Available online at www.worldscientificnews.com

World Scientific News

WSN 53(3) (2016) 122-137 EISSN 2392-2192

Analysis of the Factors Affecting Adoption of Soybean Production Technology in Pawe District, Metekele Zone of Benshangul Gumuz Regional State, Ethiopia

Fitsum Miruts

Pawe Agricultural Research Center, Pawe, Benshangul Gumuz Regional State, Ethiopia

E-mail address: fitsummiruts@gmail.com

ABSTRACT

Soybean is a legume crop grown in the tropical, subtropical, and temperate climates which is used for food and animal feed. However, the production and productivity of soybean is low and improvement in production and productivity depends on the extent to which a household has applied the recommended production technologies. The objectives of this study were: to assess the level of adoption of improved soybean production technology and to identify the major factors affecting adoption of improved soybean production technology. Multi stage sampling procedure was followed to select 123 households for the study. In this study, descriptive and inferential statistical methods were used to describe household characteristics and adoption of the technologies among households. Tobit model was used to identify the determinants of adoption of the improved soybean production technologies. The results of descriptive statistics showed that a total of 95 (77%) of the respondents have adopted the recommended soybean production technologies. The result of the econometric model indicated that the age of the households, the land holding, household size, the number of livestock owned and the extension contact are important variables influencing the level of adoption of soybean production technologies. Thus it requires improvement of the asset position, information generation and utilization capacity of farmers if successful adoption of soybean technologies is desired.

Keywords: Adoption; Soybean Production technologies; Pawe

1. INTRODUCTION

In Ethiopia, agriculture is the leading sector in terms of contribution to the overall economic growth and development. It supplies food for local consumption and raw materials for domestic manufacturing industries. It accounts for nearly 46% of GDP and supplies 70% of the raw material requirements of local industries. It also serves as the main source of food and generates 90% of the foreign exchange earnings. Having all these importance, agriculture continues to face a number of challenges. The major ones are: adverse climatic conditions, lack of appropriate land use system resulting soil and other natural resource degradation, limited use of agricultural technologies and the predominance of subsistence agriculture which is made up of smallholder farmers (ATA, 2014).

Moreover, food insecurity and malnutrition are among the major challenges. These challenges are more serious in rural than urban areas mainly because of a low level of understanding about nutrition and lack of capacity to purchase animal source proteins. A closer look at the performance of the Ethiopian agriculture reveals that over the last decades it has been unable to produce sufficient quantity to feed the country's rapidly growing human population. Even worse, the country has experienced recurrent droughts that claimed the lives of several people (CDI, 2010).

Currently the agricultural policy of Ethiopia gives high priority for increasing food production and decreasing malnutrition problems through the promotion of improved production technologies among smallholder farmer in the national extension package. In a similar sense, producing and consuming more soybeans improves the situation as it can provide a nutritious combination of both calorie and protein. It is also cheap and rich source of protein for poor farmers, who have less access to animal source protein, because of their low purchasing capacity. Besides better nutritional status, the crop has a great significance in improving the status of soil nutrients and farming system when grown solely and in combination with cereal crops. (CDI, 2010).

According to the research result of Pawe Agricultural Research Center (2010), soybean can grow in Woina Dega and Kola areas of the country. Depending on its varieties, the crop grows in an altitude ranging from 700-1800, rain fall 450-1500 mm. Day temperatures ranging from 23-25 °C are ideal for growing the crop. Potential areas for soybean are: Southern Nations Nationalities People region, Oromia region, Benshangul Gumuze region (Metekel, Kamashe and Asosa areas); Amahara region and Tigray region are expected to be more appropriate for soybean production.

Although soybean is largely grown in Ethiopia, its national average yield is low (19.98 quintal per hectare) which is below the global average, 23.1 quintal per hectare (CSA, 2014). The low national yield could be attributed to various reasons. Some of these are related to low adoption of improved soybean production technologies; lack of improved varieties and poor cultural practice PARC (2010).

So far, many agricultural technologies have been developed and our government is providing extension service to promote the adoption of agricultural technologies in the country. Despite such interventions, the adoption of agricultural technologies in Ethiopia as a whole is quite poor (FAO, 2010). For example, land improving technologies such as improved seed, fertilizer, improved agronomic practices and natural conservation measures are not widely adopted in Ethiopia (Million, 2010). Likewise, in Pawe district, a number of soybean production enhancing technologies and practices have been extended to smallholder farmers by the public extension system and non-governmental organizations. Yet, the distribution and utilization of the technologies has not been known. There is a need for location-specific empirical information on the adoption of improved soybean production technologies and the various factors affecting them in the study area, in order to understand the adoption scenario and design appropriate policy action to improve the production of the crop.

