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Review on factors affecting adoption of improved maize seed technology in Ethiopia

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Abstract

Maize is a multipurpose cereal crop that provides food for human, feed for animals and raw material for the industries. In terms of production and yield maize is the most important crop in the country. But it is generally constrained by low productivity and lack of productivity due to inputs such as high yielding variety seeds and fertilizers poor extension services, shortage of traction power and declining fertility of farmlands. To solve these problems large numbers of technologies have been generated. However, the adoption of these technologies by small holder farmer is limited. This problem seems from different factors.

Among these factors education level, extension service, credit access, distance from market, availability of improved maize seed, house hold size, off-farm income, farm size and farm This seminar has been done to review the factors affecting adoption of improved maize seed technology in Ethiopia. The objective of this seminar is to review the factors affecting adoption of improved maize seed technology and farmers' productivity in Ethiopia and to distribute improved maize seed for the society.

Keywords: Maize seed, affecting adoption, distribute improved

1. Introduction

Maize (*Zea mays* L.) is a multipurpose cereal crop that provides food for human, feed for animals especially poultry and livestock and raw material for the industries. It is the third most important cereal crop after wheat and rice. Maize is staple food in Ethiopia and can be prepared as soft pancake (Injera), porridge (Genfo), roasted (kolo), boiled (nifro) or brewed to produce an alcoholic beverage (Tela) (Farhad *et al.*, 2012).

In terms of production and yield maize is the most important in Ethiopia. The majority maize production (94%) occurs during the long rainy season (Meher, June to September) the Sidama and North Omo zones account for approximately 32% and 19% respectively of maize produced in southern Ethiopia, in this area maize is most important staple crop in terms of cultivated area production and yield. The potential for increased yield is grater where improved varieties and optimum agronomic practice are used (Getahun *et.al*, 2010) [12].

Several studies attempt to evaluate the adoption of improved technologies in Ethiopia. Identification of factors by itself is the challenging academic exercise however; depends to a large extent on their ability to attract the attention of development practitioners and policy makers in effect. If these factors are to be of practical importance, development practitioners and policy makers need to be informed about the likelihood of the effectiveness of the alternative strategies that could be used (Bedassa, 2011) [4].

In Ethiopia attempt have been made to defuse new agricultural technologies since end of 1960 when the Chilalo agricultural development unit (CADU) was established in Chilalo district. New technologies where later expand to areas out the Chilalo Agricultural Development

Unit mandate area by the extension and project implementation department (EPID) of the minister of agriculture (MOA), through a minimum package program in (Tesfaye *et al.*, 2011) [23, 24]. Since then considerable efforts have been made to extend the new technology like fertilizers, improved varieties, herbicides, insecticides and other improved agronomic practice. Even though many efforts are made improved maize seed technology has not been widely adopted by farmers (Mulugeta, 2012).

Maize & other cereal farms in the country are generally constrained by low labor productivity and lack of productivity augmenting in puts such as high yielding variety seeds and fertilizers poor extension services, Shortage of traction power and declining fertility of farmlands are also among the main problems. One feasible alternative through which the lively hood of these farmers could be improved is by adopting improved maize seed (Mulugeta, 2012).

However, high yielding improved maize variety seeds cannot be purchased or sold in competitive markets in Ethiopia yet with institutionally rationed supply of seeds, extension advice and both free market and government base supply of complementary packages such as fertilizers and pesticides, the number of small scale farmers adopting high yielding variety (HYV) maize technology in Ethiopia is rapidly growing based on the premise that achieving substantial productivity increase requires giving farmers appropriate extension messages and complementary institutional arrangements (Bedassa, 2011) [4].

Different agricultural extension programs that strive to achieve this end have been implemented over the past two and half decades all the programs have involved the distribution of modern in puts such as fertilizers, improved

seed and related technology packages however the scale and organization of institutional arrangements, the approach and emphasis were different from program to program. Thus, this review identified the constraints and the given solution to adopt improved maize seed technology packages in Ethiopian context.

