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Analyses of Factors Determine the Rate and Level of Improved Soybean Variety Adoption Under Smallholder Farmers in North Western Ethiopia

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Abstract
Adoption of improved soybean varieties has vital role on enhancing of soybean production and productivity to fill the demand gap of soybean output in domestic oil and food processing factories as well as to substitute the imported palm oil. However, different socio-economic and institutional factors hindered the adoption and adoption level of improved soybean varieties. The main objective of this study was to determine factors affected the adoption and adoption level of improved soybean variety under smallholder farmers in north western Ethiopia. Descriptive and Tobit model were used to analyze the data. Total 167 soybean producers (67 improved and 100 local soybean producers) were taking using systematic and random sampling methods. The descriptive statics result showed that 40.12% and 39.06% of adoption rate and level of improved soybean varieties was occurred in terms of respondent response and area coverage respectively. Both the adoption rate and level is higher in Pawe district (29.34% and 25.90%) and lower in Jawi district(10.78% and 13.16)respectively. The Tobit regression result revealed that participation on soybean demonstration, cooperative membership, training, soybean output affected adoption and adoption level of improved soybean varieties positively whereas seed cost and distance to nearest market affected negatively. The findings suggest that government and stakeholders focus on expanding demonstration approaches, cooperative institution, and market centers nearest to producers and private improved soybean seed enterprise to enhance smallholder farmers' income as well as to supply enough soybean output to domestic oil and food processing factory.
Keywords: Adoption rate, adoption level, domestic oil and food processing factory, demand, Tobit model
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1. Introduction

In Ethiopia, agriculture served as main source of foreign currency, staple foods for domestic consumption, and raw materials for domestic agro industries like food, feed, brewery and oil factories. Considering these facts, Ethiopian Growth and Transformation II (GTP II) program has emphasis on production of food security and industrial crops that has high productivity potential, nutrient value, high demand market with the aim of commercializing smallholder farmers by creating market linkage with potential consumers and industries(GTPII, 2015).

Soy bean is an industrial crop which used for human food, animal feeds, soil nutrient improvement and raw material for agro-industries (Abebe Z, 2015). Production of this crop is vital in Ethiopia to overcome food insecurity and malnutrition and can substitute the relative expensive of animal protein. Potentially, it grows in Benshangule Gumuz, Oromia, Amhara, Tigray and South Nation and Nationalities people and become the main of source of income for smallholder farmers(Bekabil, 2015).Soy bean was introduced to Ethiopia in the early of 1950s and becomes one of the most vital low land crops and adapted to low to medium agro ecology predominantly produced by smallholder farmers(Hagos and Bekele, 2018).

Soybean was introduced lately in Benshangul gumuze and Amahara regions during the resettlement program in 1986. However, it is dominantly produced by smallholder farmers in Metekel and Awi zones of Benshangul Gumuz and Amhara regional states respectively and it becomes the main source of income and base of their livelihood to smallholder soybean producers (CSA, 2018). Hence, the Government of Ethiopia has planned and implemented Agricultural growth and transformation program II (GTP II) and Agricultural research and extension program to improve the livelihood of rural households' through use of improved agricultural technologies. High yielding improved variety is among the vital agricultural technologies promoted and considered as industrial crop by the country's GTP II and Agricultural research and extension system. Soy bean is one of the industrial crops that has been given due emphases in GTP II as well as in Research development program. In GTP II, soy bean production has been planned to reach 1.2 million qt in 2020 from 0.72 million qt in 2015 to meet the market demand by linking to industries and exports (GTPII, 2015). To achieve this aim, Ethiopian institute of agricultural (EIAR) released 26 new improved soybean varieties and seven of them were released through Pawe agricultural research center (Hailu and Kelemu, 2014).

However, in some potential areas, willingness to produce soybean become decreased, its production growth

becomes stagnant due to low or nil demand of soybean for consumption and marketing, monopolistic soybean trade, high transaction cost to sell at district market and poor infrastructure facilities and high transport cost. Furthermore, smallholder farmers were not full adopted the newly released improved high yielding soybean varieties and used local soybean variety that decreases the productivity and production of soybean in the study area. As result its production level did not increased as expected in GTP II 1.2 million qt at the end of 2020. On the current production and marketing system it has 0.4 million qt of unachievable production gap, still fluctuated and low price of output price 11 ETB per kg. Moreover, the determinant factors of improved soybean varieties adoption were not known to promote soybean production and to fill this production gap. Due to this, it is difficult to full fill the current production gaps occurred in the GTP II of soybean production.

