

Full Length Research Paper

Determinants of adoption of improved Jalenea potato variety: The case of Chencha Woreda, Southern Ethiopia

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This study was to examine factors affecting adoption of improved Jalenea potato variety in the study area in the year 2017. Primary data for the study were collected from respondents using structured interview schedule. Focus group discussions were conducted with farmer and stakeholders. The data were analyzed using mean, percentage, frequency, chi-square test, and T-test. Binary logistic regression analysis was employed to identify factors affecting adoption of the variety. Age of the household negatively and significantly affected adoption whereas sex of the household head positively and significantly affected the adoption. Non-farm activity and farm income had positive and significant effect on adoption. Advisory service from extension agents, attending training and field day, and membership of seed multiplication cooperative had also positively and significantly affected adoption of improved Jalenea potato variety. The finding highlighted the importance of institutional support in the area of extension; training and farmers' cooperatives. Therefore, policy and development interventions should give emphasis to improving institutional support system.

Key words: potato, binary loggit, determinants, odds ratio, management practices.

INTRODUCTION

In many developing countries including Ethiopia, agriculture plays a vibrant role in promoting economic growth and development. The importance of agriculture in Ethiopia is evidenced by its share in GDP (43%), its employment generation (80%), share of export (70%) and providing about 70% raw material for the industries in the country in 2012/2013 (UNDP, 2013). Furthermore, 90% of the poor earn their livelihood from this sector (Yu and Nin, 2011). Thus, it is not surprising that policy action in Ethiopia is largely based on influencing the dynamism of

the agricultural sector. Agricultural productivity in general and crop production in particular has been given heavy emphasis over the last two decades in almost all development policies and strategies of the country. The Agricultural Development Led Industrialization (ADLI) places very high priority on accelerating agricultural growth in order to achieve food security of the nation (Byerlee et al., 2007). Agriculture was also the main focus of the 2002 Sustainable Development and Poverty Reduction Plan (SDPRP), and the 2004 Food Security

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Strategy, and also the 2006 Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) (MoFED, 2002; 2005; 2006). More recently, the first Growth and Transformation Plan (GTP) of Ethiopia also gave special emphasis to agricultural growth to achieve food security and poverty alleviation (2010-2015). One of the core goals of GTP is agricultural growth program which aims at increasing productivity to bring agricultural growth at the national level and maintain agriculture as a source of economic growth (MoFED, 2010).

Despite such policies focus on the sector over the last two decades, its productivity is constrained by lack of appropriate and affordable agricultural technologies, inefficiency in production, poor infrastructure, inefficient marketing systems, land degradation, rapidly expanding population, and inaccessibility to agricultural inputs such as improved/hybrid seeds, fertilizers and agrochemicals (Arega and Rashid, 2005; Yu and Nin, 2014). In addition, climate change, which is the principal causes for erratic rainfall and recurrent drought, is also another aggravating factor in the prevalence of low production and productivity of the sector. Besides, the sector mostly depends on rain-fed production system that is dominated by smallholders.

As a result, the growth in agricultural output has failed to provide food for the fast growing population and thus aggravated the food insecurity situation in the country. Thus, the goal of self-sufficiency in food production remains a long-term target and the question of making Ethiopia food self-sufficient continues to be a policy concern. Improvement of agricultural productivity provides an important solution in addressing the problems of food insecurity and poverty, and enhancing the development of agriculture in Ethiopia. Consequently, attempts are being channeled in ways by which increased agricultural productivity can be achieved through promoting the use of improved agricultural technologies and improving the efficiency of production of crops in Ethiopia (Yu and Nin, 2014). Potato (*Solanum tuberosum*) provides an opportunity for food security and value chain development. It is one of the most productive food crops in terms of yields of edible energy and good quality protein per unit area and per unit of time fitting into intensive cropping systems. Nutritionally, the crop is considered to be a well-balanced major plant food with a good ratio between protein and calories, and has substantial amount of vitamin, especially vitamin C, minerals, and trace element. Due to its correct balance between protein and calories, it is considered a good weaning food. Ethiopia has good climate and edaphic conditions for higher production and productivity.

Studies show that the average productivity of potato in Indonesia, Jordan, and Ecuador is 45 ton/ hectare even in Africa like Egypt the average productivity is 20- 25 tons/ hectare; but in Ethiopia where there is a suitable edaphic and climate condition for the production of high quality seed and ware potato, as the study by Tesfaye et al. (2012) on production and marketing of potato in

Ethiopia indicates that the total acreage of potato in Ethiopia exceeds 160,000 ha with an annual production of 1.28 million tons. The average yield of potato in Ethiopia is estimated to be 8 t/ha (Tesfaye et al., 2012). Indeed a recent study put the national average yield of potato at 10.5 t/ha which is very much low compared to the potential 50 t/ha elsewhere in the world.

Potato originated from South America, most probably from the central Andes in Peru. Potato has been grown by indigenous farming communities since its demonstration over 4,000 years ago. Introduced into Europe in the sixteenth century, the crop subsequently was distributed throughout the world, including Asia. It was introduced to most parts of SSA in the 19 century. Worldwide, potato comes forth in terms of production after wheat, maize, and rice. In many countries potato serves as a staple food because of its excellent nutritional content. Main potato production zones in the world are Indonesia 10125, Jordan 3400, Cheil 2149, Ecuador 2066, Uruguay 1700, Bolivia 1694, and Egypt 977. Generally total world production is 284,471 thousand tons per year. Potato production trend has shown that it is one of the fastest growing crops in SSA in relation to area coverage, but without a corresponding increase in productivity. Average yield in SSA is only about 8 t/ha, compared to a yield potential of about 40-50 t/ha. Potato arrived late in Africa, around the 20th century. Potato (*S. tuberosum*) has been grown in Ethiopia since the year 1859 (in the mid 19th century) and it was introduced by missionaries. Seventy percent of the arable land of Ethiopia is suitable for potato production.

