ADOPTION AND INTENSITY OF USE OF IMPROVED SWEET POTATO VARIETIES IN BOLOSO SORE WOREDA, SOUTHERN ETHIOPIA

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ABSTRACT: *This paper examines the adoption and factors affecting intensity of adoption of improved sweet potato varieties in Boloso Sore woreda. Data were collected from 120 randomly selected farmers through a structured questionnaire. Tobit model was used to identify factors affecting adoption and intensity of use of improved sweet potato varieties. Results from model analysis show that farm size, extension contact, farming experience, livestock ownership, farmers' perception of yield, maturity period, establishment performance of improved varieties, and distance from research centre to the farm influence adoption and intensity of use of improved sweet potato varieties. The results suggest that research and extension activities should be strengthened with due attention to improve yield potential, shorten maturity period, and better establishment performance of the crop.*

Key words: Adoption, farming system, improved variety, productivity, sweet potato

INTRODUCTION

Like many less developed countries, Ethiopia has difficulty feeding its rapidly growing population. Agriculture is the country's most important economic activity in terms of providing food, income, employment and foreign exchange. Agriculture accounts for about 45.5% GDP, 85% of employment, and 94% of Ethiopia's export (NBE, 2002). However, productivity on smallholder farms, which dominate agricultural production in the country, is low and the low agricultural productivity at least partly explains why food availability per capita in Ethiopia is one of the lowest in the world. Technologies play critical role in raising agricultural productivity and thereby contribute in improving the standard of living of smallholder farmers and the population as a whole. Over the past years various attempts have been made to raise agricultural productivity by extending new technologies to smallholder farmers through various extension and research outreach programs. Yet, despite these efforts, adoption rates remain low. Identification of factors contributing to low rate of adoption is needed to come up with possible options that would improve the level of adoption of technologies and thereby improve productivity. The study was conducted in highly populated areas of the Southern Nations, Nationalities and Peoples' Region (SNNPR). In the area, there is an increasing demand for food because of rapid population growth. Land per household is low and declines over time. Sweet potato is one of the highly productive crops and suitable to meet challenge of increasing food demand. Application of modern technologies and

improved management practices greatly enhance productivity of sweet potato. However, information on the extent of adoption and factors affecting adoption and intensity of use of improved sweet potato varieties is scarce. The objectives of this study are to examine the rate and the potential factors, which affect the adoption and intensity of use of improved sweet potato varieties. The study also aims at describing the farming systems in which improved varieties are introduced and adopted in the Boloso Sore woreda, Wolaita zone.

OVERVIEW OF SWEET POTATO PRODUCTION IN ETHIOPIA

Sweet potato is widely grown nearly in all countries south of the Sahara; the number of African countries producing the crop exceeds that of any another continent (Scott et al. 1992). Its cultivation is more intensive, particularly in the highlands of east and central Africa, in a diverse set of environments located between 800 m and 1900 m above sea level (CIP, 1991).

The exact time of introduction of sweet potato to Ethiopia is not clearly known. However, the crop has become popular particularly in densely populated areas of the south, southwest and eastern parts of the country and remained an important food source among the communities (Endale et al., 1992). It is an important food crop and plays critical roles in rural diets. In some areas, it fills food shortage gap during the

months when maize and other foods run short and in years of drought.

SNNPR is the leading sweet potato producing region in Ethiopia. The total area under sweet potato was 23,644 ha with annual production of 236,288 tons (CSA, 2002). Thus, sweet potato occupied 3% of crop area and contributed to 16% of the regional total volume of crop production. In Wolaita zone, sweet potato occupied 20% of cultivated area and accounted for 55% of the total volume of crop production. In the study woreda, it covered 29% of cultivated area and contributed to 63% of total volume of crop production.

In the study area, nine improved varieties of sweet potatoes are under production. Most of these varieties were released by Awassa and Areka Agricultural Research Centers. The varieties are destined and suitable for low and mid altitude areas. The varieties are grouped into three: early maturing (90-120 days), medium maturing (120-150 days) and late maturing (150-180 days) depending on their maturity period. The yield potentials of early, medium and late maturing varieties range between 17-24, 31-35 and 37-40 tons/ha, respectively.