Furthermore, the empirical studies conducted related to adoption of improved soybean variety were limited in its content and area coverage. (Miruts, 2016) has conducted Analysis of the Factors Affecting Adoption of Soybean Production Technology in Pawe District, Metekele Zone of Benshangul Gumuz Regional State, Ethiopia. The result identified that land holding, family size, number of livestock owned, extension contact was the determinant of improved soybean technology. (Kedir *et al.*, 2017) has conducted adoption and impact of improved soybean (Belesa-95) variety among smallholder farmer in Bambasi distict, Benshangul Gumuz region. The paper result showed that sex of household head, cooperative membership, oxen ownership, participation on training and demonstration was the determinant of improved soybean adoption. This paper indicated that improved soybean variety beneficiaries were earned birr 1118.1 amount of income greater than non-adopters. (Diro *et al.*, 2017) has also conducted Factors affecting adoption and degree of adoption of soybean in Ilu-Ababora Zone; Southwestern Ethiopia. The result of paper revealed that training on soybean production, education of the household head and access to extension service, farm size, age of the household head and distance to the market was the determinant of improved soybean variety adoption.

However, almost all these empirical researches were focused on determinant of adoption as well as limited in area of coverages. This research is wider in area coverage as well as content that conducted in Northern western Ethiopia that covers two regions (Amhara and Benshangul Gumuz) and determined both the rate and level of improved soybean adoption. Therefore, it is essential to determine the factors affecting the adoption and adoption level of improved soybean variety. The result of the paper is important to boost the soybean production at national level and to substitute the import of soybean for domestic oil and food factories. It is also important to targeted agricultural extension activities, evidence based decision and policy options for increasing soybean production of smallholder farmers. Then this paper is intended to fill the knowledge gap of determinant of improved soybean variety of the smallholder farmers.

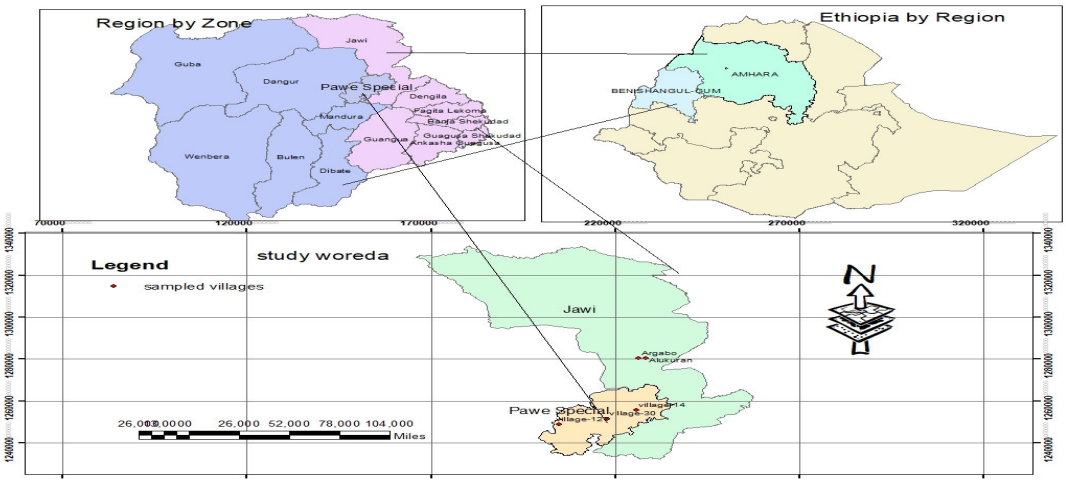
Therefore, this research has focused on factors determining improved soybean varieties adoption and adoption level under smallholder farmers in North western Ethiopia.

2. Research Methodology

2.1 Description of the study area

The study is conducted in Pawe district, Metekel zone Benshangul Gumuz region and in Jawi district, Awi zone Amhara region, North Western Ethiopia. Pawe city is the capital city of Pawe district. it found at 567 Km to North West direction far away from Addis Ababa with geographical location at $36^0$27’21.88’’- $36^0$28’22.95’’ longitude and latitude of $11^0$20’04.93’’-$11^0$17’50.43’’. It covers an area of 63,400 hectare with estimate population of 59,127(50.76%male) inhabitants (PDAO, 2018). The farming system of the district is characterized as mixed crop-livestock farming system dominated by cereal and pulses crops. Among the pulses, soybean takes a lion share in terms of production and area coverage (CSA, 2018). The district is bounded in East and North by Jawi district, in South by Mandura district, in West by Dangur districts. It is characterized as warm humid low land area with high rain fall. The district has 20 kebeles and the climate of the area is hot humid and characterized by unimodal rainfall pattern with high and heavy 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 with mean annual temperature of 16^0c to 32^0c which ranges 12^0c to 40 ^{0}c (Miruts, 2016).

Jawi is found at 602 Km to North West direction far away from Addis Ababa with geographical location at $36^0$29’17.58’’ longitude and latitude of $11^0$33’22.68’’. Fendika is the capital city of Jawi district. It covers an area of 515,400 hectare with estimate population of 122,259(53.08% male) inhabitants (JDAO, 2018). The farming system of the district is characterized as mixed crop-livestock farming system dominated by cereal and pulses crops. Among the pulses, soybean takes a lion share in terms of production and area coverage (CSA, 2018). Jawi district is bounded in East by Dangla district, in South by Dangur and pawe district, in West by Quara districts and in North by Alefa Taqusa district. It is characterized as warm humid low land area with high rain fall. The district has 25 kebeles and the climate of the area is hot humid and characterized by unimodal rainfall pattern with high and heavy rainfall that exceeds from May to October. The area receives mean annual rainfall of 1250 mm and its altitude ranges from 700 to 1500 m.a.s.l with mean annual temperature of 16^0c to 320c which ranges 12^0c to 40 ^{0}c Jawi district agricultural office (JDAO, 2018).