1.1. Statement of the Problem

The improved soybean production involves use of different practices; improved varieties, seed rate and fertilizer rate at the recommended level. The variation is not only level of adoption of the latest agricultural technologies but also the underlying determinants. To solve these problems, governmental and non-governmental bodies have made different efforts to bring change in production and productivity of soybean. They have introduced improved agricultural technologies like use of fertilizers, high yielding varieties, improved farm implements, etc. which improves the production and productivity of the crop. However, the introduced technologies were not widely accepted by farmers in different parts of the county as expected (FAO, 2010).

This indicates that there are different factors directly or indirectly influencing the adoption of technologies that believed to bring change in smallholder farmers’ production and productivity. But, the reasons why farmers do not accept the recommended soybean production technologies are not yet well understood. The level of adoption of the recommended technologies among farmers has not been determined in the study area. Knowledge of the distribution of the technologies and the factors triggering the technologies is very important in order to make informed policy decisions (Jain *et al*. 2006). Therefore, the main focus of this study was to assess the level to which the recommended soybean production technologies are adopted by farmers and to identify the factors influencing adoption of the recommended technologies in the study area.

1.2. Objectives of the Study

The overall objectives of this study was to assess adoption of recommended soybean production technologies among the smallholder farmers in Pawe district. The specific objectives are: (i) to estimate the level of adoption of the recommended soybean production technologies; (ii) To analyze the factors affecting level of adoption of recommended soybean production technologies in the study area.

2. MATERIAL AND METHODS

2.1. Description of the Study Area

This research was carried out in Pawe district which is one of the seven districts of Metekel Zone of Benshangul Gumuz Regional State, bordered by Dangure district in West, Mandura district in South and Jawi district of Amhara Region in North and Eastern par. It is foundat 575km distance from Addis Ababa between 36° 20'-36° 32'- longitude and 11° 12'-11° 21'north latitude. The district has 20 kebeles and the climate of the area is hot humid and characterized by unimodal rainfall pattern with high and torrential rainfall that exceeds from

May to October. The area receives mean annual rainfall of 1586.32 mm and it has an altitude of 1120 m (Mohammed, 2013).