In Bhutan, it is reported that the potential yield of potato can reach up to 50 t/ha (Joshi et al., 2012). In Ethiopia, the productivity of potato was very low, an average tuber yield of potato was almost between 6-8 t/ha in the last 20-30 years while the area planted with potato increased from 30,000 ha to about 160,000 ha in 2012. The development and dissemination of many improved varieties of potato contributed to the improvement and expansion of potato production in Ethiopia. Despite the production potentials and importance of potato crop for the country as well as the study area, there has been limited performance of farmers in potato farming.

Genetically improved varieties of staple crops can play an important role in ensuring the availability of sufficient food for a growing population (Rizvi et al., 2012; Serageldin, 1999). Potato is considered to be one of the main staple crops for ensuring food security (Knapp, 2008), providing more calories, vitamins and nutrients per unit area than any other staple crop (Sen et al., 2010). Improved varieties (IVs) have better yields (Chakraborty et al., 2000) and are more resistant to late blight (Song et al., 2003), virus and bacterial wilt (Thiele, 1999).

Potato (*S. tuberosum*) can play a significant role in ensuring access to food at the household level and can also generate income for smallholders, thereby contributing to the economic sustainability of agricultural

systems in developing countries (Thompson and Scoones, 2009). In Ethiopia, potato has increasingly become a source of cash income for farmers, and retains its importance for household consumption (Gildemacher et al., 2009a, b; Mulatu et al., 2005). Despite the benefits of improved potato varieties (enhanced yield and disease resistance), Ethiopian farmers are often reluctant to grow them. This is despite the efforts of the Ethiopian Institute of Agricultural Research (EIAR) which, with support from the International Potato Center (CIP), has distributed 18 improved potato varieties in the last two decades in an attempt to improve the performance of the potato sector (Gebremedhin et al., 2008). However, the rate of adoption of these improved potato varieties by ware potato farmers (farmers who grow potato for consumption rather than for seed) has been very low. Out of the total land allotted to potato production, only 0.5% of the land was covered by improved varieties in the 2013 main season (CSA, 2014a).

The Ethiopian Institute of Agricultural Research recognizes the problem with low adoption rates by ware potato farmers, although the causes have not been fully investigated. For example, the EIAR mentions shortage of improved seeds and poor supply systems as the main limiting factors (Gebremedhin et al., 2008). This assumes that adoption is low because of supply problems and potential adopters do not have access to IPVs. However, this view is not supported by empirical evidence.

Statement of problem

Adoption is a mental process through which an individual passes from hearing about an innovation to its adoption that follows awareness, interest, evaluation, trial, and adoption stages. It can be considered a variable representing behavioral changes that farmers undergo in accepting new ideas and innovations in agriculture anticipating some positive impacts of those ideas and innovations. The adoption of an innovation within a social system takes place through its adoption by individuals or groups. According to Feder et al. (1985), adoption may be defined as the integration of an innovation into farmers' normal farming activities over an extended period of time. It is also noted that adoption, however, is not a permanent behavior. This implies that an individual may decide to discontinue the use of an innovation for a variety of personal, institutional, and social reasons one of which might be the availability of another practice that is better in satisfying farmers' needs.

Dixon et al. (2006) posit that adoption of improved varieties can have impacts at different levels. First, improved varieties can generate significant field-level impact on yield and stability. Second, intensification of food crops often leads to the release of land, water and labor resources for on-farm diversification. Third, higher and more stable yields produce people-level impacts on household food security and household income. Fourth,

the combination of intensification and diversification creates further household level impacts on wider dimensions of household livelihoods and poverty reduction, including the off-farm effects on the local economy and in more distant cities.

Several studies in Africa show that adoptions of improved agricultural technologies, though variably and incompletely, had positive impacts on income, food security and poverty reduction (Wanyama et al., 2010; Solomon et al., 2010; Adekambi et al., 2009; Kassie et al., 2010). Increased productivity of potatoes can improve the livelihood of smallholder potato farmers in Ethiopia and is required to meet the growing demand. Despite the great opportunities that Ethiopia has which is suitable edaphic and climate condition for the production of high quality seed and ware potato, and about 70% available agricultural land is located at an altitude of 1800–2500 m which is suitable for potato production (Solomon, 1987 as cited in Tasew, 2008), there is a great gap between supply and demand for potato and the income from potato to the smallholder farmers is not as anticipated. This is because of problems of seed potato quality management, bacterial wilt late blight control, soil fertility management and marketing problems. SNNPR is one of the regional states and it is the third agriculturally potential crop producing regions in Ethiopia. The regional crop production data show that the total area allocated to potato production in 2015/16 was estimated at 15,978 ha and total production was 99,330 tons for Meher season (CSA, 2016).

In the region, the average potato yield was 6.95 t/ha which is very low and an estimated 455,382 people were involved in the production of potato in 2015/2016, which is about 22% of the households in the region (CSA, 2016). Jalenea potato technology package consisting of improved seed, seeding rate, fertilizer rate and spacing was introduced to the study area to improve the food security status by GOs and NGOs. People and institutions both outside and inside Ethiopia have conducted empirical studies on the adoption and diffusion of agricultural innovations. But the studies were mainly concerned with major cereals and thus, studies conducted in root and tuber crops particularly potato are very limited. So far there is no empirical information about the status of adoption of Jalenea potato variety and various factors influencing adoption of the variety in the study area. Therefore, this study was proposed to analyze determinants of adoption of improved Jalenea potato variety. This shows that there is need to conduct research work with the aim to assess factors affecting adoption of potato production.