Fig$_1$ Map of Study Area

2.2 Sampling method and sample size determination

The study used multi stage probability sampling methods. Awi and Metekel zones are the major soybean producers in Amhara and Benshagul Gumuz region respectively in North Western of Ethiopia which were target population for this study. In the first stage of probability sampling methods, soybean producer districts were listed and selected one districts from each zone using simple random sampling methods. Based on this Pawe and Jawi districts were selected randomly from Metekel and Awi zones respectively. In the second stage of probability sampling method, soybean producer kebles were listed with consecutive serial number in each district and three and two kebles were selected from Pawe and Jawi respectively using simple random sampling methods. In the third stage smallholder soybean producers were listed in consecutive serial number in each randomly selected kebles. Finally, soybean producer smallholder farmers were selected using systematic sampling method and probability proportion to sample size.

The total sample size was taken based on the following formula(Cochran, 2007).

$n = Z^2 (PQ)/e^2$ ---------- 1

Where

n - Is number of sample size , Z - Is 95% confidence limit i.e. 1.96

p - Is 0.3 (proportion of the population to be included in the sample i.e 30%)

q – Is 0.7 proportion of the population not to be included in the sample i.e 70%)

e - Is margin of error or degree of accuracy desired (0.05)

According this formula 167 sample households were taken from two districts. The sample distribution is illustrated as follow.

Table 1 Smallholder soybean producers by Districts and Kebles

District	Keble	# of sample unit selected	Share of sample in %
Pawe	127	35	20.96
	14	44	26.35
	30	22	13.17
Jawi	Alukuran	37	22.15
	Arigabo	29	17.37
Total		167	100

Source: Survey data (2018)

2.3 Types and method of data collection

The study used both primary and secondary data which collected through structured questionnaire and checklists respectively. Primary data were collected by trained enumerators from sample households of soybean producers through face to face interview whereas secondary data were collected from published and unpublished documented of zonal and district administrative offices. In addition to this, personal observation, focus group discussion and key informant interviews were conducted to support the interpretation of the result obtained from field survey.

2.4 Methods of data analysis

2.4.1 Descriptive Statistics

Descriptive statistics like mean, standard deviation and frequency were widely employed to describe the socio economic and institutional characteristics of sample households in study area.

2.4.2 Definition and rate of improved soybean variety Adoption

Adoption is a decision to use of improved variety as the best course of action available. The decision to adopt improved soybean variety, involves a process composed of learning, deciding, and acting over a period of time. The way in which an individual adopts an improved new variety is involves the following five steps namely, awareness stage, interest stage, evaluation stage, trial stage and adoption stage (Kedir *et al.*, 2017) . In this case, smallholder farmers who used and cultivated improved soybean variety in the last five years considered as adopters. Smallholder farmers who used and cultivated soybean varieties more than five years considered as non-adopters or local/old/ soybean variety producers since the gene potential of varieties become decreased after five years. The rate of improved soybean variety adoption was the percentage of improved soybean variety sown out of the total sample taken while its level of adoption was share of area coverage by improved soybean variety out of the total sown soybean area.

The adoptions of improved soybean varieties were analyzed using the Tobit model.

Tobit is more appropriate to measure the probability of adoption and level of soybean variety use and also (Regasa Dibaba *et al.*, 2018) used this model to determine the intensity of improved teff variety adoption in Benshagul region. Tobit model is more advantageous over Probit model when the dependent variables are binary and continuous characteristics. Mathematically, it expressed as follow

$$Yi = \beta i + Xi + Ui \quad ---------- \quad 2$$

Where Yi = the observed dependent variable, in this the area under improved soybean varieties

Xi = explanatory variables

βi = parameters to be estimated

Ui = is an error term

The parameter of the model was estimated using the maximum likelihood method. Similarly (Tobin, 1958), the expected value of adoption and level of soybean improved varieties adoption across all observation were estimated

$$E(Y) = X\beta F(z) + \delta f(z) \quad ---------- \quad 3$$

Where z = Xβ/σ, F(z) is the cumulative distribution function, f(z) is the value of derivative of the normal curve at a given point, Z is the value of Z- scores for the area under normal curve, β is the vector of Tobit maximum likelihood and σ is the standard error of the error term. As (Maddala, 1986) justified, the marginal effects of the explanatory variables on the expected value of dependent variables is estimated as follow

$$\frac{\partial E(Yi)}{\partial \boldsymbol{Xi}} = F(z)\beta i \quad ---------- \quad 4$$

And the change in probability of area under improved soybean varieties as the explanatory variables change is calculated as

$$\frac{\partial F(z)}{\partial Xi} = \frac{f(z)\beta i}{\sigma} \quad ---------- \quad 5$$

