*injera*<sup>3</sup>” with “*chew*” (*salt*)” and sometimes dry (“*derek*”) “*injera*”). They borrow money from saving-and-loan association to buy food for consumption. While they couldn't pay back the money, households rent their land and also migrate to the neighboring *Kebele* for work. They hire-out of their labour to others in the community.

These households contain elderly farmers with no children to support them, women who were divorced or widowed and newly formed families with no land. Such households constitute 41.5 % of the total number of households.

#### 3.1.2. Medium Households

These are households with 1-2 oxen. They on average possess 0.5 hectare of land. In most cases, they plough their land using co-paring of oxen (“*mekenajo*”). Each farm household in this category own one house with corrugated iron and two booths (“*gojjo bet*”). They do not rent out their land and also they cultivate their own land. They do not have grazing land for their cattle. Many of them do not borrow money. They have partially accepted improved agricultural inputs in the sense that they use small amount of improve seeds and fertilizers below what is recommended. Such households constitute 52.2 % of the total number of households in the study area.

#### 3.1.3. Better-off/Rich Households

These households have more than two hectare of land. They have access to land through rent or contract or “purchase” of small plot of land. They possess more than three oxen, cows, and about 15-20 goats and 15-30 sheep. They also own animals such as horse, mules and donkeys. Each farm household under this category usually own more than three corrugated iron houses and big huts. Their children are likely to go to school.

Many of them engage in other income sources like trade, animal fattening etc. They usually manage meals three times a day. They lend money to others. Many of them also lend food to many rural poor during bad times.

<sup>3</sup> The thin round flat bread made from cereals on a large round flat clay pan.

These households also sell crops on the market after feeding members. They harvest 2-3 pile of crops (“yahel kimerr”) on their field. They could hire labour. As some extension workers said rich farmers often invite guests to their homes. Such households constitute 6.7 % of the total number of households in the study area.

### 3.2. Households' Status of Extension Inputs Utilization

#### 3.2.1. Improved Seed Adoption

The adopter categories across *Kebeles*, the non-adopters are greater than adopters in each *Kebele*. Between groups comparison of percentage revealed that worse-off/poor households and female farmers are not in a good position in their use of seeds. This may be attributed to differences in household asset possession.

1.1.2. The majority of farmers (41.2%) in *Yitam-na-kosta Kebele* reported lack of income as their reason for non-use. The case, however, was different in *Koso-ber* and *Yizaba-na-woyin Kebeles* where most farmers have reported unavailability of seeds in their *Kebeles* as a reason for non adoption. Some farmers believed that seeds performed poorly within local situation and are not good than locally preferred ones. Farmers reported that they have never received advice from extension workers. They stated that “*Development agents are not often available in our Kebele.*” One of the extension workers (key informants) noted that this can be attributed to unequal proportion of worker to farmers (i.e. one extension worker for 450 households).

#### 3.2.2 Chemical Fertilizers

Results indicate that while the majority of respondents, 100(80%), have experience in using chemical fertilizers, just 46(36.8%) adopters were found during the study period. It is apparent from this figure that more than half of the farmers discontinued to use recommended amount of chemical fertilizers. They noted that “*In the past, we were using chemical fertilizers and allotted land for demonstration plots. However, all of us discontinue to them.*”

This substantial reduction in use of chemical fertilizers could be attributed to lack of money to purchase from the market, the escalating price of chemical fertilizers, its inaccessibility in nearby area although they desire to buy, choose to use animal manure which is suitable for the local agricultural zone.

In addition, lack of sufficient amount of rainfall and even unpredictable rain (especially in *Yitam-na-kosta Kebele*) that is needed to use chemical fertilizers (especially urea) without which the crops would not grow discouraged farmers from using chemical fertilizers. Farm households' decision to use chemical fertilizers is therefore affected by such risk as fear of crop failure that they have experienced in the preceding years.

### 3.3. Nexus between Household Asset and Adoption of Agricultural Inputs

#### 3.3.1. Size of Landholding

The adopters owned more hectare of land than non-adopters. When land holding is disaggregated across male and female-headed households there was no statistical difference in their adoption with regard to possession of land between male and female-headed respondents ( $t=0.741$  with 123 degree of freedom).

The Pearson's correlation, however, shows that households with large plot of land have the probability to adopt. ( $r=0.331$ ,  $p=0.003$ ).

#### 3.3.2. Oxen Possession

The “possession of livestock can facilitate households” (Abeje 2008: 14) access to extension inputs” in Ethiopia.

Oxen ownership is a principal factor that influences farmers' access to fertilizers. It serves as collateral to access to credit and fertilizer loan. Households with more oxen may have access to fertilizers loan than household with no or small number of oxen. Group interview with farmers also confirmed that shortage of oxen means poor land preparation and failure to plant at the right time, and thus discouraging farmers from buying fertilizers.