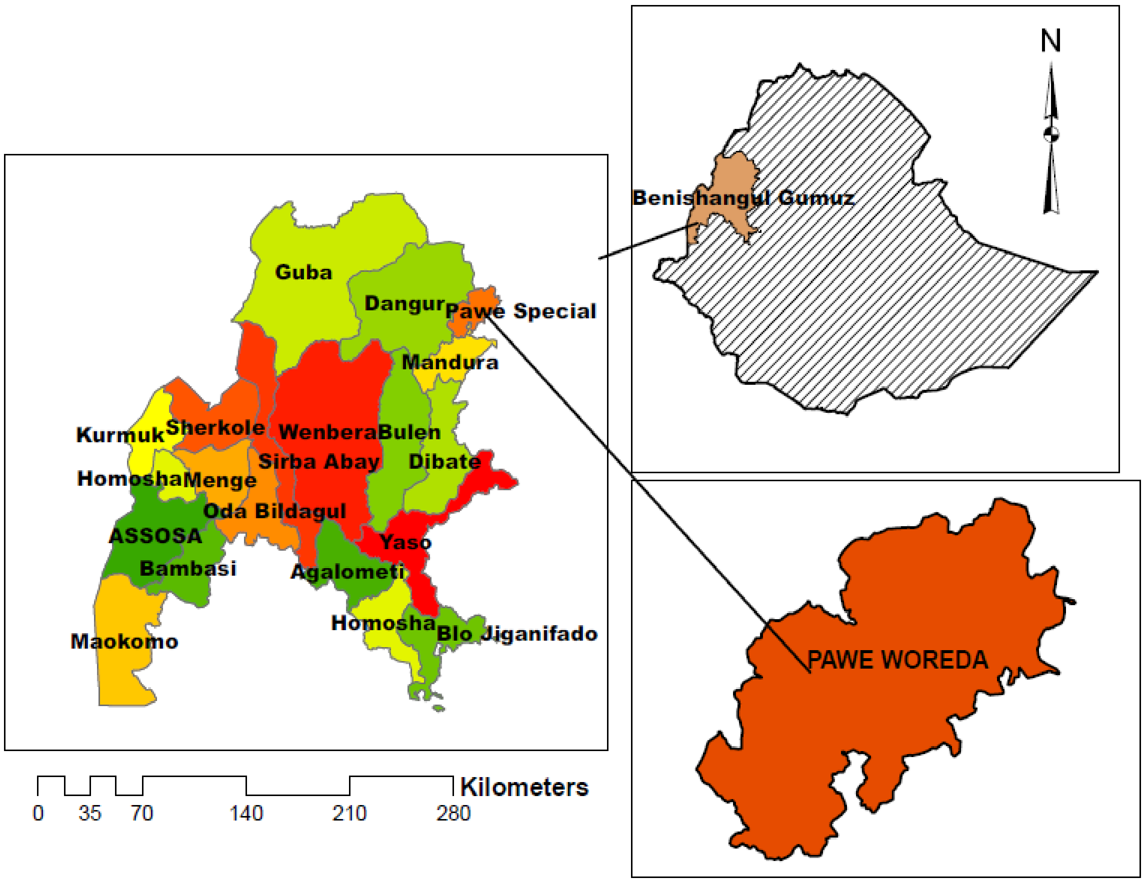

Figure 1. Location of the study area

The total area of the district is 63,400 hectares of land of which 50.4% of land is suitable for cultivation of crops and 73.9% of the land which is suitable for cultivation of crops is under cultivation of different crops. The farming system in the area is dominated by mixed crop livestock production, which accounts 96% of the population and 3.8% involved only in livestock production. Types of crop grown in the area includes cereals (maize, sorghum and finger millet), oil crops (sesame and groundnuts), vegetables, fruits (mainly mango and papaya), pulses (mainly haricot bean and soybeans). Soybean is the main pulse crop in Pawe district (Pawe district agricultural office, 2014).

2.2. Sampling Procedure

In this study, multi stage sampling procedure was employed in selecting the respondent households. First, soybean producer kebeles were identified with collaboration of district bureau of agriculture. Secondly, among the identified kebeles, four kebeles were selected using simple random sampling method. Finally, a total of 123 farm households were randomly selected based on the probability to proportional to size of households in each kebeles. The total sample size was determined following Yamane's (1967) formula,

$$n = \frac{N}{1+Ne^2}.$$

where; n = sample size, N = total number of households in the district (11,808) and e = margin of error (level of error deviation of the sample value from the population parameter). Accordingly, the number of respondents in each kebeles is shown in table 5.

Table 1. The number of households selected from each village.

Name of the kebeles	Total number of HH in the sampled kebeles	Sample household selected
Kebele 30	997	30
Kebele 17	412	28
Kebelee 23/45	1096	43
Kebele 5	415	22
Total	2920	123

Source: Computed from secondary data

2.3. Data Type and Collection Methods

The data used for the present study were collected in January – March. Two types of data were used in this study, primary and secondary data. The primary data were collected from the households by using structured questionnaire survey and focus group discussions (FGDs) while secondary data were collected by reviewing documents of the various offices in Pawe district.

2.4. Method of Data Analysis

The descriptive statistical analysis methods were employed to discuss the result of the study using frequency, mean, average, standard deviation, percentage. The chi- square test was used for the dummy variables and t-test was used for continuous variables to see the presence of statistical significant differences. The econometric model involved Tobit model to determine the relative influence of explanatory variables on the dependent variable.

2.4.1. Econometric Analysis: Tobit Model

Tobit model was used to determine the relative influence of explanatory variables on the dependent variable. This model was chosen because; one, it has an advantage over other analytical models in that; it reviles both the probability of adoption and level of use of the technology. Two, the farmer may adopt only some part of the recommended technology or may adopt all the recommended technologies. So, Tobit model is more appropriate to give reliable output of both discrete and continues variable combination (McDonald and Moffit, 1980). Third, examining the empirical studies in the literature, many researchers have employed Tobit model to identify factors affecting adoption and level of adoption. For example, Rahimeto (2007) and Alemitu (2011) used the Tobit model to estimate the probability of adoption and level of technology use.

3. RESULTS AND DISCUSSION

3.1. Results of Descriptive Analysis

In this study, recommended soybean production technology includes the use of improved varieties, seeding rate and fertilizer rate. Farmers who did not grow the improved soybean variety were considered as non-adopters while other farmers who grow improved variety of soybean with some of the recommended production technology (improved variety, seed rate and fertilizer rate) were taken as adopters.

To study the factors affecting adoption and the level of soybean production technology three groups where identified with different range of score these are 0.01-0.33, 0.34-0.66 and 0.67-1 which are assigned for low adopter, medium adopter and high adopter categories respectively and non-adopters, those who didn't cultivate the improved soybean variety, with a score of 0.

Table 2. Adoption of soybean production technologies by adoption category.

