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Factors Affecting Smallholder Farmers Potato Production in Shashemene District, West Arsi Zone, Oromia National Regional State, Ethiopia

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Abstract
Potato production plays an important role in improving household income and nutrition and thereby contributes to food security. This study investigated the factors affecting smallholder farmers' potato production in Shashemene district, Ethiopia with the objective of identifying and analyzing factors affecting potato production. A multi-stage random sampling procedure was used to select 120 potato producer households using probability proportional to size. Semi-structured questionnaires were used to collect data from potato producer households. Multiple linear regression model (OLS) were used to analyze factors affecting smallholder farmer's potato production. Ordinary least square regression model results showed that five variables such as sex of household heads, land allocated for potato production, access to input supply, potato farming experience and households' participation in non/off-farm income activities is positively and significantly affects potato production in the study area. Policy makers, planners and development practitioners are required to give due attention to these determinants in order to support smallholder farmers in improving potato production.
Keywords: Potato, Ordinary least square model, Smallholder Farmers, Shashemene District.

1. Introduction

Agriculture is the most important sector in Ethiopia; it accounts for 46% of GDP, 80% of export value, and about 73% of employment. The sector still remains largely dominated by rain-fed subsistence farming by smallholders who cultivate an average land holding of less than a hectare (Aklilu, 2015).

Potato (*Solanum tuberosam* L.) is among the major food crops produced in the world (Nyunza and Mwakaje 2012) in which Ethiopia is also inclusive. It is the fourth most important food crop in the world on the basis of production after maize, rice, and wheat with annual production accounts of nearly 300 million tons (Naz *et al*. 2011). Out of these, over half of production occurs in developing countries (Devaux *et al*. 2014). In Ethiopia, for example, the total production from potato was 943,233 tons with an average productivity of 13.5 t/ha. The area under potato was 70,132 ha cultivated by 1.4 million households in the main cropping season of 2015/16. During the same period, it ranks first in area coverage and third in both total production and productivity among the root crops grown in Ethiopia (CSA 2016).

Oromia is the major potato producing region that constitutes 51% of the national potato production (CSA, 2015). According to the Bezabih and Mengistu (2011) West Arsi is a major potato producing zone in Oromia National Regional state that smallholder farming has diversified from staple food subsistence production into more market oriented and high value commodities. Potato is a major food and cash crop produced in Shashemene district (DOA, 2016).

Therefore, potato production is a major source of livelihood for various value chain actors in Southern part of Ethiopia where it produced two times per year without any irrigation. However, potato yields are relatively low in developing countries (FAO 2013). This is true in Ethiopia in general and Shashemene district in particular. Productivity of the crop is constrained by multidimensional factors such as lack of disease resistant and high yielding varieties with desirable market qualities, limited knowledge of agronomic and crop protection management technologies, and poor post-harvest handling (Nigussie *et al*., 2012). Therefore, this study was initiated to identify factors affecting potato production at smallholder farmers' level and providing location-specific and timely information.

1.1. Objectives of the Study

- To assess the level of potato production among smallholder farmers
- To identify and analyze factors influencing potato production in Shashemene district

2. Research Methodology

2.1. Description of study area

This study was conducted in Shashemene district, West Arsi zone of Oromia National Regional State, Ethiopia. Shashemene district is located at 250 km from Addis Ababa towards South direction. The district is located at 7° 12' North and 38° 36' east having an altitude of 1600-2800 meters above sea level with a total area of 467.18 km square. The district has 37 rural kebeles and 8 sub cities. The total rural population of the district was 248,093

out of which males 124,597 (50.22%) and females 123,496 (49.78%). The district total rural household heads was 28, 306 (males 23, 627 and females 4,679) of which more than 83% depend on agriculture for their livelihood and majority of them are smallholders owning a plot of less than 0.5 hectares having featured a crop-livestock mixed farming system (DOA, 2016).

According to DOA, (2016) the major agro-ecologies of the district were mid-land (51.4%), high land (29.6%) and low land (19%) having clay loam soil type for highland and sandy soil for mid-land and low land soil types. The district receives an annual rainfall ranging from 800 mm to 1200 mm raining twice a year. The district has bi-modal rainfall distribution with small rains starting from March/April to May and the main rainy season extending from June to September/October. Its climate is characterized as temperate with annual temperature ranging from 12°C to 27°C. The district has 1 union and 38 primary cooperative and 30 FTC being operated by 87 development agents. Besides, the district has 6580, 7436 and 14586 number of model, middle, and resource poor farmers respectively having 13,500 radios, 1,510 televisions and 19,899 mobile phones.