#### 3.3.3. Income Status

Group of farmers from *Yitam-na-kosta* noted declining incomes due to low return from agriculture and high prices of agricultural inputs like fertilizers were the main issue for many farmers in the study site. In *Koso-ber* they also noted that poor households cultivate less than 0.5 hectare and spend their farm income gained from annual based agricultural produce to expenses related to family members mainly children. Lack of money to purchase agricultural inputs becomes more intensified among those who have no other sources of income outside agriculture. Accordingly, an absence of diversification of sources of income through engaging in non-farm activities is an outlined factor for being incapable to get income incurred to improve their land.

Lack of access to credit constrains farmers from adopting agricultural technologies (Doss 2003). But, a simple measure of whether farmers have access to credit is not enough since ownership of land and oxen is often thought to be a prerequisite for obtaining credit and to participate in credit and fertilizer loan schemes in Ethiopia (Abeje 2008).

The multiple correlations was run to investigate the relation between access to credit and amount of chemical fertilizers used after controlling for the effect of farm size and number of oxen. The result of Table 1 below shows that these variables accounted for about 14 percent ( $R^2=0.14$ ) of variation in amount of chemical fertilizers used.

**Table 1: Multiple Correlation Result for Some Independent Variables and Adoption of Chemical fertilizers**

Independent Variables	Unstandardized coefficient		Standardized coefficients		
	B	Std.Error	Beta-Weight	t-Value	p
(constant)	19.916	14.537		1.370	0.175
Fram Size	25.008	9.593	0.2888	2.607	0.011
Number of Oxen	2.760	4.066	0.074	0.679	0.499
Access to Credit	-8.001	5.866	-0.151	-1.364	0.177

Note:  $F=4.057$ ,  $p=0.010$ ,  $df=3$  and  $76$ ,  $R=0.374$  (Adjusted  $R^2=0.140$ )

The beta-weight suggests that land size was important independent variable than number of oxen and access to credit to use chemical fertilizers.

A strategy to know how farmers diversify their sources of income and to improve their ability to make alternative livelihood choices available in their locality is pertinent.

#### 3.3.4. Access to Extension Services

Extension services are decisive for farmers to gain information about new agricultural technologies. Access to extension inputs can contribute significantly to enhance the productivity of farmers. Since the rural *Kebeles* are far away from the *Woreda's* town (*Debre-sina*) and from towns of adjacent *Woredas*, households do not have access to information about agricultural inputs. Many of them are far from where best practices on agriculture are available. Comparing households in *Asfachew* and *Armaniya* (these are *Kebeles* along the main transport line and near to urban

centers *Debre-sina* and *Shewarobit*) it is not easy for farmers *Yizaba-na-woyin* to exchange information on agricultural related issues with the neighboring farmers.

Extension workers spend less time performing their advisory roles in the remote areas. Instead, they have been visiting repeatedly the nearby households and exerted their efforts in these areas since they are accessible through vehicles. The difference means of the categories of extension contact (i.e. never, sometimes and always) revealed that farmers who have received information frequently have high probability of adopting seeds and chemical fertilizers than those who have never and sometimes got information from development agents.

Visiting successful farmers' fields and adoption have positive correlation. Discussion with adopters also showed that many of them have adopted seeds and chemical fertilizers after they have visited a demonstration on other farmers' plots. Moreover, interviews with farmers confirm that lack of knowledge about how to use it as the factor for non-use of these inputs.

### 3.3.5. Perception of Distance of the Market

The evidence from focus group discussion and visual inspection confirms that poor households have no access to road. In *Yizaba-na-woyin* although they produce crops and other vegetables for the market, it would be difficult for farmers to transport it to the neighboring towns (*Debre-sina*, *Armaniya* and *Shewarobit*). They explained that "Bad condition of the roads does not allow trucks to come to our Kebele. This makes it difficult to sell our harvest."

Although just market accessibility may not be a good measure since market failure may occur in the provision of the desired inputs, farmers who perceived the market distance as very far did not go to adopt extension inputs ( $\chi^2=12.911$ ,  $df=3$ ,  $p=0.0005$ ).

### 3.3.6. Vulnerable to Risks

A household can become poorer through having to deal with unforeseen circumstances such as crop failure, accident, sickness, funerals or flooding (Chambers 1983). Vulnerability to bad weather conditions and pests is common for households in *Yitam-na-kosta* and *Koso-ber Kebeles*. Unpredictable natural hazards have affected many farmers. In *Yizaba-na-woyin*, for instance, many households face crop failure as a result of landslides. Except some better-off households who could withstand with this shock, many households in this Kebele, particularly in "Yizaba", "Ayna maryam", "Debr", "Korontos", "Mamid-amba" and "Zurit-amba" gotts, which already are resource-stressed areas diversely affected. Access to the area has been disrupted due to damage to feeder roads. Households were left with nothing with grazing land for their cattle. The affected communities have been displaced and moved to *Sina* and *Armaniya*.