Adoption Category	Adoption index score range	Mean of adoption index	% of farmers	Mean land allocated (improved variety)	Mean seed Rate (Kg/ha)	Mean fertilizer (DAP) application (Kg/ha)
Non adopters	0	-	22.8	-	-	-
Low adopters	0.01-0.33	0.32 (0.02)	8.9	0.44 (0.26)	61.82(20.3)	38.18(46.9)
Medium	0.34-0.66	0.61(0.06)	32.5	1.35 (1.15)	54.13(14.3)	30.25 (10.4)
High adopters	0.67-1.00	0.82 (0.11)	35.8	1.09 (0.69)	71.59(20.0)	41.84 (37.9)
Total mean	0.00-1.00	0.52(0.33)	100	0.86 (0.94)	52.66(28.2)	23.25 (34.12)
t-value		27.01***		28.52***	23.23***	2.04**

SD in parenthesis, *** and ** indicate significant at 1% and 5% level
Source: own survey data, 2014

Based on these the actual adoption index score ranges from 0 to 1 across which adoption and the level of soybean production technology was assessed. One-way analysis of variance indicates that there is significant difference (t =27.01, P = 0.00) among the adoption index score of the adoption categories at 1% significance level which indicates variation in level of adoption among the sample farmers (Table 2).

The adoption index of sample households indicated that 28 of the sample households (23%) had adoption index score of zero which shows they are non- adopters, 11 households (9%) had adoption index ranging 0.1 to 0.33 which indicates low adopters, while 40 households (32%) had adoption index score of 0.33 to 0.66 indicating they are medium adopters, and 44 households (36%) had adoption index score ranging from 0.67 to 1.00, which shows high level of adoption.

Land Covered by Improved Soybean Variety

Many of the farming households in the study area usually grow soybean. Belessa 95 variety is the most preferred and widely grown in the study area (PARC, 2010). The level of improved soybean variety adoption is measured in proportion to the area covered by the improved variety to total area of soybean. There is a difference among soybean grower farmers regarding area coverage of the improved variety of soybean. This difference is because the land holding or may be due to their level of adoption. As indicated in table 2, there was significant difference among the adopters (t = 28.52, P = 0.00) in level of land allocation for improved variety of soybean at 1% significance level. On average, the sampled households have allocated 0.86 ha for improved variety with standard deviation of 0.94. According to the result of the focus group discussions made with farmers, the difference in using improved variety is attributed to soybean market price fluctuation and the unavailability of the improved variety in the market as needed. In addition to this, the cost of purchasing the seed is high.

Seeding Rate

The recommended soybean production technologies by research to the study area is 60-70 kg/ha. As the research soybean production manual recommends the specified amount of seed is based on seed size which differs among different varieties and quality of the seed otherwise the amount can increase proportionally with decreased in seed quality. Thus, research recommends specified level of seed rate based on the range on the quality of the seed. The farmers in the study area were using varying rates of seed with the mean of 52.66 kg/ha. one-way analysis of variance revealed significant mean difference (t = 23.23 P = 0.00) in seeding rate applied among the adopter categories at 1% significance level (Table 2).

According to the result of focus group discussion made with farmers, the farmers fall below the recommended seed rate amount, because of unavailability of improved seeds and not knowing the exact amount of seed rate recommended by research extension. On the other side, farmers use higher amount of seed due to; first, due to lack of knowledge about the recommended seed rate. Second, the recommended rate is not sufficient to cover the specific amount of land well and also they explained that the main reasons for high seed rate are poor quality of seed. Moreover, they need to have denser population in order to minimize weed infestation. This implies that the need to training on soybean production technology, how to maintain quality seed for farmers or supply them with quality seed regularly by the concerned bodies and retaking research on plant spacing and recommended seed rate.

Fertilizer Rate

Soybean production requires use of different inputs. Fertilizer application is one of the most important practices that need to be adopted by soybean producers. Farmers in the study area use varying fertilizer rate. The recommended rate of fertilizer for the study area by the research is a blanket recommendation, which is 100 kg/ha of DAP only. Fertilizer application rate of sample respondents vary across adopter categories. Among the total sampled households. The average fertilizer application rate in soybean production by the sample households was 23.25 kg/ha of DAP. Analysis of mean variance indicated that there was significant mean difference among adopter categories in the application of DAP rate (Table 3). Respondent farmers from focus group discussion have mentioned different reasons for their use of lower fertilizer rates. In the first place, they were claiming that application of the recommended fertilizer rate does not give much yield advantage. As to some farmers, they also claim even though they apply the recommended rate they get the same amount of yield as the previous harvests. This has an implication for research indicating the need to revisit the previous recommendation by conducting further site-specific fertilizer trials.

3.1.2. Demographic, Socio-economic and Institutional Characteristics

Sex of the Household Head

The study result shows that, out of 123 respondents the majority 80.5% were male household heads and the rest 19.5% were female household heads (Table 3). The majority of the female household heads were found in low adoption category. Further test of association shows that there is a difference among the two sexes in terms of the categories of adoption in favor of males implying that in all cases the number of male respondents is more than the number of female respondents.