CONCEPTUAL FRAMEWORK

Adoption is a function of the physical, social, institutional, economic merit associated with the new technology, the amount of initial financial requirement to adopt, and accessibility to information. Intensity of adoption is the degree to which a technology is used once the technology is accepted. The intensity of adoption of divisible technologies (such as high-yielding varieties or new variable inputs) can be measured at the individual farm level at a given point in time by the amount or share of farm area utilizing the technology (Feder et al., 1985).

The large body of literature on adoption of high-yielding varieties and improved crop management practices in developing countries points towards a number of factors operating in a quite complex and interactive ways that condition the adoption decision of farmers (Lapar and Pandey, 1999). A study in Sera-Leone by Adesina and Zinnah (1993) showed that farmers' perception of specific characteristics of a technology significantly condition adoption decision. They further indicated that omitting such variables in modelling adoption decisions might undermine factors that determine adoption decisions of farmers. Similarly, Bereket and Adjaye (2001) indicated that family size, perception about technology, off-farm employment and labour availability affect technology adoption decision of farmers. Legesse et al. (2005) also reported that farm size and access to information influence adoption of new chickpea technologies. Yohannes et

al. (1990) reported that debt had a negative effect on the adoption of fertilizer and pesticides. Another study by Itana (1985) noted that distance to the extension center, education, farm size and adequacy of rainfall are major factors that affect the adoption of fertilizer and improved variety. Studies by Tesfaye et al. (2001), Legesse et al. (2001), Legesse and Adam (in press) also identified factors that affect adoption of new technologies. In the study area, substantial proportion of the population depends on sweet potato for food. No attempt has been made to study factors affecting adoption of improved sweet potato technologies.

METHODOLOGY

The Study Area

The study was conducted in Boloso Sore woreda, located in Wolaita Zone, SNNPR[1]. Boloso Sore woreda is connected to Wolaita Sodo town by all-weather road. The total area of the woreda is about 57,128 ha of which 42,670 (75%) ha is cultivated. The soils in the woreda vary from place to place but nitosols are common. The area receives an annual rainfall of 1,578 mm and the mean maximum and minimum daily temperature are 25.4^{0}c and 13.4^{0}c, respectively. The altitude of the study area ranges from 1,350 to 2,380 meter above see level. The total population of the woreda is estimated to be 305,409, of which 139,060 and 166,349 are males and females, respectively. Major crops cultivated in the area include maize,

sweet potato, *enset*[2], haricot bean and *tef*. Sweet potato stands as the second important staple food crop in the area.

Data and Analytical Techniques

The data for this study were collected from randomly selected sample farmers. A multi stage random sampling method was employed to identify sample farmers. Initially, kebeles where promotion of sweet potato varieties was undertaken in the past were listed in consultation with experts from Woreda Agriculture Office. From a list of kebeles, six kebeles were randomly selected. All farmers growing sweet potato were listed at each sample kebele in consultation with kebele leaders and key informants. Finally a total of 120 household heads were randomly selected using a probability proportional to size. The data were collected from October to November 2002 using structured questionnaire. Secondary data were also collected from different institutions.

The limited dependent variables model is commonly used to examine the relation between adoption and factors affecting adoption. Such models provide a good framework to study adoption behaviour of farmers. The most commonly used models capable to capture the relation between the adoption behaviour and factors affecting farmers' adoption behaviour are the logit and the probit models (Feder et al., 1985). These models capture the relationship between the probability of adoption and various explanatory variables (Bekele et al., 2000). Yohannes et al. (1990),

Tesfaye et al. (2001) and Chilot et al. (1996) employed one of these models in their adoption studies. However, these two models explain the probability of adoption and do not take into account the intensity of adoption. Data on intensity of adoption take on values of zero and values greater than zero. Tobit model is appropriate to deal with such data (Tobin, 1968; McDonald and Moffit, 1980). Among others Getahun (2004), Legesse et al. (2001) and Techane (2002) used Tobit model to analyze intensity of use of improved varieties, fertilizer and herbicides. In this study the Tobit model was used to examine factors affecting adoption and intensity of use of improved sweet potato varieties.

The Tobit model measures not only the probability that a farmer will adopt the new variety, but also the intensity of use of the technology once adopted. The Tobit model is expressed as:

$$Y_i = \beta_i X_i + U_i, \text{ if } \beta_i X_i + U_i > 0 \quad \ldots\ldots (1)$$

$$= 0, \text{ otherwise}$$

Where Y_i = area under improved sweet potato as percent of total area under sweet potato production,

X_i = explanatory variable

β_i = a Kx1 matrix of parameters to be estimated

U_i = normally distributed error term with mean zero and constant variance

The maximum likelihood method was used to estimate the parameters of the model.