Also the change in the level of adoption with respect to a change of explanatory variables among variety adopters is estimated as

$$\frac{\partial E\left(\frac{Yi}{Y} * > 0\right)}{\partial Xi} = \beta \left[1 - \frac{zf(z)}{F(z)} - \left[\frac{f(z)}{F(z)}\right]\right] \quad ---------- \quad 6$$

2.4.3 Variable definition and its measurement used in the Model

Table 2 Summary of variables used in the model

Variables	Measurement	Expected Sign
Sex	Dummy, Yes/No	+
Age	Continuous, years of old	+
Education	Dummy, illiterate/literate	+
Soybean farming experience	Continuous, growing in year	+
Soybean demonstration	Dummy, Yes/No	+
Cooperative membership	Dummy, Yes/No	+
Food security status	Dummy, Food secure/Food insecure	+
Access to Financial service	Dummy, Yes/No	+
Training on soybean production	Dummy, Yes/No	+
Extension contact with DA	Dummy, Yes/No	+
Soybean output	Continuous, output of soybean in qt	+
Cost of fertilizer	Continuous, cost of fertilizer incurred/ha	-
Cost seed(birr/ha)	Continuous, cost of seed incurred/ha	-
Distance to nearest market	Continuous, measure in minute	-

3 Results and Discussion

The study was conducted in North Western Ethiopia particularly Jawi and Pawe districts. It examines the factors

that affected the adoption rate and adoption level of improved soybean varieties under smallholder farmers. It used descriptive statistics and Tobit models method to analysis the data

3.1 Descriptive Results

Descriptive statistics were employed to describe the socio economic and institutional characteristics of sample households in study area. The descriptive results revealed that adopter households were statistically different from non-adopter groups in participation on demonstration, cooperative membership, training, soybean output, cost of seed and distance to nearest market place in minute whereas the adopter groups did not make significance difference in terms of sex of household head, age, soybean farming experience, food security status, cost of fertilizer, education, access to financial institution and extension contact with development agents (Table 3 and 4). The result is in line with (Regasa Dibaba *et al.*, 2018), (Diro *et al.*, 2017) and (Kedir *et al.*, 2017)

3.1.1 Demographic and socio economic characteristics of sampled households'

Majority of the sample households were male head(91%) and 9% of them were female headed households. 35.93% and 4.18% of the total sample households' were male and female household headed that adopted improved soybean variety respectively. The result of chi2 statistics revealed that sex of household has no difference on adopting of improved soybean variety. The average ages of adopters are slightly greater than the non-adopters of improved soybean varieties (43.71) years old with no statistical significance among them. Majority of sample households' educational level were illiterate (53.89%) and the rest of them were literate (46.11%). Among these 18.56% and 35.33% of them were adopter and non-adopters of illiterate sample households respectively. The chi2 statistics indicated that there is no educational level difference on adoption of improved soybean variety the finding is familiar with(WelayTesfay, 2019). About half of sample households were member of cooperatives (46.71). Out of this figure 31.14% and 15.37% of them are Adopter and non- adopter of improved soybean varieties. The result revealed being member of cooperative has positive effect on adoption of improved soybean variety at 1% significance level the finding is familiar with (Kedir *et al.*, 2017). This is due to cooperatives are an engine for smallholder farmers to produce more agricultural output by supplying improved crop varieties, farm tools, access to different credits and fertilizers. Quarter of sample households has been taken trainings related to soybean production practice and it has positive effect on improved soybean variety adoption. This is due to farmers get technical and practical skills through training and more susceptive to adopt improved technologies. Almost all of sample households (90.42%) were reported that food security status is secured mean able to produce annual consumption demand. There is no statically difference between adopter and non-adopters.

Table 3 Summary of statistics for Demographic and Socio-economic variables

Demographic/socio economic Variables	Adopter mean	Non-adopter mean	Total sample mean	T-test or X^2 Value
Sex				0.29
Male	60	92	152	
Female	7	8	15	
Age	43.71	42.09	43.72	-0.92
Education				2.62
Illiterate	31	59	90	
Literate	36	41	77	
Cooperative membership				
Yes	**52**	**26**		**42.94*****
No	**15**	**74**		
Soybean demonstration				**14.29*****
Yes	**24**	**29**	**53**	
No	**43**	**71**	**114**	
Food security status				0.72
Food secure	92	59	151	
Food insecure	8	8	16	

Source: Survey data (2018)

*, **, *** Statistical Significance level at 1, 5 and 10% respectively

3.1.2 Institutional and social characteristics of sampled households'

The institutional factors like access to financial service and contact with development agents have no statistically significance among adopters and non-adopters of improved soybean variety the finding is familiar with (WelayTesfay, 2019). The smallholder farmers' access to financial institution is poor in the study area. Only 37.72% of sample households 14.37 adopters and 23.35% non-adopters were access to financial service. This is due to limited of outreach of rural finance in study area. The chi2 result showed that there is no statistical significance between adopter and non-adopters. This is due to poor saving habit as well as few amount money is saved in financial institution. This indicates that, even the saved money is not good enough to purchase improved

agricultural technologies. The majority of sample households have been gained extension services during the study period (86.76 %), which is 25.75% adopter and 61.01% non-adopter).