Education of the household head

Among the sampled households 26 % of the sampled households were illiterate and the rest 74% of the sampled households were literate. This means that majority of household heads at least can write and read. However, the result of the test association shows that there is no difference among adopter categories related to education of farm household heads (Table 3).

Participation in off- farm activities

Farmers can earn additional income by engaging in different off-farm activities. Off-farm activities are believed to raise farmer's financial position to acquire new inputs. Based on this assumption the variable was hypothesized that there is a positive relationship between adoption of soybean production technology and farmers' participation in off-farm activities. Out of the total households interviewed about 8.9 % were participated in off-farm activities through their family member while 91.1%had not participated in off farm activities (Table 3). The result of the test association shows that there is no difference among adoption categories related to off-farm activity participation by members of the household.

Participation in non-farm activities

Out of the total sample households interviewed only 31.7% have participated in non-farm activities through their family members, while 68.3% had not participated in non-farm activities (Table 3). The result of the test association shows that there is no difference among adoption categories related to non-farm activity participation by members of the household.

The result from focus group discussion shows in the study area involvement in non-farm jobs is common. Some are engaged in petty trading, daily wage laborers and brewing local beverages were found to be the major non-farm activities in which the sample households were participating. These non-farm activities have served farmers as sources of additional income to purchase food crops mainly in the scarcity of agricultural produces.

Contact with extension agents

Among households who were interviewed, about 85.7% had contact with extension agents and shared information regarding soybean production technology while 14.3% had no contact (Table 4). Further the test of association shows that there is a difference among farmers across the adoption categories in favor of those who had contact with extension agents. This could indicate that adopters have better contact with the development agents. This shows the significant role of extension agents in adoption of recommended soybean production technology.

Credit use

Out of the total sample respondents, only 30.1% received credit. On the other hand, 69.9% of the total sample households not recipients. The result of the test association shows that there is no significant difference among farmers across the adoption categories related to credit use (Table 3).

Table 3. Characteristics of the sampled households (dummy Variables).

Variables	Character	Proportion across adoption categories (%)					X^2-value
		Non	Low	Medium	High	Total	
SEX	Male	67.9	54.5	95.0	81.8	80.5	12.97***
	Female	32.1	45.5	5.00	18.2	19.5	
EDU	Literate	25.0	36.4	20.0	29.5	26.0	0.75 NS
	Illiterate	75.0	63.6	80.0	70.5	74.0	
EXTCONT	YES	64.3	100	87.5	90.9	85.7	12.44***
	NO	35.7	0	12.5	9.1	14.3	
CRDITUS	YES	17.9	45.5	27.5	36.4	30.1	4.178 NS
	NO	82.1	55.5	72.5	63.6	69.9	
PARTOFF	YES	10.7	9.10	5.00	11.4	8.90	1.18NS
	NO	89.3	90.9	95.0	88.6	91.1	
PARTNON	YES	28.6	9.1	42.5	29.5	31.7	4.972 NS
	NO	71.4	90.9	57.5	70.5	68.3	

***and ** indicate significant at 1% and 5% levels
Source: Own survey data, 2014

The focus group discussion result shows, majority of the farmers did not need to take credit because they did not experienced shortage of money. Whereas, some of them replied that, they did not take the credit because it was inaccessible due to the requirements of taking credit like grouping and saving and the rest did not take the credit because they did not repay the previous credit taken.

Age of the Household head

Age is one of the household characteristics important to describe the households and can provide a clue as to age structure of the sample and the population too. It is obvious that increase in farmers' age also increases farmers' experience in farming as well as increases the awareness of the benefits of specific technology. On the other end older farmers become more risk averse to new technology. The result of the study shows that; the mean age of sampled household heads was 41.14 years with standard deviation of 9.66. The test of mean difference shows that, there was no significant difference among the farmers in terms of their age across the adoption categories (Table 4).

Land holding (LANDHOLD)

In this study, the average land holding of sample households were 2.75 hectare with standard deviation of 1.87. This shows that, farmers in the study area owns more than the national average which is 2 hectares. Implying farmers in the study area has better land holding. The survey result also showed that the mean land holding of adopter groups is much larger than non-adopter groups (Table 4). However, the test of mean difference shows that, there was no significant mean difference among the farmers in terms of their land holding size across the adoption categories.