METHODOLOGY

Description of the study area

This study was conducted in Chencha Woreda; located north east of Gamo Gofa zone of South Nations Nationalities People Regional

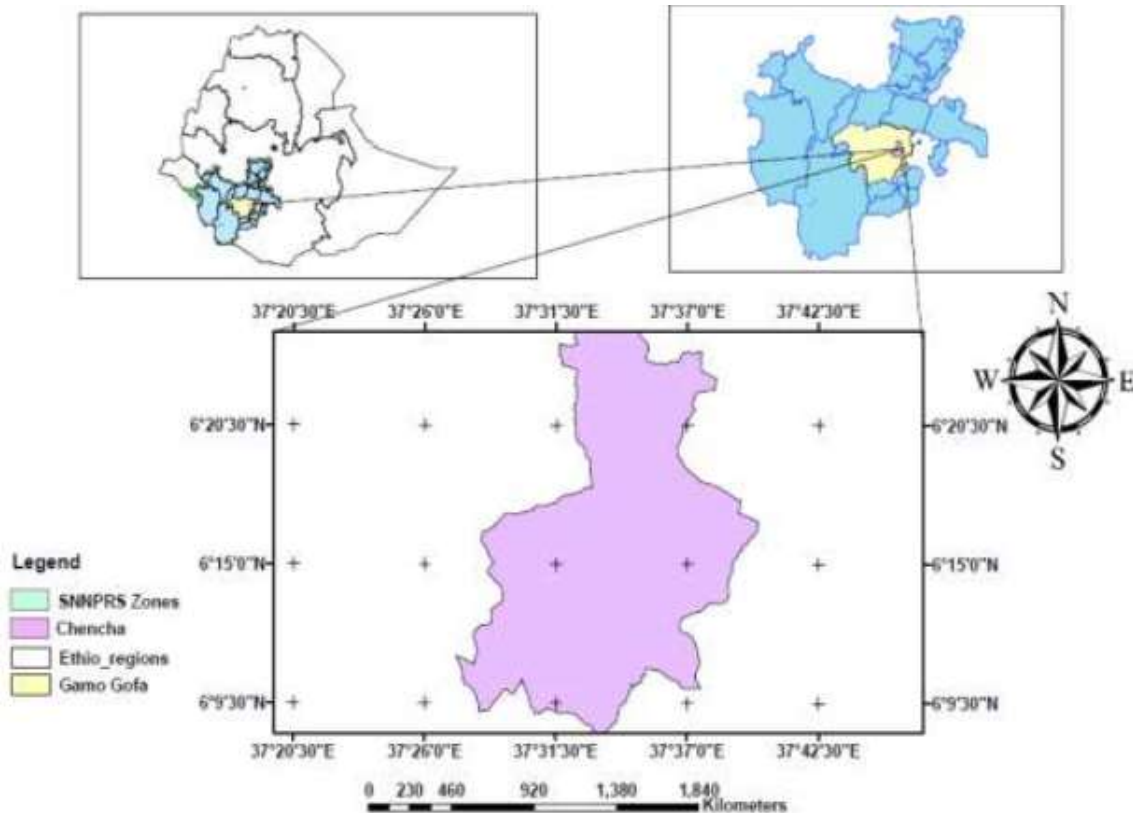


Figure 1. Map of the study area

State, Ethiopia. Chenchu Woreda is located at 542 km from Addis Ababa towards South direction. It is geographically located at 6.13-6.41 latitude and 37.46-37.65 longitude. The district covers an area of 374 square kilometers and has 45 rural and 5 urban Kebeles. The Woreda had a total population of 145,750 persons of which 52.8% are females and with an average family size of six people per household. The altitude of the study area ranges from 1800-3,380 meters above sea level. Temperature ranges from 10 to 26.9°C and the mean annual rainfall ranges from 1,000-1,400 mm. The rainfall pattern is usually bimodal: January–June for belg season and July – October for Meher season. The potato-based farming system is found in almost all parts of the Woreda. The Woreda is divided into three major agro-ecological zones: lowland (*kola*), midland (*woinadega*), and highland (*dega*). Chenchu Woreda is one of the 15 chronically food insecure Woreda of SNNPR. The district is characterized by mixed farming system (crop-livestock). Barley, Potato, Wheat, Maize, Enset, fruits; Cabbage and Head Cabbage are widely grown in the Woreda. Potato is the main crop in terms of production and it is a source of income in the study area. Even though potato is grown everywhere in the study area, the productivity is very low which is about 8 tons per hectares but plays a key role in food security. The major constraints that hinder the development of potato production and marketing are lack of sufficient quality seed, pest and diseases infestation and storage problem. Unless and otherwise these problems are solved the expansion and development of potato production is under question. The land use pattern of the Woreda shows that 40,260 hectare is cultivable, 2,629 ha is grazing land, 3,852 ha is covered by forest, bushes and shrubs, and 4,486 ha is being used for other purposes such as encampments, and infrastructure facilities (CSA, 2016) (Figure 1)

Research design

As the objective of this study is to investigate the factors affecting adoption of improved Jalenea potato variety, descriptive and diagnostic (analytical) research design was used. It is descriptive because the study intends to portray accurately the characteristics of respondents, current status of adoption of improved Jalenea potato seed and the nature of the potato producer. The socioeconomic characteristics of the study group were described by age, source and size of income, level of education, family size, and religion. The study is diagnostic as it investigates the relationship between the socio economic situation of the subjects under the study and their adoption status.

Sampling procedure and technique

A multi-stage sampling procedure was used to identify the sample households for data collection. The Woreda was selected purposively and potato producers of the *Kebeles* were identified based on the potential to produce potato. Four potato producing *Kebeles* were randomly selected. The sample size of the study was determined by using Yemane's formula. The sample respondents of the study were selected by using systematic random sampling technique. The sample size of each kebele was determined through probability proportional to size. The formula provided by Yamane is given as follows:

$$N = \frac{N}{1 + N(e)^2}$$

Table 1. Sampling frame and sample size.

Name of selected <i>Kebeles</i>	Total number of potato producers	Sample
Gendo gemebela	591	18
Doko yoyera	1257	38
Doko losha	647	19
Doreze dosheky	1515	45
Total	4010	120

Where: n is the sample size considered from potato producer households in the selected kebeles, N is the total potato producer households in the selected kebeles ($N = 4010$) and $e = 0.09$ is the level of precision defined to determine the required sample size at 91% level of precision (Table 1).

Type and source of data

Primary data were collected from selected farmers using semi-structured interview schedule by using personal interview technique from sampled farmers. Secondary information relevant for this study was gathered from *Woreda* Office of Agriculture and Natural Resource, Central Statistics Agency (CSA).

Methods of data collection

Different tools were used to collect the data so as to develop a near accurate understanding of the topic of research. The main tool of data collection techniques used in the study was semi-structured interview schedule and focus group discussion.