Following Madalla (1983), the estimates of marginal effects of explanatory variables on the expected value of the dependent variable are given by:

$$\frac{\partial E(Y_i)}{\partial X_i} = F(z)\beta \quad \text{..... (2)}$$

Where, $z = X\beta/$, F (z) is the cumulative distribution function, z is the z-score for the area under normal curve and β is the vector of Tobit maximum likelihood estimates.

The effects of explanatory variables can be decomposed into adoption and intensity effects (McDonald and Moffit, 1980). Thus, a change in the probability of adopting improved sweet potato variety as dependent variable X_i changes is estimated by:

$$\frac{\partial F(z)}{\partial X_i} = F(z)\frac{\beta_i}{\sigma} \quad \text{..... (3)}$$

Similarly, the change in intensity of adoption with respect to change in an

explanatory variable among adopters is estimated by:

$$\frac{\partial E(Y_i|Y_i>0)}{\partial X_i} = \beta\left[1 - z\frac{f(z)}{F(z)} - \left(\frac{f(z)}{F(z)}\right)^2\right] \quad \text{..... (4)}$$

Variable Specification and Hypothesis

The factors assumed to affect adoption and intensity of use of improved sweet potato varieties include farm and farmer characteristics and technology specific attributes. These factors are described and the possible impact that each explanatory variable will have in relation to the dependent variable is pointed out.

Education: Education enables farmers to have access to new information and idea. It is hypothesized that education of household head has a positive impact on adoption of improved varieties.

Gender: Male farmers have more access to information than female household heads. Doss and Morris (2001) confirmed that women farmers tend to adopt improved technologies at a lower rate than men farmers because of limited access to information and resources. It is, therefore, hypothesized that gender of a farmer i.e. being male has a positive influence on the adoption and intensity of use of improved sweet potato varieties.

Experience: Experience improves the technical and management skill of the individual farmer. Thus, a farmer's experience of growing sweet potato is expected to be related to his/her ability to obtain, process and use information relevant to its cultivation. Therefore, a positive relationship between experience and the probability of adoption and intensity of use improved sweet potato varieties is hypothesized.

Labour: Labour is a key input of agricultural production particularly in hoe culture. Sweet potato production requires more labour compared to cereals production. In the study area, there is a large family size, implying availability of labour for different farm activities. Thus, a household with larger family size (i.e., more labour in terms of man-equivalent) is expected to adopt new sweet potato varieties compared to household with small family size.

Off-farm activity: Off-farm employment takes away labour from farm operation. This would reduce the amount of labour available for farm activities. Thus, involvement in the off-farm activity is likely to negatively influence the adoption and intensity of use of improved varieties of sweet potato.

Farm size: There are two arguments regarding the relationship between farm size and adoption of improved technologies. One of the arguments is that farm size has a positive influence on adoption of the technologies as farmers with large farms generate more income, which provides a better

capital base and enhances risk bearing ability (Shiyani et al. 2000). Another argument advocates that farmers with small farm size make an effort to utilize their limited resources more efficiently and thus adopt new technologies at a faster rate (Allaudin and Tisdel, 1988). In the present study, the latter argument appears to be in line with local conditions and the crop considered is more in the interest of farmers with small farm size who has limited option to produce other crops on wider scale. There is a probability that farmers with small farm size adopt improved sweet potato varieties more than cereals producing farmers having relatively large farm size. So a negative relationship is expected between farm size and adoption and intensity of use of improved varieties of sweet potato.

Livestock ownership: Livestock ownership is a key indicator of wealth. Farmers with large number of livestock are wealthy and this wealth is measured in terms of money value at the prevailing market price. There is high interaction between sweet potato production and livestock production due to the fact that farmers use manure to fertilize sweet potato fields and feed sweet potato leaves and roots to livestock. Livestock contribute larger portion of farm income and this would enhance the capacity of farmers to purchase and adopt new varieties. The value of livestock owned is expected to have a positive effect on adoption and intensity of use of improved sweet potato varieties.

Variety characteristics: Farmers' perception of different characteristics of technology such as yield, maturity period, colour, and establishment

ability determine farmers' decision to adopt a new technology. These varied characteristics were measured using dummy variable (Annex A). Workneh and Parikh (1999) found out that farmers' perception of different characteristics of modern variety has a highly significant effect on adoption. Thus, farmers perception about these characteristics of improved varieties is expected to have positive effect on adoption and intensity of use of improved varieties.