1.2. Objective

1.2.1. General objective

- To Review on factors affecting adoption of improved maize seed Technology

1.2.2 Specific objective

- To identify factors constrained improved maize seed technology packages
- To evaluate and identify the obtained results from previous research works

2. Literature Review

2.1. Importance of the Maize Crop

Maize is cultivated in almost all countries, occupying an area of approximately 160 million hectares (Silva *et al.*, 2017). In nutritional terms, maize has a carbohydrate-rich composition, mainly in the form of starch, and also has proteins, lipids, vitamins and minerals (Oliveira *et al.*, 2014). One important feature is that grains can be directly consumed, without the need for processing to remove the hull as it is done with other cereals, such as rice and wheat. In sub-Saharan Africa, maize is the most important agricultural species, both for being the most cultivated and produced in quantitative terms and for being the one which supplies 40 to 50% of the calories and proteins consumed in Malawi, Zimbabwe and Zambia (Prasanna, 2012; Cairns *et al.*, 2013).

In the production systems of commercial plantations, there is a greater economic investment, aiming at obtaining higher yields with higher level of management, through the chemical control of insects and diseases, greater application of fertilizers, use of irrigation and seeds of hybrid cultivars (Argenta *et al.*, 2003). Alternatively, it is also possible to use seeds of the intervarietal hybrids of maize (hybrids of F2 maize populations), and open pollinated varieties (or cultivars) (OPV), which are obtained by free pollination between maize plants. Therefore, they are highly heterozygous and heterogeneous, with the characteristic of having greater production stability and genetic variability (Fritsche-Neto & Mõro, 2015).

The wide adaptability of the maize crop and the potential to produce more calories and food per area of land cultivated than all major cereals grown in Ethiopia were important factors in considering maize as part of the national food security strategy, including its inclusion under the government-led intensive agricultural extension program. With increased production driving market prices down, maize became more affordable (e.g., relative to other staples such as teff and wheat) to rural and urban consumers. It is now increasingly used both separately as well as in mixed flour with other more expensive cereals in traditional Ethiopian diets. Maize is the most important staple in terms of calorie intake in rural Ethiopia (Abate *et al.*, 2015) ^[1].

2.1. Stage of Technology Adoption

2.1.1. The Process of Adoption

The adoption is a decision-making process, in which an individual goes through a number of mental stages before making a final decision to adopt an innovation. Decision-making process is the process through which an individual pass from first knowledge of an innovation, to forming an attitude toward an innovation, to a decision to adopt or reject, to implementation of new idea, and to confirmation of the decision (Roger and Shoemakers, 1971). The adoption or rejection of an innovation is the consequence of diffusion of an innovation.

Diffusion is a process by which new ideas are communicated to the members of a social system (Roger and Shoemakers, 1971). An innovation is an idea, method or object which is regarded as a new by an individual, but which is not always the result of recent research (Van den Ban, 1998). Diffusion and adoption are thus closely interrelated even though they are conceptually distinct (Dasgupta, 2009) ^[8]. Not all innovations diffuse at the same rate. The differences in the diffusion rates of innovations in a community can be largely explained by the differences in the traits of innovation, as perceived by potential adopters such as: relative advantage, compatibility, complexity, trial ability and observability (Dasgupta, (2009) ^[8].

According to Dasgupta (2009) ^[8], adopters have a high rate of literacy and higher level of formal education, operate large sized holdings, own the land they operate, have a relatively high income and economic status, are commercial in farming operation, have relatively high level of extension contact, and belong to upper socio-economic status categories. On the other hand, non-adopters have a low rate of literacy and level of formal education, operate smallholdings, are mostly small and marginal farmers, belong to low income group, have a low level of socio-economic status categories.

2.2. Classification of stage of Technology Adoption

Christensen's R (2008) ^[7] classify stage of technology adoption as follows:

Stage 1. Awareness: when someone aware that technology exists but have not used it, perhaps he or she might be even avoiding it and anxious about the prospect of using technology.

Stage 2. Learning the process: someone currently trying to learn basis.

Stage 3. Understanding & application process: when someone beginning to understand the process of using the technology & can think of specific task in which it might be useful.