Table 4. Characteristics of the sampled households (continuous variables)

	Mean across adopter category						
Variables	Non	Low	Medium	High	Total	SD	t-value
AGE	39	45	38	44	41.14	9.66	1.16^{NS}
HSIZE	2.65	2.3	3.05	3.18	2.94	1.15	1.002^{NS}
KRSPT	2.29	2.64	2.95	3.14	2.84	1.21	4.403^{***}
LANDHOLD	2	2.16	2.81	3.32	2.75	1.87	1.371^{NS}
LIVHOLD	5.48	5.37	6.83	8.00	6.81	5.66	0.766^{NS}
MKTDST	5.93	6.07	5.3	4.92	5.45	3.7	1.621^{*}

*and *** indicate 10% and 1% level of significance respectively
Source: Own survey data, 2014

Household size (HSIZE)

In this study, household size is considered as the number of individuals who live in the respondent's house. The average household size, in man equivalent, of the sample respondents was found to be about 2.94 with standard deviation of 1.15 (Table 4). The test of mean difference shows that, there was no significant difference among the households in terms of their household size measured in man equivalent across the adoption categories.

The focus group discussions result revealed that farmers in the study area have faced labor shortage during different farm operations of soybean especially during weeding and harvesting time. Farmers in the area used different measurements to solve the labor shortage problems. They hired labor in order to fill the labor shortage problem. Debo, assistance from relatives and a combination of this are reported as a solution by the group. In addition to this, the farmers from the focus group discussions explained about the role of women in soybean cultivation. In the study area women farmers were participating in different activities starting sowing, fertilizer application, weeding, harvest, storage, threshing and marketing of the product. Especially during weeding and harvesting time all members of the household is participant.

Livestock holding (LIVHOLD)

Livestock is an important source of income and draft power, food and means of transport. Farmers in the focus group discussion mentioned that, farmers in the study area have major problem regarding animal disease called tse-tse fly, which diminishes the availability of draft power from oxen and increases the expenditure of the farmer’s year in and year out. They also mentioned that feed for livestock is a problem in months between November-June which is the peak season for draft power requirements.

In this study, the average livestock holding of the sample household was 6.81TLU with standard deviation of 5.66. The survey result also showed that the mean livestock holding of adopter groups is much larger than non-adopter groups (Table 4). However, the test of mean difference shows that, there was no significant mean difference among the farmers in terms of their livestock holding across the adoption categories.

Knowledge about the recommended soybean production technology (KRSPT)

Knowledge of technology was hypothesized to influence adoption of soybean production technology positively. The average score of the knowledge on soybean production technology among sampled household was 2.84 with standard deviation of 1.21 (Table 4). The test of mean difference shows that sampled households are different in terms of their knowledge about soybean production technology across the adoption categories. Implying that knowledge of the technology is higher in adopter groups than non-adopter groups.

Market Distance (MKTDST)

Sample farmers reported that they had to travel an average of 5.45 km with standard deviation of 3.7 km to reach to the main market. The test of mean difference shows that sampled households are different in terms of their distance to market across the adoption categories (Table 4). Implying farmers in the adopter category travel less kilometers than non-adopter category farmers. The result from focus group discussion shows farmers in the study area have all weather roads and it is possible to drive mule pulled carts and if needed public transport facility is available. So they have no problem regarding road facility to reach the main market. However, the majority of farmers in the study area sell their soybean products mostly through brokers which in turn results in lower income from selling the products and also they replied about the trend of the price as increasing year after year.

3.2. Result of the econometric analysis

The results of the Tobit model show that the model was significant at 1% level indicating the relevance of the model for estimating the relationship between the dependent and at least one independent variable. Model output revealed household size (in man equivalent), land holding, number of livestock owned in TLU, extension contact and age of the household head are the variables which are found to affect positively the dependent variable (Table 5).

Table 5. Results of maximum likelihood (Tobit model).

Variables	Coefficient	Standard Error
Constant	0.1246	0.3094
Sex	0.0679	0.6537
Age	0.0051*	0.0026
Education	0.0311	0.0582
Household size	0.0383*	0.0216
Land Holding	0.0256*	0.0138
Off-farm participation	0.4777	0.4458
Non-farm participation	-0.0108	0.2684
Livestock holding	0.0162***	0.0051
Market distance	-0.0086	0.0061
Credit received	-0.2889	0.2711
Extension contact	0.0032**	0.0012
Knowledge RSPP	0.0212	0.0203

***, ** and * show significance at 1%, 5% and 10% levels respectively
Source: Model Output

Household size (man equivalent) has significant positive influence at 10% level of significance on the likelihood of adoption of recommended soybean production technologies. On average a unit increase in the household size in man equivalent increases the level of adopting soybean production technology by 0.0383 units (Table 5). Family provides the human labor and management inputs. This can affect the level of use of technologies in terms of quality of management decision and the availability of labor required by the technology. Normally, the larger the household size, the more likely the household is to become successful as the household has more labor to work on the farm. However, this would only work if all family members are old enough to perform the farm work. On the other hand, household size can create certain demand which may motivate the adoption of new technologies that would increase the farmers' income as a means of meeting these demands.