Extension: Extension creates awareness about new technologies. The higher the frequency of extension contact, the more likely a farmer will receive valuable information about these technologies. A positive relationship is, thus, hypothesized between the variable extension contact and adoption and intensity of use of improved sweet potato varieties.

Distance to research centre: The relationship between adoption and distance to the research centre is based on the idea that those farmers nearer to research centre have better access to information and improved technologies. Hence, distance from the research centre to farm is likely to have a negative effect on the adoption and intensity of use of improved sweet potato varieties.

Distance to market centre: Sweet potato is perishable product and given the state of transport and storage technologies, there is limited opportunity of marketing it in bulk or preserve it for later consumption or marketing. Hence distance from the farm to market place is expected to be negatively

related to the adoption and intensity of use of improved sweet potato varieties. The list of explanatory variables used in the model and their expected signs are summarized in Annex 1.

RESULTS AND DISCUSSION

Farming System Characteristics

The farming system of the study is characterized by subsistence mixed farming system of crop and livestock production. The major crops produced are *enset,* sweet potato, maize, *tef*, wheat, haricot bean, sorghum, yam and taro. Cattle, donkey, sheep, goats and poultry are also raised on-farm. With so many crops, the cropping sub-system of the study area is complex and farmers are continuously engaged in land preparation, planting, weeding or harvesting of different crops. However, planting and weeding of different crops largely depend on the onset of rainfall.

There are two main cropping seasons: *belg* and *meher* in the area. The *belg* season runs from late February to late March/early April where maize, haricot bean, *enset*, sweet potato and Irish potato are planted. The *meher* cropping season begins towards the end of June and continues to the end of September. *Tef*, wheat, Irish potato, haricot bean and sweet potato are planted in the *meher* season. Sweet potato is planted at three

broadly distinct planting times in a year: July through August, April through June and October through December. Sweet potato fields are ploughed two to three month before planting. Weeding is undertaken depending on the amount of rainfall, which creates favourable conditions for growth of weeds. The crop matures three to eight months after planting depending on the variety and management. In addition, sweet potato is planted from October to December using residual moisture. Planting of sweet potato during this period is to fill the critical food shortage gap from May to July until green harvests of maize and haricot bean are ready for family consumption. Sweet potato produced during this period fetches higher prices as compared to sweet potato produced in other seasons and is sent to urban markets like Addis Ababa market.

Farmers propagate sweet potato entirely by vine cuttings; top (apex) and middle cuttings. Vines are maintained on small plots of land usually under *enset* and coffee fields. Farmers either obtain vines from their own plots or procure them from neighbours or the local market. In cases where drought occurs and farmers have lost planting material, public institutions may supply limited quantities of vines.

Sweet potato is planted in rows commonly on ridges. It is rarely planted on flat bed. Plant spacing i.e. spacing of vines within and between rows varies from place to place and from farmer to farmer. Most farmers use spacing of approximately 15 cm x 20 cm to 30 cm x 50 cm between rows

and plants, respectively.

Intercropping is practiced by 63.3% of the sample farmers. This practice allows intensive crop production both in time and place. It involves varying degree of interference between crop species. The crops usually intercropped in the study area are maize with haricot bean, maize with sweet potato and sorghum with haricot bean. In the study year, only 9.2% of sample farmers intercropped maize with sweet potato. Crop rotation was carried out by 89.2% of sample farmers to maintain and improve the soil fertility status of their farm. The common crop rotations practiced by farmers are: maize-sweet potato-maize; maize-sweet potato-*tef*; *tef*-maize-haricot bean-*tef*. Relay cropping[3] is practiced by 67.5% of sample farmers as a strategy for efficient utilization of land. Crops like haricot bean, *tef* and wheat are planted under maize before maize is harvested.

About 27% of the farmers in the study area use oxen plough for land preparation. The remaining 73% of farmers have no oxen and use hand hoe. For land preparation, they use a hoe locally called *tikiya* and *shalkuwa*. Harvesting is done by sickle for cereal crops and by *doma* (hoe) for root crops.