Institutional and social factors like member of community leadership, training gained in soybean production and soybean output obtained has positive effects on the adoption of improved soybean variety the finding is familiar with (Kedir *et al.*, 2017), (Regasa Dibaba *et al.*, 2018) and (WelayTesfay, 2019). 25.14 %(13.77 adopter and 11.37 non-adopter) and 46.46 %(20.96 adopter and 25.50 non-adopter) of the total sample households were member of community leadership and taking training on soybean production. Chi 2 results showed that member of community leadership and training on soybean production has positive effect and statistically significance at 5% and 1%, respectively. It is obvious that being member of community leadership helps to distinguish the importance of improved technology and trained on soybean production helped and encouraged to adopt improved soybean variety.

Other socio economic factors like soybean farm experience, income from sell of soybean and cost of fertilizer was not showed statistically significance. Adopters of improved soybean varieties were experienced more in soybean farming, earned higher income from sell of soybean and expense lower fertilizer costs than the non-adopters. However, the T-test value result showed statistically insignificance. Cost of seed has negative effect on the adoption of improved soybean varieties. The T-test results showed that negative statistical significance difference at 5% to adopt improved soybean variety. This is because of adopters used near to the recommended seed rate than non-adopters as well as incurred lower cost of seed than non-adopter. The result is in line with (Miruts, 2016). The distance in minute to district market affects the soybean producers negatively. The T-test showed that negative statistical significance at 5% to adopt improved soybean variety. This indicated that as nearest market far away, they are less likely to adopt the improved soybean varieties. The result is in line with(Kedir *et al.*, 2017).

Table 4 Summary of statistics for Institutional and social variables

Social and institutional variables	Adopter mean	Non-adopter mean	Total sample mean	X^2 or T-test Value
Access to Financial service				0.17
Yes	24	39	63	
No	43	61	104	
Training on soybean production				**13.8*****
Yes	**49**	**44**	**93**	
No	**18**	**56**	**74**	
Extension contact with DA				0.26
Yes	43	68	111	
No	24	32	56	
Member of community leaders				**5.01****
Yes	**23**	**19**	**42**	
No	**44**	**81**	**125**	
Soybean farm experience	6.64	6.15	6.35	-.75
Soybean output	**21.15**	**17.89**	**19.20**	**1.66***
Cost of fertilizer(ETB)	228.28	232.9	231.05	0.05
Cost seed(ETB)	**770.63**	**966**	**887.62**	**-1.95****
Distance to market in '	**45.24**	**61.31**	**54.86**	**-2.03****
Income from soybean sell	11,388.36	9739.30	10,400.90	1.42

Source: Survey data (2018)

*, **, *** Statistical Significance level at 1, 5 and 10% respectively

3.1.3 Improved soybean variety adoption rate and level of adoption in North western Ethiopia

The adoption rate of improved soybean variety is the percentage of improved soybean variety sown out of the total sample taken while its level of adoption is share of area coverage by improved soybean variety out of the total sown soybean area. The adoption rate of improved soy bean variety is larger in Pawe district (29.34%) than Jawi district (10.78%). On average 40.12% of the sample household head responses were iam Adopter (use improved soybean variety) whereas the rest 59.64% responses were non adopters. The adoption level of improved soybean varieties is also larger in Pawe district (25.90%) than Jawi district (13.16%). The level of improved soybean adoption is 39.06% which is the area covered by improved soybean varieties(97.98 hectare) out of the total area cultivated under soybean(250.86 hectare) by whole sample smallholder farmers. The chi2 test showed that there is statistically significance between the two districts in terms of adoption rate and level of improved soybean varieties (Table 5). This is due to the high contact with researchers and Pawe district is nearest than Jawi district to the Pawe research center. Near distance to research area affects positively to adopt improved soybean variety the finding similar with(Kedir *et al.*, 2017).

Table 5 Improved soybean varieties rate and level of adoption in North western Ethiopia

District	Rate of improved soybean varieties adoption		% Adopter	% Non-Adopter
	Adopter	Non Adopter		
Pawe	49	52	29.34	31.14
Jawi	18	48	10.78	28.74
Total	67	100	40.12	59.88
	Level of improved soybean varieties adoption			
Pawe	64.98	68.63	25.90	27.36
Jawi	33	84.25	13.16	33.58
Total	97.98	152.88	39.06	60.94

Source: Survey data (2018)

Improved soybean producers by region Pearson chi2 = 7.50 and Pr = 0.006

3.1.4 Adoption rate of improved soybean varieties

Most of sample households prefer Belesa 95 variety (59.28%). Among these 25.15% were adopters and the rest 34.13% are non-adopters. 32.34% of the sample households prefer TGX variety. Among these 13.17% were adopters and 19.17% were non-adopters. However 8.38% of the sample households were not sure about the variety they sown. Among these 6.58% were non-adopters and 1.8% were adopters.