The land use pattern of the district shows that 40,800 ha is cultivable land, 3500 ha is covered with forest, 1500 ha is grazing land, 2100 ha is being used for other purposes such as encampments, and infrastructure facilities. The major agricultural crops widely grown in the district include barley, potato, garlic, beetroot, carrot, wheat, teff, maize, cabbage, and haricot bean. The districts area used for production during belg and meher season was 11, 616 ha and 41, 184 ha respectively having crop production vegetables, cereals and pulses during meher season and having only pulse and cereals production during belg season. The district is known for its predominance of potato production hub in west Arsi zone.

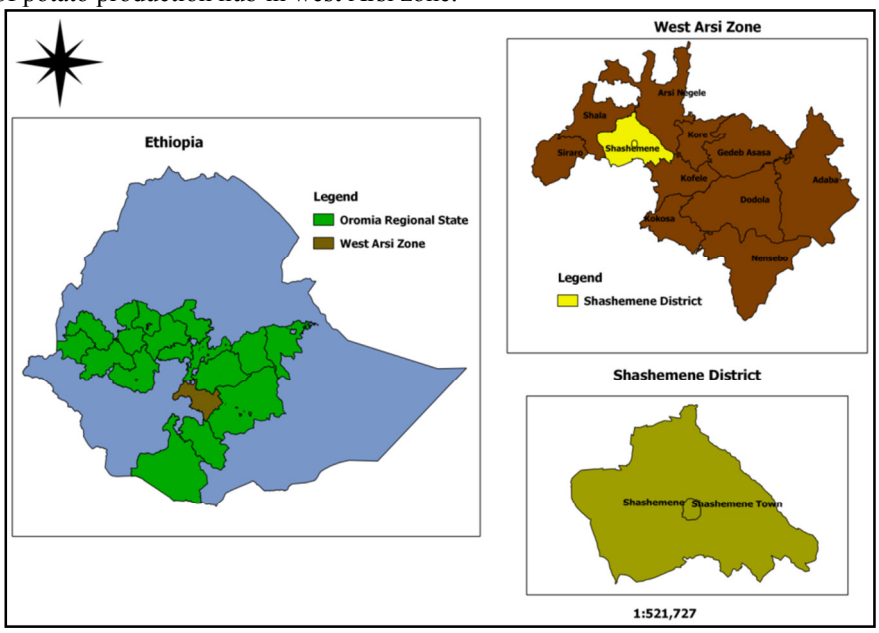

Figure 1. Map of the study area
Source: Own sketch from GIS data, 2016.

2.2. Sampling procedure

A multi-stage sampling procedure was used to identify sample households for data collection. In the first stage, potato producer *kebele* were purposefully identified in collaboration with concerned experts from the district office of agriculture and development agents based on the intensity of potato production. The second stage involved random selection of four potato producing *kebeles* from a list of the potato producer *kebeles* in the district. In the third stage, 120 potato producer households were randomly selected from the total potato producer households in the district.

Table 1. Sampling frame and sample size

Name of sampled kebeles	Total potato producers households (number)	Proportion sampled households (%)	Number of sample household heads (number)
Hursa Simbo	722	37.70	44
Aredano Shifaw	461	24.10	30
Kerara Filicha	250	13.10	16
Ilala Korke	480	25.10	30
Total	**1,913**	**100.00**	**120**

2.3. Data types, sources and methods of data collection

Both primary and secondary data were used for this study. This study used household survey data that were collected from Shashemene district during early beginning of November 2016. Semi-structured questionnaires were employed to collect primary data on the demographic, socioeconomic, and institutional characteristics from representative sample of households. The questionnaire was designed and pre-tested in the field for its validity and content, and to make overall improvement of the same and in line with the objectives of the study. After necessary correction was made for questionnaire, Enumerators were given one day training on the objectives, content of the interview schedule and method of data collection before primary data were collected. Secondary data that could relevant for this study were gathered from Shashemene district office of agriculture, CSA, and from published and unpublished sources.

2.4. Methods of data analysis

Both descriptive statistics and econometric model were used for analyzing the data. Descriptive statistics was applied to the basic characteristics of the sample households to assess differences or similarities among the households. The descriptive statistics such as mean, standard deviations, minimum and maximum values, frequencies, and percentages were used to describe the households.

2.5. Econometric model

This part of the analysis deals with the understanding of the factors affecting production of potato by smallholder farmers in Shashemene district. Quantity of potato produced is a continuous variable that represents the actual potato produced by individual households measured in quintals (100kg). Multiple linear regression model (OLS) was appropriate to analyze factors affecting production of potato because all sampled households is producers of potato. However, when some of the assumptions of the Classical Linear Regression (CLR) model are violated, the parameter estimates of the above model may not be Best Linear Unbiased Estimator (BLUE). Thus, it is important to check the presence of heteroscedasticity, multicollinearity and endogeniety problem before fitting important variables into the regression models for analysis.

$$Yi = b0 + biXi + \mu i \quad (1)$$

Where

Y = Quantity of potato produced, Xi= explanatory variable included in the model and μi =Error term