### 3.3.7. Availability of Labour Power

Since farming is a labour intensive activity in rural Ethiopia, it becomes difficult without adequate labour force at household level. Rural communities, therefore, have local system of labour exchange arrangements. The majority of adopters (82.8%) and non-adopter (69.6%) used community labour arrangements (i.e. *däbo* and *wänfäl*). Hired labour covered the labour power of 17.2 percent (5) and 21.7 percent (10) of adopters and non adopters respectively. This shows that non-adopters used more hired labour. A local labour arrangement called *Lammäna* (i.e. imploring) was the source of labour for 8.7 percent (4) of non-adopters. In *Yizaba-na-woyin* and *Koso-ber* hard working and labour-rich households are more likely than labour-poor households to

adopt seeds and chemical fertilizers which require more intensive labour.

Female-headed households often rent-out a small tract of land to farm as sharecropper because they are unable to farm their land since they lack male labour power. As women explained, "We do not start to do farming on our land. If we have started to plough it, we would not able to go through all stages of farming activities successfully. We are saying this since our harvest was adversely affected in the last (2009) "belg" season". Since they received half of the (50%) farm output, they could not fulfill the food demand of the households and face food shortage in the next pre-harvest season.

### 3.3.8. Effect of Alcoholism

Physical weakness reduces the earning capacity of household members. Households are unable to cultivate larger areas or to work longer hours on the farm. Household head illness during critical farm operation season creates problems to some poor households. Alcoholism is one of the cause for this the problem. It weakens their ability to effectively work on their farm and thus they choose to rent their land to other farmers.

### 3.3.9. Memberships of Cooperatives and Village-insurance Schemes

Interpersonal relations and their networks as being members of cooperatives and village-insurance schemes facilitate diffusion of information (Rogers 1995) regarding to chemical fertilizer and improved seeds ( $\chi^2 =10.544$ ,  $df=4$ ,  $p=0.032$ ).

### 3.3.10. Education Achievement

Education can facilitate awareness and affect farmers' use of agricultural inputs. It enables farmers' to access information needed to make a decision to use an innovation and helps them to understand easily instructions given for them about new technologies. Adoption status increased when the farmers moved from inability to read and write to able to read and write through primary school to secondary school and so forth ( $\chi^2 =7.088$  with 5 degree of freedom, 0.0012 alpha and +0.167 gamma value).

### Conclusions

In order to enhance agricultural productivity and ensure food security at farm household level in Ethiopia, the government has been disseminating improved agricultural inputs. However, adoption of these inputs remains very low among small farmers.

In order to identify the potential factors responsible for non-use of extension inputs understanding local realities is relevant. To this end, using well-being rankings method farm households were categorized into worse-off/poor, medium and better-off/rich wealth rank categories based on land size, livestock holdings (mainly oxen for ploughing), the number of times that a family feeds its members per day, housing conditions (e.g. type of roof, other materials by which houses were constructed and number of huts), land renting and/or sharecropping arrangement, household labour force availability (hired-in or hired-out of labour by the household), loan status, membership of cooperatives and ability to send children to school. Accordingly, out of 2120 farm households, worse-off/poor, medium and better-off/rich households accounted for 41.5%, 52.2% and 6.7% respectively.

Based on farmers own perception income loss, vulnerability to crop losses and asset depletion; physical weakness which lessened the working capacity of farmers;

social isolation in terms of lack of access to market (market constraints), information about improved agricultural inputs and health services, road are some of the causes of poverty and constraints of adoption of improved seeds and chemical fertilizer. Big population size cause serious pressure on land leads to fragmentation of land and therefore low agricultural productivity as it results in short fallow period.

Households with large members are striving to get food for consumption instead of allocating money for buying extension inputs. The adoption status of farmers will increase as they achieve the highest education (grade). Worse-off, medium and female headed households have low educational achievement and more likely non-users of technologies. This calls for the need to emphasis strengthening educational level across different wealth ranks.

Land holding is crucial to get loan for chemical fertilizers. Households having more oxen were also more likely to use fertilizers. Membership of cooperatives and of village-insurance schemes influences adoption decision of farmers.

Farmers who have received information frequently from extension workers were found to be adopters of improved seeds and chemical fertilizers. Visiting successful farmers' field and receiving trainings influences use of improved seeds and chemical fertilizers. After controlling the effect of two most important prerequisites for loan (i.e. land and oxen), land size found to be decisive factor for access to credit. Farmers mainly fear to take loan from local lenders and saving-and-credit institutions since they would expect crop yield failure to pay back as per the agreement. Perceiving market distance as far also affects adoption of extension inputs.

#### Acknowledgments

We would like first to express our appreciation to *Tarmaber Woreda* Agricultural and Rural Development Office for facilitating the fieldwork and providing us with the required information. We would also like to thank those farmers who participated in the research.

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