Table 6 Sample household head soybean variety use

Sample HHs	Belesa 95	TGX	Did not know
Adopter	42	22	3
Non-Adopter	57	32	11
Total	99	54	14

Source: Survey data (2018)

3.2 Result of Econometrics Analysis

3.2.1 Determinant of improved soybean variety adoption and Model of adequacy

The Tobit model was employed to identify factors that determined the rate and level of improved soybean varieties adoption. To identify the adoption rate and level of improved soybean producers in North Western Ethiopia fourteen explanatory variables has been taken. Multi collinearity and heteroscedasticity problem among explanatory has an effect on model output estimation. Hence, before running of the Tobit model multi collinearity and heteroscedasticity problem among explanatory variables were checked using VIF and Breusch-pagan **See Appendix I**. The chi-square ($\chi 2$) distribution was used as the measure of overall significance of a model in Tobit model estimation.The prob > chi2 = 0.0000 is used to test the dependence of the adoption of improved soybean varieties on the selected independent variables in the model (the hypothesis that all coefficients are equal to zero is rejected at 1% significance level). The pseudo R^2 (0.2555) which indicates that 25.55 % of the improved soybean variety adoption is explained by the explanatory variables include by the model.

In the model prob > chi2 = 0.0000 indicated that the Tobit model is adequate to determine the factors that influenced the adoption of improved soybean variety. Hence, the adoption decision of improved soybean varieties by households is best explained by the Tobit mode. The results of the model show that out of the fourteen variables included in the model, six variables are correlated with probability of improved soybean varieties adoption and found to have statistically significant effects on the adoption of improved soybean varieties. The Tobit model outputs showed that participation of soybean demonstration, member of cooperative, taking training on soybean production practices, amount of soybean output produced are variables that positively influencing the adoption improved soybean varieties whereas improved soybean seed cost and distance to farmer training center in minute are variables negatively influencing the adoption of improved soybean varieties in North western Ethiopia.

Table 7 Determinant of improved soybean varieties adoption

Variables	Coef.	Std. Err	T-value	P>T
Sex	-0.057	0.262	-0.22	0.83
Age	0.004	0.006	0.59	0.56
Education	0.133	0.151	0.88	0.38
Soybean farming experience	0.018	0.018	1.01	0.31
Participation on demonstration	**0.417**	**0.156**	**2.68**	**0.01*****
Cooperative membership	**0.918**	**0.161**	**5.70**	**0.00*****
Food security status	-0.068	0.234	-0.29	0.77
Access to financial institution	-0.199	0.157	-1.27	0.21
Training on soybean production	**0.394**	**0.160**	**2.46**	**0.02****
Extension contact	0.045	0.159	0.28	.078
Soybean output	**0.018**	**0.008**	**2.4**	**0.02****
Fertilizer cost	-0.000	0.0001	-1.55	0.12
Seed cost	**-0.001**	**0.0002**	**-2.98**	**0.00*****
Distance to market in ‘	**-0.0002**	**0.0001**	**-1.83**	**-0.07***
Constance	-0.891	0.544	-1.64	-1.64
Observation = 167				
LRchi^2 = -83.56				
Prob>chi^2 = 0.000				
Pseudo R^2 = 25.55				

Source: Survey data (2018)

***, **, and * are significant at 1%, 5%, and 10% significance levels, respectively.

3.2.2 Factors determining adoption level of improved soybean varieties

The factors that affect the adoption of improved varieties and its level of adoption were identified using the Tobit model. Fourteen explanatory variables were included in the model to identify the determining adoption and adoption level of improved soybean varieties under smallholder farmers in north western Ethiopia. Six out of fourteen variables were statically significance and determined the adoption and adoption level of improved soybean varieties in North western Ethiopia. The result of Tobit model indicated that participation on soybean demonstration, cooperative membership, training on soybean production, soybean production, seed cost of improved soybean and distance to nearest market in minute was determined adoption and level of adoption of improved soybean varieties. These determinants are affecting the adoption and level of adoption of improved soybean varieties.

Participation on soybean demonstration: The participation on soybean demonstration has positive effect and statically significance at 1% both on the adoption and level of adoption improved soybean varieties in north western Ethiopia (Table 8). This implies that smallholder farmers who are participated on soybean demonstration are more likely to adopt the improved soybean varieties. This is due to farmers more believed on practical exercising than theoretical. Moreover, participation on soybean adoption was increased the area cultivated under improved soybean varieties by 18.20, 13.74 and 21.71% on average for the adopter, non-adopter and whole respondent respectively. The finding is in line with (Bezabih, 2012) and (Kedir *et al.*, 2017)

Cooperative membership: being a member of cooperative has positive effect on adoption and level of adoption of improved soybean varieties at 1% statistical significance level (Table 8). This is due to cooperative members are more advantageous on accessing financial service, cooperative extension, inputs and output markets. This facilitated the adoption of improved soybean varieties. As a result, area cultivated under improved soybean varieties enhanced by 40, 30.25 and 45.65% on average for the adopter, non-adopter and whole respondents respectively. The finding is in line with (Aweke, 2013) and (Kedir *et al.*, 2017)