Variable descriptions and hypothesis

Table 1: Description of the variables used in the analysis

Dependent Variables	**Measurement**	
Quantity of potato produced	Quintals*	
Explanatory variables	**Description of variables**	**Exp Sign**
Sex of the household head	Dummy, favorable response=1	+
Education status of household head	Continuous, education status in years	+
Potato farm experience	Continuous, in years	+
Family size	Continuous, in numbers	-
Land cultivated under potato	Continuous, Hectare	+
Number of oxen	Continuous, in number	+
Access to input supply	Dummy, favorable response=1	+
Access to market information	Dummy, favorable response=1	+
Access to credit service	Dummy, favorable response=1	+
Participation in non/off-farm activities	Dummy, favorable response=1	+
Access to extension service	Dummy, favorable response=1	+

* 1 quintal=100 kilogram

3. Result

3.1. Descriptive analysis

The average family size of the sample households was 6.50 persons, which is larger than the national average of 4.6 persons per household (CSA, 2014b). The average potato farming experience of the sampled farm households was 15.31 years. The average livestock holdings measured in terms of TLU was found to be 6.02. As study result depicts, of the entire household heads interviewed, 90.83% were male-headed, 85.83% attended formal education, 37.5% participated in non/off-farm activities, 62% have access to market information, 56 have access to input supply, and only 30% had access to credit for potato production. The average area covered with potato during the 2015/16 cropping season was 0.64 hectares which accounts for about 39 of average total cultivated 1.64 hectares.

Table 2: Descriptive statistics of selected variables used in the empirical analyses

Variables (Continues)	**Mean**		**Std. Dev.**
Family size	6.50		3.60
Potato farm experience	15.31		9.08
Land cultivated under potato	0.64		0.543
Number of oxen	1.54		0.435
Variables (Dummy)	**Frequency**		**Percentage**
Sex of the household head	Male	109	90.83
	Female	11	9.17
Education status of household head	Illiterate	17	14.17
	Literate	103	85.83
Access to input supply	Yes	67	55.83
	No	53	44.17
Access to market information	Yes	74	61.67
	No	46	38.33
Access to credit service	Yes	36	30
	No	84	70
Participation in non/off-farm activities	Yes	45	37.5
	No	75	62.5
Access to extension service	Yes	55	45.83
	No	65	54.17

3.2. Regression Analysis

Analysis of factors affecting quantity of potato production was found to be important to identify factors constraining potato production. Prior to fitting multiple linear regressions, the hypothesized explanatory variables were checked for existence of multicollinearity, heteroscedasticity and endogeniety problem. The problem of endogeniety occurs when an explanatory variable is correlated with the error term in the population data generating process, which causes, the ordinary least squares estimators of the relevant model parameters to be biased and inconsistent. The source of endogeniety could be omitted variables, measurement error and simultaneity (Maddala, 2001). Both Hausman test and Durbin-Wu-Hausman (DWH) test were applied to check the presence of endogeniety. In case of this study, there is no endogeniety problem from the explanatory variables included in the model that could cause endogeniety bias if OLS is applied. The VIF results (Appendix Table 1) indicate that, there was no serious multicollinearity problem among the explanatory variables included in the model because all VIF values are less than 10. If there is presence of multicollinearity between independent variables, it is impossible to separate the effect of each parameter estimate in the dependent variables. It is thus, important to test multicollinearity between explanatory variables. Furthermore, all the variables were tested for the problem of heteroscedasticity using the Breuch-Pagan test and there was no heteroscedasticity problem. So since there is no heteroscedasticity problem in the data set, the parameter estimates of the coefficients of the independent variables are BLUE. Also, the model specification was carried out using the Ramsey-reset test, and the results revealed that there were no omitted variables in the model. Therefore, OLS method was used to identify factors affecting potato production by smallholder farmers in the study area since all assumption was fulfilled.

As depicted in 3 Table, the model was statistically significant at 1% probability level indicating the goodness of fit of the model to explain the relationships of the hypothesized variables. Coefficient of multiple determinations (R^2) was used to check goodness of fit for the regression model. Hence, R^2 indicates that 59 percent of the variation in the quantity of potato produced was explained by the variables included in the model.

Table 3: Factors affecting potato production (OLS estimates)

Variable	Coef.	Std. Err.	P>t
Constant	2.404***	0.790	0.000
Sex of household heads	4.563**	1.855	0.043
Education status	0.219	0.226	0.335
Potato farm experience	0.243**	0.101	0.017
Family size	-0.026	0.023	0.257
Land allocated under potato	3.56***	0.836	0.000
Access to input supply	11.087***	2.102	0.000
Number of oxen	0.840	0.692	0.250
Market information	0.604	0.461	0.121
Access to extension service	0.206	0.146	0.180
Access to credit service	0.611	0.579	0.199
Participation in off-farm income activities	0.146**	0.073	0.045
Number of Observation	120		
F(11, 108)	12.23		
Prob>F	0.0000***		
R-Squared	0.590		

***, ** and * are Significant at 1%, 5% and 10% level of probability, respectively.

Source: Model result, 2016.