Methods of data analysis

The statistical analyses employed in this study were mean, percentage, frequency, minimum, maximum values, t-test chi-square test and binary logistic regression analysis. Descriptive analysis was used to describe the socioeconomic characteristics of the sample households as it exists. The t-test was used to determine the existence of statistically significant mean difference between the groups, and chi-square test was used to determine whether there is statistically significant proportionate difference between groups. Binary logistic regression analysis was used to identify factors that affect adoption of improved jalenea potato variety (Table 2).

RESULTS AND DISCUSSION

Status of adoption of Jalenea potato variety

In this study, adoption of Jalenea potato variety refers to a continued use of the variety on an area of land. Here, the respondents who have cultivated improved Jalenea potato varieties in the study area during the survey year and in any one of the year before the survey year of this study are considered as adopters. Farmers who never adopted Jalenea potato variety are categorized as non-adopters of the variety. Accordingly, the study reveals that out of the total respondents 68 (56.7%) of them

applied the variety on their piece of land whereas 52 (43.3%) of sample households used the local variety only in the process of producing the crop.

Status of adoption of inorganic fertilizer

Jalenea potato production, like any other crop, requires use of different inputs. Fertilizer application is one of the most important practices that need to be adopted by Jalenea potato growers. Moreover, proper application of the recommended rate (200 kg/ha) is also crucial to obtain the required yield. Out of the variety adopters (68 farmers) 60 farmers were found using fertilizer for Jalenea potato variety cultivation. From the 60 farmers who used DAP fertilizer for Jalenea potato cultivation 6 respondents (10%) applied below (120-180 kg) the recommended rate and 54 respondents (90%) used the recommended rate. Also from the 60 farmers who used Urea fertilizer for Jalenea potato cultivation 8 respondents (13.3%) applied below the recommended rate (120-180 kg) and 52 respondents (86.7%) used the recommended rate. Fertilizer adoption of sample respondents varies across adopter and non-adopter categories. The result of analysis indicated that there was significant mean difference between adopter and non-adopter categories ($\chi^2=1.200$, $P= 0.000$) in relation to fertilizer utilization at 1% significance.

Potato management practices in the study area

Spacing

Appropriate plant spacing is important because overcrowded sowing would result in slow and stunted growth and eventually in poor yield. The research recommended spacing for improved Jalenea potato production is 30 cm between plants and 70 cm between rows. This study about plant spacing in the study area reveals that from total adopter respondent 15 (22%) of them used below the recommended spacing whereas 46 (67.7%) used the recommended spacing and the rest 7 (10.3%) used above the recommended spacing (Table 3). Respondents have mentioned different reasons for not using the recommended spacing. According to the

Table 2. The summary of explanatory variables.

S/N	Independent variable	Units of Measurement	Expected sign	Justification about the expected relationship
1	Age of HHH	Years	±	The role of a farmer's age in explaining technology adoption is somewhat controversial in the literature. As farmer age increases probability of adoption is expected to decrease (Techane, 2006). Younger farmers were more likely to adopt and the effect of age on the probability of adoption was elastic (Hailu, 2008).
2.	Sex of the respondents	Dummy	±	Due to many socio-cultural values and norms, male have freedom of mobility and participation in different extension programs and consequently have greater access to information (Taha 2007; Mesfin 2005).
3.	Education level	Years	+	It is often assumed that educated farmers are better able to process information and search for appropriate technologies to alleviate their production constraints. Adoption is expected to correlate positively with education (Getahun et al., 2000).
4	Farm experience of HH	Years	+	Farmers with higher experience appear to have often full information and better knowledge and are able to evaluate the advantage of the Technology (Chilot 1994).
5	Off -farm activity	Dummy	+	Additional income earned from non-agricultural activities outside the farm increases the farmers' financial capacity and increases the probability of investing on new technologies (Techane, 2006).
6	Market distance	Km	+	As market distance decreases adoption and intensity of adoption was expected to increase (Dereje, 2006)
7	Contact with extension agent	Dummy	+	Contact with extension agent is hypothesized to have positive influence on adoption of improved technologies.
8	Number of livestock	TLU	+	Livestock ownership is hypothesized to influence adoption positively
9	Participation in training	Number	+	Participation in training is expected to positively influence farmers' Jalanea potato variety adoption.
10	Participation in field day	Number	+	Attendance of agricultural training is positively and significantly related to adoption.
11	Participation in demonstration	Number	+	Participation in on-farm demonstration is expected to positively influence farmers' adoption of Jalanea potato variety.
12	Credit access	Dummy	+	Farmers without cash and no access to credit will find it very difficult to adopt new technologies
13	Seed multiplication member	Score	+	A farmer who is membership of farmer's association in rural kebeles and different Cooperatives are more likely to be aware of new practices as they are easily exposed to information
14	Farm Land size	Hectares	+	Farmers with larger farms are more likely to adopt an improved technology (especially modern varieties) compared with those with small farms.
15	Farm income	Birr	+	The effect of farm income on household's adoption decision is positive (Degnet and Belay, 2001) and Leggese (1998).
16	Labor availability	Man equivalent	+	Household's labor availability is hypothesized to positively influence adoption of the potato technology.

respondents, spacing requires additional labor and skill. Because of this, it is difficult for them to manage with labor that exists in the household.

Prevalence of potato disease

Maximum yield from a plot of land depends not

only on the use of improved seed and inorganic fertilizer, but it also depends on measure taken to control insect/pest and disease when it occurs on

Table 3. Fertilizer utilization of households 2016/2017.

Fertilizer utilization	Adopter		Non-adopter		Chi-square value	P-value
	N	%	N	%		
No	8	11.8	52	100	1.200***	0.000
Yes	60	88.2	0	-		
Total	68	100	52	100		

. ***, Significant at 1% level.

Source: Own field survey (2017).

the plant. In this study assessment was made to investigate prevalence of disease occurrence and the result indicates that 53.3% of the respondents reported the existence of bacterial wilt disease problem in the study area.