Major crop production problems in the study area include land shortage, erratic rainfall distribution, pests and diseases, high cost and untimely delivery of fertilizer. Sweet potato butterfly is a major pest constraining sweet potato production in the study area. It regularly occurred in the past

few years and affected sweet potato production. Farmers use physical measures and spray cow dung diluted in water on vegetative part of the plant. However, the traditional control measure is not effective as judged by farmers.

Storage and Marketing System of Sweet Potato

Sweet potatoes are highly perishable and are seldom stored for a long period after harvest. Once harvested most of the tubers are consumed or sold immediately after harvest. However, some farmers store sweet potato in the ground for future sale or consumption for a period of up to 12 months by refraining from harvesting it. Most of the sweet potato growers sell part of their produce in local market. Relatively rich farmers sell their crop on the field to traders who harvest, pack and transport it to markets. The main channel of sweet potato marketing in the area is 'producer-assembler-consumer.' Perishability of the tubers, storage problems and high transport cost are the major marketing problems of sweet potato in the study area.

Adoption and Intensity of Use of Improved Sweet Potato Varieties

In the study area four sweet potato varieties are under production. These include *Erbo* (local) *Wolaita shukaria* (local), *Ogan Sangan* (improved) and Awassa-83 (Improved). About 88% of the sample farmers adopted the two improved varieties: *Ogan Sangan* and Awassa-83. With the exception of these two improved sweet potato varieties, the improved sweet potato

varieties released by research are not under production.

Farmers plant sweet potatoes in rows on ridges. This practice is in line with the research recommendation. However, they do not follow the recommended spacing within and between rows. Farmers plant potatoes three times in a year. Because of this, their planting dates may not necessarily match with the planting dates recommended by research for *belg* and *meher*. For propagation purposes, farmers cut a single vine into two or three small pieces for rainy season planting. They plant three vines per hill to ensure at least one of them survive and well establishes. This practice is in agreement with research recommendation of two to three cuttings per hill. However, in the late season planting, they cover the entire vine by soil to minimize moisture loss and avoid wilting. Such practice is not in line with research recommendation and planting the whole vine is costly as it requires more planting materials. It also results in high plant population that compete for nutrients and reduces yields. Sweet potatoes are weeded during the first two months after planting. This practice is in agreement with research recommendation. Research findings confirmed that sweet potatoes suppress weeds growth after it fully covered the ground. For sweet potato production 175 kg/ha DAP at planting and 80 kg/ha Urea four weeks after planting is recommended. At present farmers do not use fertilizer for sweet potato production and the recommendation is not yet adopted.

Among the variables included in the Tobit model farm size, extension contact and distance from the farm to research centre were highly significant and these factors influence the probability of adoption and intensity of use of improved sweet potato varieties (Table 1). Legesse et al. (2005) also found similar results for improved chickpea variety adoption in the central highlands of Ethiopia. There was a positive relationship between perceived attributes of the improved varieties and its adoption and intensity of use. The coefficient of variable representing farmers' perception of yield performance of improved variety is significantly different from zero. This implies that farmers' perception of yield performance affected the adoption and intensity of use of improved sweet potato varieties. The coefficients of the variables representing farmers' perception of maturity period and establishment performance of improved varieties were significantly different from zero. Thus, farmers' perception of earliness of a variety and its better establishment performance affects the adoption and intensity of use of improved sweet potato varieties. This shows that early maturing varieties of sweet potato are more likely to be adopted by farmers at a faster rate than late maturing varieties. This could be for the reason that farmers require such varieties to meet urgent food requirements during food shortage period as sweet potatoes very often harvested when food from other sources becomes in short supply or nonexistent.

The possible explanation for the positive and significant relationship

between establishment performance and probability of adoption and intensity of use is that improved varieties with better establishment performance are of potential benefit to farmers since failure of the crop due to lack of moisture at its initial times of planting is reported by the farmers. Moreover, better establishment performance gives chance of vigour growth of sweet potato, which is directly related to better yield performance. The coefficient of variable is significantly different from zero; implying that livestock ownership influences adoption and intensity of use of improved sweet potato variety. This could be attributed to positive interaction between the two enterprises. Livestock provide residue for soil fertility maintenance while sweet potato is used as livestock feed. These results are in conformity with the findings of Adesina and Zinnah (1993) in Sierra Leone.