Stage 4. Familiarity & confidence: someone gaining a sense of confidence in using technology for specific task and starting to feel comfortable in using technology.

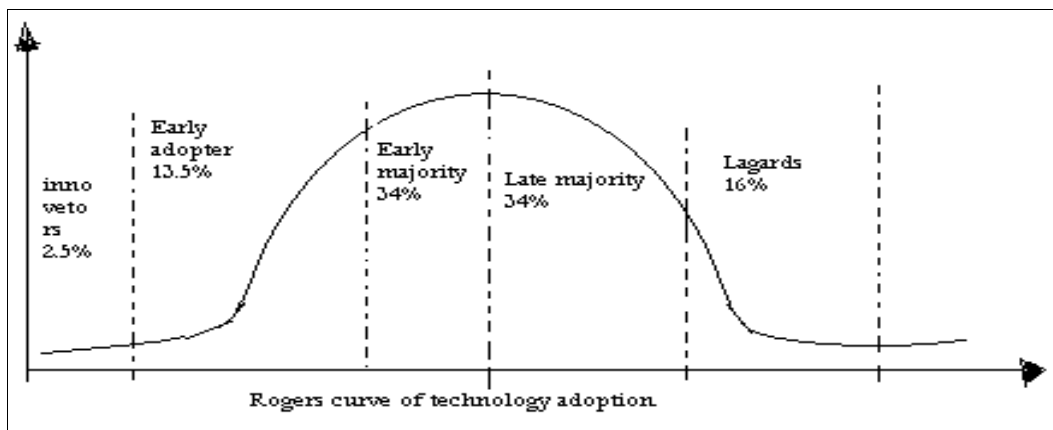
Stage 5. Adoption to other Context: someone thinks about the technology and no longer concerned about it as a technology. he or she use many applications & as an instructional aid.

Stage6. Creative application to new context: someone apply what he or she know about technology in the class room, able to use it as instructional to &integration into the curriculum.

2.3 Model of Technology Adoption

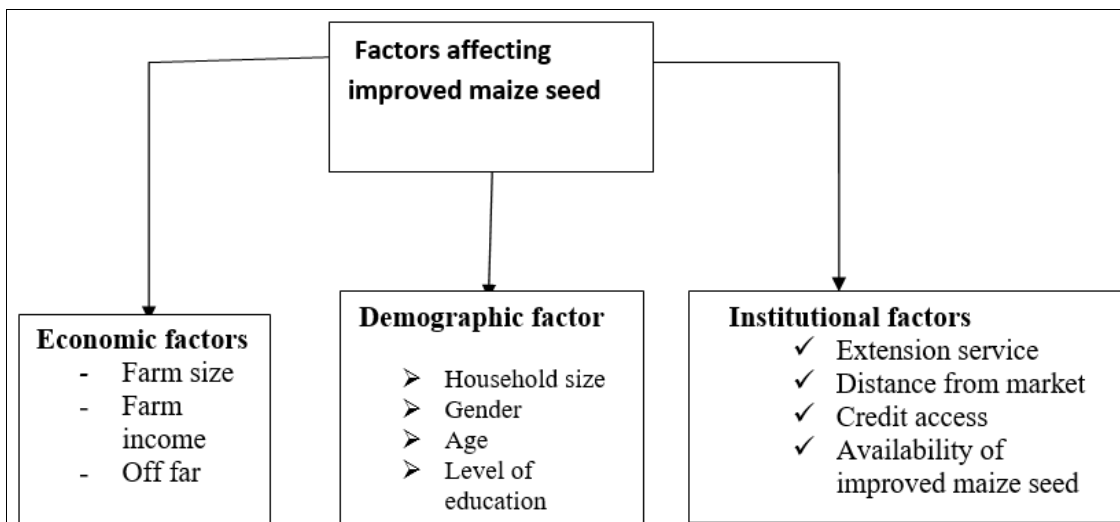
Rogers model for the adoption &diffusion of innovation:
The innovation adoption curve of Rogers is a model that classifies adopters of innovation to various categories based on idea that certain individuals are inevitably more open to adaptation than others it is also referred as multi step flow theory of diffusion of innovations theory.