Potato disease control measures

Respondents were also asked about methods they used to control disease. The result reveals that 47 (73.4%) respondents used cultural method and 17 (26.6%) respondents used chemicals.

Weed problem and its control practice

In this study attempt was made to assess the prevalence of weed problem and its control mechanism. The result indicates that 66 (97%) of the adopter respondents reported that they did not encounter weed problem in their potato farm. While 2 (3%) of adopter respondents reported weed occurrence (peritomeum weed) but they controlled them with hand weeding.

Comparison of variety adoption status based on age of household head

The role of age in explaining technology adoption is somewhat controversial. It is usually considered in adoption studies with the assumption that older people have more farming experience that helps them to adopt new technologies. On the other hand, because of risk averting nature older farmers are more conservative than the youngest one to adopt new technology. The mean age of adopter respondents was 43.18 years old and non-adopter respondents were 41.96 years old. The t-value (.555) indicates that the mean ages of the two groups were not significantly different (Table 4).

Comparison of variety adoption status based on sex categories

55% of female respondents adopted the variety whereas

57% of male respondents adopted the technology. The result of chi-square analysis ($\chi^2=0.057$, $P=0.654$) revealed that there is no significant relationship between sex and the adoption of Jalenea potato variety. The result of this study is not in agreement with result of previous researchers who reported the significant relationship between sex and adoption of agricultural technologies (Degnet and Belay, 2001; Mulugeta et al., 2001) (Table 5).

Comparison of variety adoption status based on educational categories

The study shows that 60% of the non-educated farmers adopted the variety whereas 54 percent of educated farmers in the study area adopted the variety. The result also indicates that there is no statistically significant difference between educated and illiterate farmers in terms of adoption of the variety ($\chi^2=9.344$, $P=0.638$) (Table 6).

Comparison of variety adoption status based on involvement in non-farm activities

Many farmers can earn additional income by engaging in various off-farm activities. This is believed to raise their financial position to acquire new inputs. The result of the present study reveals that 61 of non-farm activity participants adopted the variety whereas only 46% of the non-participants of non-farm activity adopted the technology. The result of chi-square test indicates participation in non-farm activities ($\chi^2=2.504$, $P=0.065$) had significant relationship with adoption of improved Jalenea potato variety at 10% probability level. In the study area, weaving, trading, and daily laborer activities, were found to be some of the non-farm activities in which sample households participated in (Table 7).

Comparison of variety adoption based on membership in seed multiplication group

Participation in social organization is expected to have an indirect influence on the adoption behavior of farmers.

Table 4. Comparison of variety adoption based on Age of respondents.

Age of respondents'	Adopter		Non-adopter	
Mean	43.18		41.96	42.65
SD	12.88		10.43	11.85
t-value				0.555

P-value = 0.173.

Source: Own field survey (2017).

Table 5. Comparison of variety adoption status based on sex categories.

Sex of respondents'	Adopter		Non-adopter		Total		Chi-square value
	N	%	N	%	N	%	
Female	17	55	14	45	31	100	0.057 [*]
Male	51	57	38	43	89	100	

P-value = 0.654, *, Significant at 10%level.

Source: Own field survey (2017).

Table 6. Comparison of variety adoption status based on education categories.

Education Level	Adopter		Non-adopter		Total	
	N	%	N	%	N	%
Illiterate	31	60	21	40	52	100
Read and write	11	42	15	58	26	100
Grade 1-4	9	90	1	10	10	100
Grade 5-8	14	61	9	39	23	100
Grade 9-12	2	28.6	5	71.4	7	100
Diploma	1	50	1	50	2	100
Total	68	56.6	52	43.4	120	100

P-value =0.638.

Source: Own field survey (2017).

Table 7. Comparison of adoption of variety based on involvement in non-farm activities 2016/2017.

Participation on non- farm activity	Adopters		Non-adopters		Chi-square value
	N	%	N	%	
No	17	46	20	54	2.504***
Yes	51	61	32	39	
Total	68	58	52	42	

P-value = 0.065, ***, Significant at 10% level.

Source: Own field survey (2017).

This exposure exposes them towards innovative ideas and practices (Tesfaye and Shiferaw, 2001). As seed multiplication cooperative is one of farmers' associations, it is expected to have significance relationship on adoption. Out of total participants of seed multiplication group 86.8% adopted the variety and only 13.2% of the non-participants adopted the variety. The Chi-square result reveals existence of statistically significant

association between adoption and being member of seed multiplication cooperatives ($\chi^2 = 63.974$, $P = 0.012$) at 5% level of significance (Table 8).

Comparison of adoption the variety based on credit utilization

Access to credit is one way of improving farmers' access

Table 8. Comparison of variety adoption based on seed multiplication membership.

Seed multiplication group member	Adopters		Non-adopters		Chi-square value
	N	%	N	%	
No	9	13.2	45	86.5	62.974**
Yes	59	86.8	7	13.5	
Total	68	100	52	100	

P-value = 0.012, **, Significant at 5% level.

Source: Own field survey (2017).

Table 9. Comparison of adoption of the variety based on credit utilization.

Use of credit	Adopter		Non-adopter		Chi-square value
	N	%	N	%	
No	4	7.27	51	92.73	1.009***
Yes	64	98.46	1	1.54	
Total	68	56.67	52	43.33	

P-value = 0.000, ***, Significant at 1% level.

Source: Own field survey (2017).

Table 10. Comparison of adoption of the variety based on contact with extension agent.

Contact with extension agent	Adopter		Non-adopter		Chi-square value
	N	%	N	%	
Never	7	31.82	15	68.18	13.674**
Yes	61	62.24	37	37.36	
χ^2 =value					

P-value = 0.005**, Significant at 5% level.