Farm size was negatively related with the adoption of improved sweet potato varieties, and its coefficient was significantly different from zero. The result is in line with the hypothesis that small farmers replace local varieties with new varieties at a faster rate if the expected additional gains are substantial. Most of the farmers in the study area have landholdings of less than one hectare. This group is poorer as compared to those few farmers cultivating cereals such as *tef*, wheat and maize that generate higher cash income. Moreover, small farmers look for the best alternatives to secure food supply from their small landholdings. Shiyani et al. (2000)

who studied the adoption of improved chickpea varieties in tribal region of Gujarati, India reported similar trend.

Extension contact was highly significant and positively related with the adoption of improved sweet potato varieties. This suggests that wider extension coverage would hasten the adoption of improved varieties of sweet potato and hence calls for expansion of the existing limited extension contact.

Distance from farmer's house to the research centre was negatively related to the adoption of improved sweet potato varieties. This indicates that farmers closer to the research centre are likely to have more awareness and have access to the new sweet potato varieties than those who are away from research centre. This suggests increased farmers' participation in technology generation and dissemination would enhance the adoption and intensity of using improved varieties.

Using a decomposition procedure suggested by McDonald and Moffitt (1980), the results of Tobit model can be used to assess the effects of changes in explanatory variables into adoption and intensity effects (Table 2). The computed results indicate that an increase in farm size by one unit would decrease the probability of adoption and intensity of use of improved sweet potato varieties by about 0.21% and 0.30%, respectively.

Table 1. Estimated coefficients of factors influencing adoption and intensity of use of improved sweet potato variety, Tobit model

Variable	Coefficient	Standard error	t-ratio
Constant	0.23090	0.1966	1.175
Education	0.00899	0.0074	1.209
Gender	-0.04321	0.1454	-0.297
Off-Farm	0.01426	0.0178	0.800
Experience	0.00527	0.0025	2.081**
Labour	-0.01365	0.0479	-0.285
Farm size	-0.31255	0.0691	-4.527***
Livestock ownership	0.00005	0.0000	1.722*
Yield potential	0.30310	0.1629	1.850*
Maturity period	0.13930	0.0666	2.322**
Colour of tubers	0.03480	0.0531	0.655
Establishment performance	0.10760	0.0549	1.961**
Extension	0.19880	0.5243	3.785***
Distance from research centre	-0.00732	0.0024	-3.069***
Distance from Market Centre	0.00198	0.0101	0.196
Sigma	0.24000	0.0162	
Log likelihood function		-6.107	
F(z)		0.9963	
Z		2.68	

****, ** and * represent significance at 0.01, 0.05 and 0.10 levels, respectively.*

Table 2. Effects of changes in explanatory variables on adoption and intensity of use

Variable	Change in probability of adoption*	Change in intensity of use*	Total change
Farm size	-0.21220	-0.3033	-0.51550
Yield potential	0.20460	0.29240	0.49700
Extension	0.13450	0.19300	0.32750
Maturity period	0.09460	0.018520	0.21960
Establishment performance	0.07310	0.10440	0.17750
Experience	0.00360	0.00500	0.00860
Distance from research centre	-0.00490	-0.00190	-0.00680
Livestock ownership	0.00004	0.00005	0.00009

*Computed using mean values

A change in the perception of the farmer on yields of improved variety to be higher than that of local variety (i.e., a change from 0 to 1) brings about 0.20% increase in the probability of adoption and 0.29% increase in the intensity of use of improved sweet potato varieties. If farming experience increases by one year, adoption and intensity of using improved sweet potato varieties increases by about 0.009%.

CONCLUSION AND POLICY IMPLICATIONS

The farming systems of Boloso Sore woreda is characterized by an integrated crop-livestock production system. An intensified and diversified production system is practiced by farmers as a strategy to confront the problem of land scarcity and risks of crop failure. The fact that a large number of crops are grown and animals are raised suggests that no single discipline/commodity oriented research and development effort can improve the food security status of the area. Rather, an integrated approach, which involves various development partners and stakeholders, is a key factor to enhance the capacity of farmers in managing their own resources and solving their difficulties. Institutional support including credit, marketing and extension services should be strengthened to lift up the utilization of the crop beyond family food insurance. Post harvest loss of sweet potato is tremendous. Thus, research and extension should give due attention to generation and transfer of post harvest technologies which are non-existent at present.

Results suggest that farm size is negatively and significantly related to the adoption of improved sweet potato varieties. This implies that the varieties are more likely to be adopted and used by smallholder farmers. Thus, research and extension activities should give more attention to farmers with small farm size than farmers with relatively large farm sizes for faster adoption and wider use of improved sweet potato varieties. Extension contact has a strong and positive relationship with the adoption

and intensity of use of improved sweet potato varieties. Thus, extension coverage should be widened by establishing additional development centres and increasing the number of extension workers.