According to McDonald and Moffit (1980) the results of Tobit model can be used to assess the effects of changes in the explanatory variables into adoption and level of use. Analyses of the marginal effects shows that a unit increases in household size would increase the probability of adopting soybean technologies by 4.1% and its level by 3.4% respectively (Table 6). The positive relationship was also found in Techane (2002) and Idrisa (2012).

The study also reveals a positive and significant relationship between extension contact and adoption and level of adoption of soybean production technology at less than 5% level of significance. This shows that the households who had contact with the extension are more probable to adopt soybean production technology than those who have no contact and the expected level of adoption would increase by 0.0032 units (Table 5). Extension contact determines the information which the farmers obtain and the application of that information through counseling, meeting and demonstrations. This could be because increased farmers' interaction with extension agents greatly increases farmers' knowledge of available technologies and their potential benefits. According to the model output of marginal effect, for an average farmer who has access to extension, the probability of adoption and level of adoption of soybean production technology would increase compared to their counterparts by 3.8% and its level by 2.9% respectively (Table 6). This is similar to the finding of Taha (2007), Saka and Lawal (2009) and Olagunju *et al.* (2010).

Table 6. Marginal Effect after Tobit.

Variables	Change in Probability of Adoption	Change in Level of Adoption	Total Change
Age	0.0045	0.0045	0.0050
Household size	0.0408	0.0336	0.0373
Land holding	0.0165	0.0224	0.0250
Number of livestock owned	0.0182	0.0142	0.0157
Extension contact	0.0382	0.0293	0.0031

Source: Model Output

The model output also indicates that the number of livestock owned by a household in TLU affects positively and significantly the level of adoption of soybean production technology at less than 1% level of significance. On average a unit increase in the number of livestock owned increases the level of adopting soybean production technologies by 0.0162 units (Table 5). Analyses of the marginal effects shows that a unit increase in amount of livestock owned would increase the probability of adopting soybean technologies by 1.8% and its level by 1.4% respectively (Table 6). The positive relationship was also found in Yishak (2005) and Chilot and Hassen (2013).

The result of the Tobit model also shows that the age of household head influences adoption and the level of adoption of soybean production technology positively at 10% level of significance. One more unit (year) increase in farmers age increases the level of adopting soybean production technologies by 0.0051 units (Table 5). The implication is that the increase in farmer's age increases farmers' experience in farming and understanding more the benefits of the technology. This could be also mean that farmers who have more years' farm experience are more likely to adopt soybean production technology than those farmers who have less number of years of farm experience. Analyses of the marginal effects shows that a unit increases in farmers' age would increase the probability of adopting soybean technologies by 0.45% and its level by 0.45% respectively (Table 6). The positive relationship was also found in the study of Omonona *et al.* (2005) and Kariyasa and Dawi (n.d).

Finally, Land holding as a variable had a positive and significant influence on adoption of soybean production technology at 10% level of significant. One more unit (ha) increase in land size increases the level of adopting soybean production technologies by 0.0256 units (Table 5). This indicates that farmers who have large farm land are more likely to adopt soybean production technology. The reason for this was a farmer with large farm size means relatively harvest more and likely to generate sufficient income, which could help them to buy agricultural inputs. According to the model output of marginal effect, if land size increases by one more unit, would increase the probability of adopting soybean technology 1.7% and its level by 2.2% respectively (Table 6). This is Similar to the findings of Gibegeh and Akubuilo (2013).

4. CONCLUSIONS AND RECOMMENDATIONS

According to the findings of this study, variation in adoption and level of adoption of recommended soybean production technology among sampled households were found to be affected by different sets of factors. Based on the findings of the study, the following recommendations are forwarded.

The fact that age influences adoption of soybean technologies could suggest that older farmers are more likely to adopt soybean production technology than younger farmers. The difference may be that younger farmers have less experience in soybean farming than older farmers and therefore older farmers have better understanding or knowledge and skills which enable them to perceive risks and constraints related to transfer of new technologies. Hence, extension organizations, research and other stockholders should include younger farmers in different extension activities and arrange periodic experience sharing sessions among young and old age group farmers so that they can have much more understanding of the knowledge and benefits of recommended soybean production technologies.

Farmers with large numbers of livestock are more likely to adopt soybean production technologies. This implies that encouraging and helping farmers in improving livestock production is necessary. On the other hand, in the study area there is critical problem of animal disease (tse-tise fly), and this needs special attention from the research, extension and other stakeholders. This suggests looking for improving livestock production sub-system through provision of improved veterinary services and feed on sustainable basis.

Household size was another factor that affects adoption of soybean production technology positively. Households with large size in man equivalent were found to adopt recommended soybean production technology than those with small household size. Soybean production demands labor for different activities. Hence, different technologies with relatively less labor requirements should be developed so that it can reduce the labor requirements.