Source: Own field survey (2017).

to new production technology. It increases the farmers' economy to purchase improved seed, fertilizer and other inputs (Tesfaye et al., 2001). Thus, it is expected that access to credit can increase the probability of adopting improved Jalenea potato variety but in the study area there is no access to credit in cash but there is access to credit of improved Jalenea potato seed and fertilizer in kind. Different types of improved potato varieties were available on credit basis to farmers from the Office of Agriculture and Natural Resource and NGOs in the cropping season. The result in Table 9 shows that 98.46% of the respondents who have access to credit adopted the improved variety and only 7% of the respondents who do not have access to credit adopted the variety. The result clearly indicates the crucial role that access to credit plays in adopting the technology. The result of this study also shows existence of statistically significant difference between adoption categories on access to credit at less than 1% percent probability level ($\chi^2=1.009$, $P=0.000$). Farmers without cash and no access to credit will find it very difficult to adopt new technologies. Previous authors verified this

preposition on access to credit (Hailu, 2008; Teshale et al., 2006).

Comparison of adoption of the variety based on contact with extension agent

Adoption of the variety is higher among farmers who have contact with extension agent (62%) than those farmers who did not have contact with extension agent (32%). The chi-square result ($\chi^2=13.674$ and $P=0.005$) shows statistically significant difference between adoption categories with respect to farmer contact with extension agent. Lelisa et al. (2002), Mulugeta et al. (2001) also reported similar result (Table 10).

Comparison of adoption of the variety based on participation in training

Adoption of the variety is higher among farmers who have participated in agricultural development training

Table 11. Comparison of adoption of variety based on participation in training 2016/2017.

Participation on training	Adopters		Non-adopters		Chi-square value
	N	%	N	%	
No	9	15	51	85	84.84***
Yes	59	98.33	1	1.67	
Total	68	56.67	52	43.33	

P-value = 0.000, ***, Significant at 1% level.

Source: Own field survey (2017).

Table 12. Comparison of adoption of the variety based on field day participation 2016/2017.

Participation on field day	Adopter		Non-adopter		Chi-square value
	N	%	N	%	
No	11	34.38	21	65.63	8.83**
Yes	57	64.77	31	35.23	
Total	68	56.67	52	43.33	

P-value = 0.003, **, Significant at 5% level.

Source: Own field survey (2017).

programs (98%) than those farmers who did not attend the training (15%). The chi-square result ($\chi^2=84.842$ and $P=0.000$) shows existence of statistically significant difference between participants and non-participants of agricultural development training programs on their adoption status. In other words the proportion of adopters is higher among training participants than non-participants. The result of this study is in agreement with the findings of Tesfaye et al. (2001) and Teshale et al. (2006) who studied determinants of adoption of improved maize technology in Yelma Dansa Woreda in Ethiopia. According to their report, training is an important input that improves farmers' performance and equips farmers with new knowledge and skills (Table 11).

Comparison of adoption of the variety based on field day participation

As can be seen from Table 11, the proportion of variety adopters is higher among field day participants (65%) than their counterpart (34%) (Non-participants of the field days). The chi-square result ($\chi^2=8.83$, $P=0.003$) shows that there is statistically significant difference between participants and non-participants of field day program on their status of variety adoption. The result of this study is in agreement with the findings of Tesfaye et al. (2001). According to his report, in field days, neighboring farmers get an opportunity to observe how the new technology is practiced in the field. This situation may facilitate the adoption process (Table 12).

Comparison of adoption of the variety based on participation in demonstration

Demonstration is an important method of extension to create concrete awareness among the farm community. It is also a means of diffusing information to neighboring farmers practically. This situation facilitates the adoption process and it is hypothesized that there is a positive correlation with adoption. The result on Table 13 indicates that variety adoption is higher among participants of method and result demonstration (80%) than non-participants of the demonstration (40%). It also shows existence of statistically significant proportionate difference between participants and non-participants on their variety adoption status ($\chi^2 =6.55$, $P=0.009$) at 1% probability level. Similar results were reported by Kidane (2001) and Belay (2003).

Comparison of adoption of variety based on farming experience of the household head

Farmers with higher experience in Jalenea potato production appear to have often full information and better knowledge and supposed to evaluate the advantage of the technology. Hence it was hypothesized to affect adoption positively. With respect to the respondents' farming experience, the average farming experience of variety adopters was 11.86 years and that of non-adopter was 10.27 years. The t-test result ($t=0.732$ $P=0.835$) shows that there is no statistically significant mean difference among adoption categories. The result

Table 13. Comparison of adoption of the variety based on participation on demonstration 2016/2017.

Participation on demonstration	Adopter		Non-adopter		Chi-square value
	N	%	N	%	
No	28	40	42	60	6.55**
Yes	40	80	10	20	
Total	68	56.67	52	43.33	

P-value = 0.009, **, Significant at 1% level.
Source: Own field survey (2017).

Table 14. Comparison of adoption of the variety based on experience of households.

Adoption categories	N	Mean	SD	t	R
Adopter	68	20.58	11.86	24.60	0.785
Non-adopter	52	20.84	10.27		
Total	120	20.7	11.15		

P-value = 0.835.
Source: Own field survey (2017).

of this study is in complete agreement with the findings of Chilot et al. (1996) (Table 14).

Comparison of adoption of the variety based on land holding

Land is perhaps the single most important resource, as it is a base for any economic activity especially in rural and agricultural sector. Farm size influences households' decision to adopt or to reject new technologies. Hence, land holding was hypothesized to have positive and significant relationship with adoption.

The result reveals that the mean land holding in the study area was 1.02 ha. The average land size of adopter and non-adopters was 0.92 and 1.16 hectare respectively. The t-test result ($t=1.555$, $P=0.054$) shows there is significant mean difference of the land holding size between adopters and non-adopter respondents' household at 10% significance level. This significance mean variation shows that the variation in the land holding size between two groups has its own implications on the adoption of Jalenea potato production package. The result reveals that farmers with smaller size of land are more likely to adopt improved variety than their counterpart as it helps them to get higher yield from smaller land size (Table 15).

Comparison of adoption of the variety based on livestock holding

Livestock holding is an important indicator of household's wealth position in rural context. The number of livestock owned by a farmer was hypothesized to affect the

adoption of improved Jalenea potato variety positively. Livestock is the farmers' important source of income, food and draught power for crop cultivation in Ethiopian agriculture. Hence, a household with large livestock holding can have good access for more draught and it is one of the main cash sources to purchase inputs. As indicated in Table 16 the average livestock ownership of sample households in TLU was 3.5. The result of t test ($t=1.218$, $P=0.269$) revealed that there is no significant variation in average livestock ownership between adopter and non-adopters of the variety. The results of this study are not in conformity with earlier adoption studies. On the other hand, Doginet (2001) and Habtemariam (2004), in their studies reported that livestock holding has a positive and significance influence on adoption of agricultural technologies.