Distance from farmers' house to research centre has negatively and significantly influenced the probability of adoption and intensity of use of improved sweet potato varieties. Hence, attention should be given to establish sub-centres and testing sites to improve farmers' access to improved varieties and thereby increase the probability and rate of adoption of improved varieties of sweet potato. In addition, participation of farmers in designing research, extension and other intervention will allow farmers to have access to information and technologies. Yield is one of the preferred traits/characteristics of the technology in influencing its adoption. This suggests that due attention should be given by researchers to improve the yield potential of existing and new varieties of sweet potato. The earliness in maturity of improved varieties is also an important character considered by farmers in their adoption decision. This preference emanates from farmers' attitude to overcome crop failure resulting from long maturity period and ensure food supply during transitory food insecure period in the year. Research efforts should, therefore, give emphasis to shortening maturity period, and extension intervention should consider early maturing varieties of sweet potato varieties in its promotion activities. Farmers' perception of the establishment performance of the varieties is another very important

characteristic that fosters the adoption process and intensity of use of sweet potato varieties. Research and development activities should be geared towards generating sweet potato varieties that can easily be established using low soil moisture in dry months and resist moisture stress during the time of drought.

Notes:

1. SNNPR is one of the regions of Ethiopia, comprising a wide range of agro-ecologies and peoples of various ethnic groups. It covers about 10% of the country's total area.

2. Enset is a banana like plant cultivated as food crop in southern and south western Ethiopia. Its corm and pseudo stem are edible parts used to process different kinds of cultural foods.

3. Relay cropping is introducing/planting additional crop (s) to the same field when the first crop is matured.

REFERENCES

Adesina, A. A. and Zinnah M. M. 1993, Technology characteristics, farmers' perceptions and adoption decisions: A Tobit model application in Sierra Leone, Agricultural Economics, V. 13:1-9.

Allaudin, M. and Tisdel A. C. 1988, Dynamics of Adoption and Diffusion of HYV Technology: New Evidence of Inter-Farm Differences in Bangladesh. Occasional Paper No. 155. Department of Economics. New South Welse, Australia.

Bekele Hundie Kotu, Verkuijl H., Mwangi W. and Tanner D. 2000, Adoption of Improved Wheat Technologies in Adaba and Dodola Woredas of Bale Highlands, Ethiopia. Mexico, D. F.: Internationa Maize and Wheat Improvement Center (CIMMYT) and Ethiopian Agricultural Research Organization (EARO).

Bereket Araya and John Asafu-Adjaye 2001, Adoption of Farm Level Soil Conservation Practices in Eritrea, Indian Journal of Agricultural Economics, V. 56:239-252.

Chilot Yirga, Shapiro I. B. and Mulat Demeke 1996, Factors Influencing the Adoption of New Wheat Technologies in Wolmera and Addis Alem areas of Ethiopia, Ethiopian Journal of Agricultural Economics V. 1:63-84.

International Potato Center(CIP) 1991, Annual Report. CIP. Lima, Peru.

Central Statistical Authority (CSA) 2002, Ethiopian Agricultural Sample Enumeration, 2001/2002 (1994 E. C). Report on the preliminary results of area, production and yield of temporary crops (*meher* season, private holdings). V. I, Part II. Addis Ababa, Ethiopia.

Doss, C. R. and Morris L. M. 2001, How Does Gender Affect the Adoption of Agricultural Innovations? The Case of Improved

Maize Technologies in Ghana, Journal of Agricultural Economics, V. 25:27-39.

Endale Tabogie, Terefe Belehu, Mulugeta Diro and Geleta Legesse 1992, Improvement Studies on *Enset* and Sweet Potato. In Proceedings of the Second National Horticultural Workshop of Ethiopia, 1-3 December 1992, Tsedeke Abate, Hiebsch C., Brandt A. S. and Seifu Gebremariam (eds), Addis Ababa, Institute of Agricultural Research.

Feder, G., Just E. R. and Zilberman Z. 1985, Adoption of Agricultural Innovation in Developing Countries: A Survey, Economic Development and Cultural Change, 33:25-299.