Training on soybean production: Training on soybean production has an ability to fill the gap of knowledge and skill of smallholder farmers how to use improved inputs, agronomic practices, control disease and pests. The result of the Tobit model revealed that training on soybean production has positive effect and statically significance at 5% on adoption and level of adoption of improved soybean varieties (Table 8). In addition to this, it enhanced the area cultivated under improved soybean varieties by 17.18, 13.00 and 20.37% on average for the adopter, non-adopter and whole respondents respectively. The result is in line with (Regasa Dibaba *et al.*, 2018), (Diro *et al.*, 2017) and (WelayTesfay, 2019)

Soybean output: The smallholder farmer who was cultivated soybean area and obtained more output of soybean has positive effect and statically significance at 5% on the adoption and level of adoption of improved soybean varieties (Table 8). This is due to the output of soybean obtained from a given of cultivated area is motivated to adopt the new improved soybean varieties with the demand of gaining higher soybean output in the future. Consequently soybean output obtained is increased the area cultivated under improved soybean varieties by 0.8, 0.6, and 0.9% on average for the adopter, non-adopter and whole respondents respectively.

Cost of improved soybean seeds: it has negative effect and statically significance at 1% of significance level on adoption and adoption level of improved soybean technologies (Table 8). This is obvious that smallholder farmers are sensitive to increment of input price particularly improved crop varieties and substitute the improved soybean varieties by their own saved local seeds or forced to purchase uncertified soybean seeds from neighbor, related farmers and traders. Adoption of improved soybean varieties by smallholder farmers decreased as the cost of improved soybean increased. As result, it decreased the area cultivated under improved soybean varieties by 0.02, 0.02 and 0.03% on average for the adopter, non-adopter and whole respondents respectively. The finding is in line with(WelayTesfay, 2019)

Distance of soybean market place in minute: it has negative effect and statically significance at 10% on adoption and adoption level of improved soybean varieties (Table 8). This implies respondents who are nearest to soybean market place are more likely adopted improved soybean variety than the furthest one. This is due to farmers nearest to input and output markets are more informed about the importance of improved technology than those who are in furthest areas. The finding is in line with (Awesa, 2015), (Kedir *et al.*, 2017) and (WelayTesfay, 2019). Moreover it decreased the area under improved soybean varieties by 0.1% on average for adopter, non-adopter and entire respondents.

Table 8 Tobit estimation for soybean improved variety adoption

Explanatory variables	Area under improved soybean Variety					
	Coe.	Std. Err	**P>|T|**	Marginal Effect		
				Adopter	N/adopter	All sample
Sex	-0.057	0.262	0.83	-0.025	-0.019	-0.030
Age	0.004	0.006	0.56	-0.002	0.001	0.002
Education	0.133	0.151	0.38	0.058	0.044	0.07
Soybean farming	0.018	0.018	0.31	0.008	0.006	0.009
Participation on demo	**0.417**	**0.156**	**0.01*** **	**0.1820**	**0.1374**	**0.2171**
Cooperative membership	**0.918**	**0.161**	**0.00*** **	**0.40**	**0.3025**	**0.4565**
Food security status	-0.068	0.234	0.77	-0.03	-0.023	-0.036
Access to financial inst	-0.199	0.157	0.21	-0.087	-0.066	-0.0103
Training on soybean	**0.394**	**0.160**	**0.02****	**0.1718**	**0.130**	**0.2037**
Extension contact	0.045	0.159	.078	0.02	0.015	0.02
Soybean output	**0.018**	**0.008**	**0.02****	**0.008**	**0.006**	**0.009**
Fertilizer cost	-0.000	0.0001	0.12	-0.0001	-0.0001	-0.0001
Seed cost	**-0.001**	**0.0002**	**0.00*** **	**-0.0002**	**-0.0002**	**-0.0003**
Distance to market in ‘	**-0.0002**	**0.0001**	**-0.07****	**-0.0008**	**-0.001**	**-0.0011**

Source: Survey data (2018)

***, **, and * are significant at 1%, 5%, and 10% significance levels, respectively.

4 Summaries and Conclusion

The study was conducted at Metekel and Awi zone in North western Ethiopia, with the purpose of identifying the factors hinder and promote of improved soybean variety adoption and adoption level of smallholder soybean producers’. The descriptive statistics result revealed that adopter of sample households are relatively more engaged in cooperative membership, more food secure, getting training, member of community leader, experience of soybean farming, obtained higher soybean output, earned higher income from sell of soybean output and nearest to market place than the non-adopters. However, adopters used lower amount of fertilizer and seed of soybean per hectare and incurred lower cost of fertilizer and seed costs. In addition to this, adopters are less educated, lower participation on demonstration, less accessed to financial service, extension contact with development agent than non-adopters. The adoption rate and level of improved soybean varieties is 40.12% and 39.06% in terms of respondent response and area coverage under improved soybean variety respectively. Both adoption rate and level of improved soybean varieties is greater in Pawe district (29.34% and 25.90%) than Jawi district (10.78% and 13.16) respectively. The result of Tobit regression showed that Participation on demonstration, cooperative membership, Training, soybean output, seed cost and distance to nearest market was the main factors that determining improved soybean varieties adoption and adoption level in the study area. The four former variables have statistically significance and positive effect whereas the latter two variables have statistically significance and negative effect on the adoption and adoption level of improved soybean variety respectively. Therefore, government, policy maker, planners, research centers, Agricultural offices and stakeholder who participated on soybean production sector should be focused on expanding demonstration approaches, cooperative institution, and market centers nearest to producers and establish private improved soybean seed multiplier to enhance improved soybean seed accessibility at fair price, income of smallholder farmers as well as to supply enough soybean output to domestic oil processing factory and to substitute imported palm oils. This enhanced the adoption and level of adoption of improved soybean varieties in particular and other crop varieties in general. As consequences the

livelihoods of smallholder farmers become improved.