Comparison of variety adoption status based on labor availability

Large working labor force in a family means the household may not need to hire more additional labor and the money saved due to use of own labor force could be used for purchasing other crop production inputs. This will increase household's possibility to adopt improved Jalenea potato variety. Therefore, it was hypothesized to have positive relationship with adoption of improved Jalenea potato production package.

Overall the average labor availability in terms of adult equivalent for sample household in the study area was 3.11 with standard deviation of 1.38. The average labor availability in the adopters and non-adopter household was 2.96 and 3.3 respectively. However, the t-test ($t=1.168$ and $P=0.454$) shows that there is no

Table 15. Comparison of adoption of the variety based on land holding.

Land size	Adopter		Non-adopter		Total	
	N	%	N	%	N	%
≤0.5	30	44.11	20	38.4	50	41.6
0.51-1	28	41.1	7	13.4	35	29.2
>1	10	14.8	25	48	35	29.2
Mean	0.92		1.16		1.02	
SD	0.74		0.89		0.81	
t-value						1.555*

P-value = 0.054*.

Source: Own field survey (2017).

Table 16. Comparison of adoption of the variety based on number of livestock owned in TLU.

Livestock holding	Adopter		Non-adopter		Total	
	N	%	N	%	N	%
≤3	4	5.9	-	-	4	3.3
3.1-6	54	79.4	43	82.7	97	80.9
>6	10	14.7	9	17.3	19	15.8
Mean	3.8		3.69		3.5	
SD	1.67		1.67		1.68	
t-value						1.218

P-value = 0.269.

Source: Own field survey (2017).

significant mean difference between adoption categories (Table 17).

Comparison of variety adoption status based on farm income

Farm income is the main source of capital to purchase farm and other household inputs. In this study the household farm income was estimated based on the sales of crop, livestock and livestock products. The major cash income for sample households in the study area is from sale of potato and apple fruit.

The average annual farm income for the total sample households was birr 14,508 (1 Ethiopian birr is equivalent to \$0.03 USD) whereas; the average farm income for non-adopter was Birr 5301.2 and that adopters mean on-farm income was 9206.3 Birr. The minimum and maximum farm income of the variety adopter households ranges from 0 Birr to 28,000 Birr, whereas the minimum and maximum farm income for non-adopters was 0 Birr to 25,000 Birr. Analysis of variance was conducted to test the relationship of farm income with adoption of Jalenea potato variety and the result ($t=1.018$ and $p=0.479$) showed that there is no significant mean difference among adopter and non-adopters of the variety (Table 18).

Comparison of variety adoption status based on distance to output/input market

Markets are communication centers both for producers, consumers and traders (Hailu, 2008). In this study, it is hypothesized that the distance between the respondents' residence and the nearest market place (measured in kilo meters) is negatively correlated with the decision to adopt newly introduced crop varieties with its associated agronomic practices. Regarding the distance taken to travel from home to the nearest market place, sample farmers reported that they had to travel an average of 10.13 km with standard deviation of 5.81 km. For sample respondents the minimum and the maximum distances that a farmer had to travel to access market center were, 1 and 23m, respectively. Results of t-test ($t=2.303$ and $P=0.132$) reveal that there is no statistically significant mean difference among adopters and non-adopter categories (Table 19).

Determinants of adoption of Jalenea potato variety using binary logistic regression analysis

In the binary logit model result, the maximum likelihood estimates reveal that adoption of improved *Jalenea* potato variety was determined by the interaction of

Table 17. Comparison of variety adoption status based on availability of labour in household in adult equivalent.

Labor	Adopter		Non-adopter		Total	
	N	%	N	%	N	%
0-2	40	58.8	5	9.6	45	37.5
2.1 –4	15	22	35	67.3	50	41.7
>4	13	19.2	12	23.1	25	20.8
Mean	2.96		3.30		3.11	
SD	1.21		1.57		1.38	
t-value						1.32

P-value = 0.454.

Source: Own field survey (2017).

Table 18. Comparison of variety adoption status based on farm income 2016/2017.

Adoption categories	N	Mean	SD	Min	Max	t-value	P
Adopter	68	9206.3	7782.3	0	28,000		
Non -adopter	52	5301.2	10121.3	0	25,000	1.018	0.479
Total	120						

P-value = 0.479.

Source: Own field survey (2017).

Table 19. Comparison of variety adoption based on market distance.

Adoption categories	N	Mean	SD	Min	Max	t-value	P-value
Adopter	68	10.29	5.98	1	19		
Non-adopter	52	9.93	5.63	1	23	2.303	0.132
Total	120	10.13	5.81	1	23		

Source: Own field survey (2017).

different factors: demographic, socio-economic and physical factors. The model results in Table 20 show that, among the 12 independent variables included in the model, eight variables were found to significantly affect adoption of improved *Jalenea* potato variety. These variables are briefly discussed as follows:

Age of respondent: The odds ratio implies that a unit increase in age of a household heads will reduce the probability of adopting the technology by 116.9%. In other words, as age increases the probability of adopting the variety decreases. This might be due to need for high physical labor. The elders are physically weak to adopt improved *Jalenea* variety. According to them, age is one of the factors that determine decision making of a person. Household heads with advanced age are more reluctant to accept new technology than younger household heads.

Sex of household head: It had significant and positive effects on the adoption of improved *Jalenea* potato

variety at 10% significance level. The odds ratio implies that being male favors the adoption of improved *Jalenea* potato production package by a factor of 4.743. This shows that male headed households are more likely to have better access to information on improved *Jalenea* potato production technologies and more likely to adopt new technologies than female headed households. This result agrees with Tesfaye et al. (2001) and Mesfin (2005).