Land holding was also an important variable which positively and significantly influenced adoption of soybean production technologies. This would imply that, farmers with increasing land holding are more likely to adopt recommended soybean production technologies. Thus, research and extension organizations should give attention in solving farmers' problem especially by improving the contribution of recommended soybean production technologies to enhance productivity per unit of area.

Finally, it was found that extension contact positively affects soybean production technology, which implies the need for more regular contact and extension services. Thus, the extension system needs to be strengthened further to increase the flow of agricultural information. It is necessary to establish strong network between farmers, research, and extension and policy makers. Therefore, it requires improvement of the asset position and information generation and utilization capacity of farmers if successful adoption of soybean technologies is desired.

References

[1] Alemitu Mulugeta. 2011. Factors affecting adoption of improved Haricot bean varieties and associated agronomic practices in Dale woreda, SNNPRS. MSc Thesis, Hawassa University.

[2] ATA (Agricultural Transformation Agency). 2014. Transforming agriculture in Ethiopia. *Annual report.* 2013/2014.

[3] CDI (Center for Development Innovation). 2010. Developing New Value-Chains for Soybean in Ethiopia, *Policy Brief.*

[4] Chilot Yirga and R.M. Hassen, 2013. Determinants of Inorganic Fertilizer Use in the Mixed Crop Livestock Farming System of Central Highlands of Ethiopia. *African Crop Science Journal,* vol. 21. pp. 669-68.

[5] CSA (Central Statistics Agency), 2014.Agricultural sample survey, report on area and production of crops. Addis Ababa, Ethiopia.

[6] FAO (Food and Agricultural Organization). 2010. International Assessment of Agricultural Knowledge, Science and Technology for Development: Summary for Decision Makers of the Sub-Saharan Africa report.

[7] Gibegeh, B.D and Akubuilo J.C. 2013. Socio-economic determinants of adoption of Yam minister by farmers in rivers states, Nigeria. *Wudpecker journal of Agricultural Research.*

[8] Idrisa, Y.L., Ogunbameru, B.O. and Madukwe, M.C. 2012.Logit and Tobit analysis of the determinants of likelihood of Adoption and Extent of Adoption of Soybean seed in Borno state, Nigeria. *Greener Journal of Agricultural Sciences.* vol. 2 (2), pp. 037-045.

[9] Jain Rajni, Alka Arora and Raju, S.S. 2006. A novel Adoption Index of Selected Agricultural Technologies: Linkages with Infrastructure and Productivity. *Agricultural Economics Research Review*. vol. 22, pp. 109-120.

[10] Kariyasa K and Dewi A. (n.d).Analysis of factors affecting Adoption of Integrated crop management in farmers' field school. *International Journal of Food and Agricultural Economics*. Vol. 1 No. 2, pp. 29-38.

[11] Million Tadesse. 2010. Essay on contracts, Risk coping and Technology Adoption in Ethiopia. Department of Economic and Resource Management, Norwegian University of Life Science.

[12] Mohammed Yemam. 2013. Selected Soil Quality Indicators under different land use management and soil types at Pawe North Western Ethiopia.

[13] Olagunju, F. I., Lyabo, S. and Kayode, K. 2010. Effects of adoption pattern of fertilizer technology on small scale farmer's productivity in Boluwaduro, Nigeria. Department of Agricultural Economics and Extension, Ladoke Akintoala University of Technology.

[14] Omonona, B. T., Oni, O.A. and Uwagboe, A.O. 2005. Adoption of Improved Cassava Varieties and its Welfare Impact on Rural Farming Households in Edo State, Nigeria. J.*Agric. Food Info.* 7(1): 39-55.

[15] PARC (Pawe Agricultural Research Center), 2010. Soybean production manual (unpublished).

[16] Pawe District Beuro of Agriculture. 2014. Agricultural report.

[17] Rahemeto Negash. 2007. Determinants of Adoption of Improved Haricot Bean Production Package in alaba Special Woreda, Southern Ethiopia. MSc. Thesis, Haramaya University.

[18] Saka, J. and Lawal, B. 2009. Determinants of adoption and productivity of improved rice variety in south Nigeria. *African Journal of Biotechnology* Vol. 8 (19), pp. 4923-4932.

[19] Techane Adugna, Mulut Demek and Bezabhe Emana. 2006. Detrminants of Fertilizer Adoption in Ethiopia: The Case of Major Cereal Producing Areas. *Agricultural Society of Ethiopia.*

[20] Yamane, T. 1967. *Statistics: An Introductory Analysis, 2nd Ed*. New York: Haper and Row.

(Received 14 June 2016; accepted 12 July 2016)