1. Innovator: brave people, pulling the change innovators are very important communication
2. Early adopters: respectable people, opinion leaders, try out new ideas but in a careful way
3. Early majority: thoughtful people, careful but accepting change more quickly than the average
4. Late majorities: skeptic people will use new ideas/ product only the majority is using it
5. Laggards: traditional people, caring for the old way, are critical towards new ideas &will only accept it if the new idea has been mainstreams.



Source: (Tesfaye, 2011) [23, 24].

Fig 1: Roggers model for diffusion adoption of technology.



Sources; (Bedassa, 2011) [4].

Fig 2: Different factors that affect adoption of improved maize seed

2.4. Factors Affecting Improved Maize Adoption in Ethiopia

There are different factors that affect adoption of improved maize seed, these factors can be categorized in to three main groups.

2.4.1 Institutional factors

Institutional factors are also having important role in influencing the behaviors of farmers contact in adoption of improved technologies. Institutional factors like frequent extension contact is positively related to the adoption decision of farmers (Habtemariam, 2014, and Kansana *et*

al., 1996) [13, 14] in their study reported that the availability of reliable information sources will enhance communication process and had significant associations with adoption of improved technologies. (Tesfaye *et al.*, 2011) [23, 24]. reported that access to credit had a significant and positive influence on the adoption of improved technologies.

The study conducted by (Rahmeto, 2013) on adoption of improved maize technology has shown significant relationship to nearest market distance. However, (Shivani *et al.*, 2010) reported that the distance to market is negatively related to maize adoption. Participation in extension training will enable farmers to get more

information and improve their understanding about the available packages, which may intern leads to a change in their knowledge, attitude and behavior. According to (Tesfaye *et al.*, 2011) ^[23, 24], attendance of agricultural training is positively and significantly related to the adoption of improved maize technologies.

1. **Extension service:** it was hypothesized that contact with extension agent (development agent) will increase farmers' livelihood of adopting improved maize seed. It is measured as the number of contacts between the extension agent and the farmer (Mulugeta, 2005) explained that extension service is measure of number of visits per month by the extension worker to a farmer during the cropping season. It is positively and significantly influenced the adoption and intensity of use of improved maize seed. each additional by the extension agent to farmer increased the probability of adoption of improved maize seed and also increased the number of hectares of land planted with improved seed and the number of users.
2. **Distance the nearest market:** Distance to the nearest input market is another factor which has a negative significant influence on the extent of adoption of the farmers. It was hypothesized that those farmers who live in remote area are reluctant to adopt improved seed. This is possibly because they have limited access to modern agricultural inputs and market information (Tesfaye, 2011) ^[23, 24].
3. **Access to credit:** the provision of micro credit to farmers is seen as effective strategies for promoting the adoption of improved technologies. it is be lived that access to credit promotes the adoption of technology through the relation of the liquidity constraints as well as through boosting of house hold risk bearing ability with the option of borrowing. A house hold can do away with risk reducing but in efficient income diversification and concentrate more on risky but efficient investment and credit constraint are responsible for the low adoption of hybrid maize seed due to its requirement for costly seed (Eswaran and Kiowa, 2010) ^[10].
4. **Availability of maize seed:** availability of maize seed at the right time and the required quantity has the expected positive and significance influence on adoption and level of use of improved maize seed. More over provision of improved maize seed increases the number of hectares planted with improved variety of maize and users of improved seed. Ethiopia in general about the supply of improved seed in short supplies and hence adoption becomes a question of provision of the recommended quantity and problem of timely provision of maize seed (Alene, 2010) ^[2].

2.4.2. Personal and demographic factors

These factors are the most common household characteristics which are mostly related with farmers'

adoption behavior. These includes Ages, sex, education, farming experience have reviewed by (Shivani *et al.*, 2010).