Total land size: Land size owned by farmers had positive and significant effect on the adoption of improved *Jalenea* potato variety at 10% significance level. The value of the odds ratio indicates that a unit increase in the land size of farmers will increase the probability of adopting improved *Jalenea* potato variety by 34.8%. Land is perhaps the single most important resource, as it is a base for any economic activity especially in rural and agricultural sector. Farm size influences household's decision to adopt or to reject new technologies. According to the information from focus group discussion

Table 20. Binary logistic regression results of independent variables.

Variable	B	S.E.	Wald	df	Sig.	Odds ratio
Age of household	-0.156***	0.059	7.044	1	0.008	1.169
Sex of household	1.557*	0.807	3.719	1	0.054	4.743
Land size	1.055*	0.548	3.713	1	0.054	0.348
Farm income	0.000***	0.000	7.545	1	0.006	1.000
Participation on field day	2.628***	0.861	9.315	1	0.002	0.072
Seed multiplication member	2.458**	0.973	6.379	1	0.012	0.086
Participation on training	4.818***	1.320	13.328	1	0.000	0.008
Education level	-0.066	0.259	0.065	1	0.798	0.936
Number of livestock	-0.224	0.177	1.590	1	0.207	0.799
Non-farm activity	1.609*	0.873	3.398	1	0.065	0.200
Labour availability	-0.497	0.369	1.810	1	0.179	0.608
Farm experience	-0.033	0.057	0.325	1	0.568	0.968
Constant	13.165	4.186	9.892	1	0.002	5.218E5

a. Variable(s) entered on step 1: LANDSIZE, PARTFILDAY, SEDMULMEM, TOTfarINC, AgeHH, SEXHH, EDULEVHH, NUMLISTO, TRAININGINJAL, NONFARACTI, Labour, and FARMEXPHH. *, ** and *** represent significant at 10, 5 and 1% level respectively. Source: Computed from field survey data (2017).

(FGD) farmers who have better land have more chance to adopt improved *Jalenea* potato variety.

Total farm income: Farm income is the main source of capital to purchase farm and other household inputs. In this study farm income had positive and significant effect on the adoption of improved *Jalenea* potato variety at 1% significance level. The value of odds ratio shows that as farm income increases adoption of improved *Jalenea* potato variety will increase.

Participation in field day: Participation on field day is one of the means of teaching and learning process of improved technologies. Participation in field day had significant positive effect on the adoption of improved *Jalenea* potato variety at 1% significance level. The odds ratio implies that participation in field days will increase the likelihood of variety adoption by 7.2%. Farmers who have an opportunity to attend field day of improved *Jalenea* potato production are more likely to use improved *Jalenea* potato production technology than those farmers who have no similar opportunity. In other words, the result indicates that farmers who are exposed to formal extension information have a higher probability towards adoption than those with less exposure. This suggests that access to participation in field days for improved production of *Jalenea* potato farmers could be aware of the various aspects of the production and productivity of the crop. This result agrees with the findings of Tesfaye et al. (2001).

Membership of seed multiplication: Being member of seed multiplication association had significant and positive effect on the adoption of improved *Jalenea* potato variety at 5% significance level. The value of odds

ratio implies that being member of seed multiplication group favors the adoption of improved *Jalenea* potato variety by 8.6%. Organizing of farmers to be a member of seed multiplication group would help them to get access to seed credit (received basic seed from research and NGOs for multiplication), access to extension information and also access to market. This implies strengthening and expansion of seed multiplication is of paramount importance to improve availability of sustainable seed supply system in the area and enhance adoption of improved *Jalenea* potato variety.

Participation in training: Training is one of the extension events where by farmers get practical skill and technical information for new technology. Participation in training had significant and positive effect on the adoption of improved *Jalenea* potato variety at 1% significance level. The odds ratio implies that participation in training improves the likelihood of adopting improved *Jalenea* potato variety by a factor of 0.008. This may be explained by the fact that farmers who have training gain better knowledge on production practices and technologies than non-participants of training program. The implication is that emphasis has to be given to farmers' training since it helps to enhance adoption of improved *Jalenea* potato production package. The result is agreement with findings of Tesfaye et al. (2001) and Asfaw et al. (1997).

Non-farm activities: Participation in non-farm activity had positive and significant effect on the adoption of improved *Jalenea* potato variety at 10% significance level. The value odds ratio indicated in Table 20 implies that participation in non-farm income generating activity improves the likelihood of adopting *Jalenea* potato variety by 20%. Many farmers can earn additional income by

engaging in various non-farm activities. This is believed to raise financial position to acquire new inputs.

Conclusion

The study reveals that out of the total respondents 68 (56.7%) of them applied the variety on their piece of land whereas 52 (43.3%) of sample households used the local variety only in the process of producing the crop. Out of the variety adopters (68 farmers) 60 farmers were found using fertilizer for Jalenea potato variety cultivation.

This study about plant spacing in the study area reveals that majority of variety adopters (67.7%) used the recommended spacing between rows and plants. According to the respondents, spacing requires additional labor and skill. Because of this, it is difficult for them to manage with labor that exists in the household. The result indicates that 53.3 percent of the respondents reported the existence of bacterial wilt disease problem in the study area and 47(73.4%) respondents used cultural method and 17 (26.6%) respondents used chemical to control disease problem. Most of the variables assumed to influence the adoption behavior were significantly associated with the adoption of improved Jalenea potato variety. The model results indicated that eight variables were found to significantly affect adoption of improved Jalenea potato variety. These are age of respondent, sex of household head, total land size, farm income, participation in field day, membership of seed multiplication, participation in training and non-farm activities. Among the personal and demographic factors age of the household was negative and sex of the household head was positive significantly related to the adoption of improved Jalenea potato production.

This implies that male farmers have better access to information on improved technologies and are more likely to adopt new technologies than females. Concerning economic and wealth related variables which were hypothesized to influence adoption of improved Jalenea potato variety, non-farm activity and farm income had positive and significant relationship with adoption. Out of the institutional variables, getting advisory service from extension agents, attending training, field day, and membership of seed multiplication group also had positive and significant relationship with adoption of improved Jalenea potato production.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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