Getahun Degu 2004, Assessment of factors affecting adoption of wheat technology and its impact: The case of Hula woreda Ethiopia, M. Sc. Thesis, Alemaya University.

Itana Ayana 1985, An Analysis of Factors Affecting the Adoption and Diffusion Patterns of Packages of Agricultural Technologies in Subsistence Agriculture: A Case Study of Two Extension Districts of Ethiopia. M. Sc. Thesis, Addis Ababa University.

Lapar, M. L. and Pandey S. 1999, Adoption of Soil Conservation Technologies: The Case of the Philippine Uplands, Agricultural Economics, 21:241-256.

Legesse Dadi and Adam Bekele (in press) Review of Adoption and Impact of Improved Food Legumes Production Technologies in Ethiopia, Paper presented on the Second Legume Workshop, 2003, Gion Hotel, Addis Ababa, Ethiopia

Legesse Dadi, and Burton M. and Ozanne A. 2001, Adoption and Intensity of Fertilizer and Herbicides Use in the Central Highlands of Ethiopia, Agrekon, V. 40: 368- 385.

Legesse Dadi, Senait Regassa, Asnake Fikre and Demissie Mitiku 2005, Adoption Study on Improved Chickpea Varieties in Ethiopia. Addis Ababa, Ethiopia: Ethiopian Agricultural Research Organization; and Patancharu 502 324, Andhra Pradesh, India: International Crops Research Institute for Semi-Arid Tropics.

Madalla, G. S. 1983, Limited Dependent and Qualitative Variables in Econometrics. Cambridge: Cambridge University Press.

McDonald, J. F. and Moffitt A. R. 1980, The Use of Tobit Analysis, Review of Economics and Statistics, V. 62:318-321.

National Bank of Ethiopia (NBE) 2002, Annual Report for the Year 2000/2001. Economic Research Department of the National Bank of Ethiopia, Addis Ababa.

Scott, G., Ferguson I. P. and Herrena E. J. 1992, Product Development for Root and Tuber Crops. ILbadan: IITA.

Shiyani, R. L., Joshi K. P., Asokan M. and Bantihan C. M. 2000, Adoption of Improved Chickpea Varieties: Evidences from Tribal Region of Gujarati, Indian Journal of Agricultural Economics, V. 5: 160-171.

Techane Adugna 2002, Determinants of fertilizer adoption in Ethiopia: The Case of Major Cereal Producing Areas, M. Sc. Thesis, Alemaya University.

Tesfaye Zegeye, Girma Taye, Tanner D., Verkij H.l, Aklilu Agidie, Mwargi W. 2001, Adoption of Improved Bread Wheat Varieties and Inorganic Fertilizer by Small-scale Farmers in Yelmana Densa and Farta Districts of North Western Ethiopia. Mexico, D.F. EARO and & CIMMYT)

Tobin, J. 1968, Estimation of Relationships for Limited Dependent Variables, Econometrica V. 26:24-36.

Workneh Nigatu and Parik A. 1991, The Impact of Perception and Other Factors on the Adoption of Agricultural Technology in Moret and Jiru Woreda of Ethiopia, Journal of Agricultural Economics, V. 21:205-216.

Yohannes Kebede, Gunjal K. and Coffin G. 1990, Adoption of New Technologies in Ethiopian Agriculture: The Case of Tagulet Bulga District, Shewa Province, Agricultural Economics, V. 4:27-43.

Annex 1: Explanatory variable used in the Tobit model

Variable	Description	Expected effect
Education	Education of the household head in years of schooling	+
Gender	Gender of the household head (0=female, 1=male)	+
Off-Farm	Involvement in off-farm activity	-
Experience	Farming experience of the household head in years	+
Labour	Labour available for field work in man equivalent	+
Farm Size	Total farm size in hectares	-
Livestock ownership	Monetary value of livestock owned	+
Yield potential	Farmers perception of yield (0=inferior compared to local cultivars, 1=superior compared to local cultivars)	+
Maturity period	Farmers' perception of maturity of improved varieties (0=not early maturing, 1=early maturing)	+
Colour of tubers	Farmers' perception of colour of tuber of improved varieties (0=not preferred, 1=preferred)	+
Establishment performance	Farmers' perception of establishment performance of improved varieties (0=not better, 1=better)	+
Extension	Extension contact (0=no, 1=yes)	+
Distance to research centre	Distance to research centre in kilometres	-
Distance to market	Distance to market centre in kilometres	-