1. **Farming Experience:** Habtemariam, (2014) ^[13] found that the most efficient farmers appear to have less farming experience than the least efficient once. More experience is negatively related to adoption at older age. The result of (Chilot *et al.*, 2011) ^[6] also indicated that farming experience does not matter in the adoption of improved wheat and coffee technologies.
2. **Household size:** it is the number of persons lived in one house. Larger house hold will be able to provide the labor that might be required by improved maize seed. This house hold size would be expected to increase the probability of adoption (Getahun *et al.*, 2010) ^[12].
3. **Level of education:** education level of farmer is a factor that the literature frequently relates to greater rates of adoption of new technology. Education level is the years of schooling of farmers, participation in formal training. Schooling increases the probability of adoption. a farmer who has more years of education is more likely to adopt improved maize seed than those who have never been to school (Tesfeye, 2011). The more house hold head is expected to be more efficient to understand and obtain new technology in shorter period of time than un educated people. education enhance farm productivity directly by improving quality of labor, to help farmers master new information and develop new skill by increasing the ability to adjust instability of situation and though this increase the propensity to successful adopt innovation. One can conclude that adoption of improved technology is directly influenced by the level of education of the farmer (Asfaw, 2014) ^[3].
4. **Age of the farmer:** the age of farmer can generate or erode confidence in other words with age a farmer can became more or less risk averse to new technology. It is hypothesized that a farmer age can increase or decrease the probability of adopting technology. Younger farmer is more knowledgeable and are likely to bear risk due to longer planning horizon, older farmers will be in opposition to experience much with their traditional farming practice and expected to be less responsive to newly introduced agricultural technology. So the age has negative influence on the probability of adoption (Million &Belay, 2014) ^[16].
5. **Gender of a house hold head:** female or male headed house hold can have different adoption rate. This variable can both positively or negatively affect the adoption rate (Getahun *et al.*, 2010) ^[12].

Table 1: Demographic factors of maize farmers in the regions of Ethiopia

Characteristics	Adopters	SD	Non-adopters	SD	t-statistic
	Mean		Mean		
Age of head of household	42.33	13.32	42.00	13.40	0.464 NS
Level of education	2.46	3.26	1.53	2.59	4.892***
Farm experience(own farm)	20.3	12.55	20.21	13.2	0.85NS
Family size under 14 years	7.30	3.10	6.30	2.70	5.546***
Children under 14 years	3.31	1.90	2.85	1.82	3.848**
Adult male,15_60	1.98	1.27	1.74	1.19	3.150***
Adult female ,15_60	1.86	1.22	1.56	1.08	4.115***
Dependent male and female 61 years and above	0.16	0.43	0.13	0.38	1.016NS
Level of education	N	%	N	%	X ² Statistic
Illiterate	391	35.0	175	52.0	35.422***
Primary school	253	23.0	61	19.0	
Junior secondary	64	6.0	9	3.0	
Secondary school	96	9.0	15	4.0	

Source: (Tsfaye, 2011) [23, 24].

2.4.3. Economic factors

Economic related factors such as farm size, off- farm activities, live stock ownership influence farmers' adoption behavior. Concerning farm size, the findings of (Nkonya *et al.*, 2005) reported that farm size exerts a positive influence on adoption of improved technologies. Contrary to this study, (Rahimeto, 2017) were reported that land holding was not significant in adoption of improved maize technology package. Off-farm and non-farm activities are the other important activities through which rural households get additional income. The income obtained from such activities helps farmers to purchase farm inputs. Review of some of the past empirical studies shows that the findings regarding the influence of off-farm/ non-farm income on adoption vary from one study to the other. However, majority of the studies reported positive contribution of off-farm and non-farm income to households' adoption of improved agricultural technologies.

1. Off-farm income: it is generated when a farmer or other family member works off on the farm, there by generating income for the family. it is also referred to

as pluriactivity. off farm income is direct linked with part time farming, it refers to the portion of farm house hold income obtained off the farm (non-farm) including wages and salary and interest income earned by farm family. A farmer annual off-income positively increase the adoption of improved maize seed technology (Tsfaye, 2011) [23, 24].