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5 References

Abebe Z, A.D., Woldemeske E, (2015). On farm yield responses of sobean(glycine max L(merrill) to fertiizer sources under different acidicity status in Gobu Sayo district, western Ethiopia. Journal of Agronomy 14, 30-36.

Aweke, M., (2013). Factors Influencing Adoption of Improved Maize Varieties: The Caseof Goro- Gutu Woreda of Eastern Hararghe, Ethiopia presented to school of graduate studies of Haramaya University.

Awesa, D.D., (2015). Does Adoption of QunchoTef Increases Farmers' Crops Income? Evidence from Small Holder Farmers in WayuTuqa District, Oromia Regional State, Ethiopia.

Bekabil, U.T., (2015). Empirical review of production, productivity and marketability of soya bean in Ethiopia. International Journal of u-and e-Service, Science and Technology 8, 61-66.

Bezabih, T., (2012). Study On The Intensity And Adoption of Improved Wheat Varieties And Associated Agronomic Practices In Kaffa Zone, The Case Of Gesha Woreda. Indira Gandhi National Open University (IGNOU).

Cochran, W.G., (2007). Sampling techniques. John Wiley & Sons.

CSA(Centeral Statics Agency), (2018). Area and production of major crops Centeral Statistics, Government of Ethiopia.

Diro, S., Asfaw, E., Erko, B., Anteneh, M., (2017). Factors affecting adoption and degree of adoption of soya bean in Ilu-Ababora Zone; Southwestern Ethiopia. Agricultural Science Research Journal 7, 15-26.

GTPII(Growth Transformation Program II), (2015). Ministry of Agriculture and Rural Development Second Growth and Transformation program. Addis Ababa, Ethiopia.

Hagos, A., Bekele, A., (2018). Cost and returns of soybean production in Assosa Zone of Benishangul Gumuz Region of Ethiopia.

Hailu, M., Kelemu, K., (2014). Trends in Soy Bean Trade in Ethiopia. Research Journal of Agriculture and Environmental Management 3, 477-484.

JDAO(Jawi District Agriculture Office), (2018). Annual Agricultural activities performance report.

Kedir, M., Bekele, A., Zemedu, L., (2017). Adoption and Impact of Improved Soybean (Belessa-95) Variety among Smallholder Farmers in Bambasi Woreda, Benishangul Gumuz Regional State. Haramaya University.

Maddala, G.S., (1986). Limited-dependent and qualitative variables in econometrics. Cambridge university press.

Miruts, F., (2016). Analysis of the factors affecting adoption of soybean production technology in Pawe District, Metekele Zone of Benshangul Gumuz Regional State, Ethiopia. World Scientific News 53, 122-137.

PDAO(Pawe District Agriculture Office), (2018). Annual Agricultural activities performance report.

Regasa Dibaba, Afework Hagos, Chilot Yirga, Habite, E., (2018). Determinants of Improved Teff Varieties Adoption and Its Impact on Productivity: The Case of Non-Traditional Teff Growing Areas of Western Ethiopia. Journal of Natural Sciences Research Vol.8, No.22, 2018, 55-67.

Tobin, J., (1958). Estimation of relationships for limited dependent variables. Econometrica: journal of the Econometric Society, 24-36.

WelayTesfay, D.T., (2019). Impact of Improved Soybean Variety on Enhancing Productivityand Gross Farm Income of Smallholder Farmers in North Western Ethiopia. Journal of Natural Sciences Research Vol.9, No.15, 2019, 25-39.

Appendix I

Testing of multicollinearity

Variable	VIF	1/VIF
Soy product	1.76	0.567657
Cost seed	1.68	0.594318
Demo parti	1.18	0.844680
SEX	1.17	0.851833
Train soy	1.17	0.851891
Coop member	1.16	0.860113
Access save	1.15	0.870859
SOY_EX	1.13	0.885591
Food secure	1.13	0.885723
EDU	1.12	0.895360
Cost fertilizer	1.10	0.911884
AGE	1.08	0.923000
Exn contact	1.07	0.930619
DM in ‘	1.07	0.937801
Mean VIF	1.21	

hettest

Breusch-Pagan / Cook-Weisberg test for heteroscedasticity
Ho: Constant variance
Variables: fitted values of ImpGrowTwo
chi2(1) = 0.61
Prob > chi2 = 0.4345