2. Farm income: it is the income of farmer gained annually. The farm income has influence on the adoption of improved maize seed; it enables a farmer to buy improved maize seed and other new technology (Asfaw, 2014) [3].

3. Farm size: it is the average size of farm land owned by farmer. Farm size an indicator of wealth and perhaps a proxy for social status and influence within a community. It is positively associated with the decision to adopt improved maize technology (Getahun *et al.*, 2010) [12].

Table 2: Economic factors of maize farmers in the regions of Ethiopia

Characteristics	Adopters			Non-adopters			
	N	Mean	SD	N	Mean	SD	t-statistic
Total Farm Size	1104	2.04	1.54	339	1.42	1.23	6.753 ***
Cultivated Land	1101	1.69	1.20	392	1.27	1.13	5.828***
Area of The Maize	1120	0.91	0.85	349	0.66	0.51	5.019***
Hire Seasonal Labor	N	%	N	%	X ² statistic 22.686**		
Yes	324	29.5	55	16.4			
No	776	70.5	281	83.6			
Use Community Labor for Farm Operations							
Yes	891	81.4	262	77.3	2.740*		
No	204	18.6	77	22.7			

Source; (Shiferaw, 2011)

2.5. Adoption of Technology and Farmer Productivity

Agricultural productivity increases one of the desired out comes from sensible food security & agricultural policies. increased productivity might lead to improved welfare of rural populations through several pathways .first increased productivity leads to higher food availability at the house hold level second increased food availability leads to lower

price of Agricultural products and higher real wage to the benefit of poor net buyers and wage laborers respectively .third a well performing agricultural sector has important economic multiplier effect on vibrancy of the of off-farm rural economy (Chencho, *et, al.*, 2011) [5]. Productivity improving agricultural technology reduces poverty by increasing rural agricultural income, reducing

food price, facilitating the growth of non-farm sector, by stimulating the transition from low productivity subsistence agriculture to high productivity agro-industrial economy.

The potential for poverty reduction through the above transmission mechanisms depend on the extent to which agricultural productivity can be increased. Agricultural innovation can have both direct and indirect effects on poverty. The direct effects of the technological innovation on poverty reduction are those productivity benefits enjoyed by farmers who actually adopt the innovation, the benefits typically manifest themselves in form of higher farm profits. The indirect effects productivity induced benefits passed on to other by the innovating farmers. These may comprise lower food price, higher non-farm employment level, increases in consumption for all farmer. all of these effects dominantly depends largely on the speed with which farmers adopt new technology and on whether or not the affected house hold is net food buys or sellers (Dereje, 2006) [9].

3. Summary and Conclusion

Maize is a multipurpose cereal crop that provides food for human, feed for animals and raw material for the industries. In terms of production and yield maize is the most important in crop in Ethiopia. But it is generally constrained by low productivity and lack of productivity due to inputs such as high yielding variety seeds and fertilizers poor extension services, Shortage of traction power and declining fertility of farmlands.

To solve these problems large numbers of technologies have been generated; however, the adoption of these technologies by small holder farmer is limited by many factors. These factors can be categorized in to three main groups. These are institutional factors like extension service, distance from market, availability of credit service and availability of improved maize seed. Economic factors like farm size, farm income and off-farm income and demographic factor like house hold size, Level of education, age and gender can affect adoption of improved maize seed technology positively or negatively. Among these factors education level, extension service, credit access, distance from market, availability of improved maize seed, house hold size, off-farm income, farm size and farm income can affect adoption of improved maize seed technology positively; whereas, affect adoption of technology and gender can have both negative or positive impact on adoption of improved maize seed technology.

4. Recommendations

To increase the rate of adoption of improved maize technology the following measure must have been taken by both governmental and non-government organizations. Due attention should be given to education of farmer and extension service. Obstacle on shortage of income might be overcome if government and non-government organization provide farmers with credit when they need. Due attention should be given to the participation of farmers in agricultural information. Finally, attention should be given to the participation of farmers on new technology to promote adoption through sharing of knowledge by strengthening the frequency of extension contact.

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