Sex of household head was found to be positive and statistically significant influence on potato production at 5% level of significance. The positive sign shows being a male head of a household significantly increase potato production by 4.56 quintals as compared to that of female-headed households, keeping others factors constant. The reason behind male headed households produce more potato than female headed households, is that male headed households have better financial capability, better land size, better extension contacts, and better access to market information than female headed households.

The result showed that potato farming experience of households has significant effect at 5% significant level on potato production with expected positive sign. Thus, the result implied that, as farmers experience increase by one year, the quantity of potato produced increased by 0.243 quintals, keeping others factors constant. This means that the farmers with more experience in potato production have higher ability to produce potato products than less experience because they have more skills and information.

Land allocated for potato production has a positive and significant impact on potato production at 1% level. This implies that one hectare additional land allocated for potato production would increase potato yield by 3.56 quintals, keeping other factors constant. The reason could be access to more arable land that encourages farmers to produce more potatoes. This result is in line with the finding of (Aman, et al., 2013; Yassin, 2017).

Access to complementary inputs (such as fertilizer and chemical) has a significantly positive effect on quantity of potato production at 1% significance level. Provision of supplementary inputs like fertilizer and chemical, is considered as a complementary inputs in potato production, facilitating in increasing productivity of potato production positively. Being access to complimentary inputs such as improved seed variety, chemicals and fertilizers increases quantity of potato production by 11.087 quintals. So, this result indicates that for potato production to be successful, the availability of complementary inputs at the right quantity and time is quite indispensable.

Participation in non/off-farm activity had a positive influence on the potato production at 5% level. This implies that as the respondents participated more in non/off-farm activity the quantity of potato production would increase by 0.146 quintals, keeping other factors constant. This may due to the fact that farmers who had cash from these sources used as supplementary income to purchase inputs like improved seed, fertilizers, chemicals and farm implements for potato production and thus produce more potato quantity than those who had not because they are business oriented. This finding is inconsistent with the finding of (Yassin, 2017).

Potato production in the study area

Shashemene is one of the potential areas for potato production from west Arsi zone. Potato is produced for the purpose of consumption and sale in the study area. From total sample respondents, 42.86% of them perceived that trends of potato production in the past five years were increasing. Vast majorities of sample potato producers in the study area produce potato by rain-fed and only 4.17% use irrigation. Both local and improved varieties were used for potato production in the study area. Currently, improved potato varieties being grown in Shashemene district are Gudane, Jalane and Kulumsa whereas, the major local varieties grown are Agazer, Bule, Nech ababa, Dima, Key ababa, China and Durame. From local varieties grown *Bule* is the most commonly known for home consumption whereas, *Agazer* was commonly known for market. Farmers look for specific

traits and characteristics which suit their production and marketing situations when choosing varieties for production.

The average productivity per hectare is 10.8 ton per hectare in the study area. This shows that although a considerable effort has been done nationally by research, productivity still exists below national average yield i.e. 13.7 ton/ha. The research station based results show that there is an achievement of up to 30 tons per hectare nationally. This result reveals that the small farmers productivity and research station productivity is by far different with very little farmers productivity. It is probably related with a number of factors among some is lack of access to improved variety, disease and pest, and inadequate use of input as well as price fluctuation. This result is consistent with the study of Bezabih and Mengistu (2011). The same way, Abdi (2016) indicated that biophysical and socioeconomic factors are the limiting factors of potato production in West Arsi zone.

The result further attests that the major opportunities of potato production in the study area are good weather condition, good infrastructure and good market availability while, the major constraints of potato production are unavailability of quality seed at the right time, lack of cash and credit, lack of irrigation, poor input supply such as chemicals and fertilizers and lack of modern storage. According to the sample respondents, 79.19% of respondents used traditional storage mechanism (dark space in the house, Gotera, spread outside the house and covers it with crop residues, *inset* leaf and others) whereas, 15.83% of the sample respondents practiced postponed storage mechanism (farmers store seed potato by leaving the tubers in the soil un-harvested/ delay harvesting) in the study area.

The survey result further attests that the sources of potato seed are own recycled potato seed from previous growing seasons (stock), local market, neighbor farmers and farmers' cooperative. From these sources, own recycled seeds from previous growing seasons and local markets shared the greater amount of potato seed planted by the sample farmers. Farmers select and store small tubers from their own production to plant it in the next season. The probable reason for such practice is to save cash expenses and furthermore, farmers may have more confidence in the quality of their own seed and with their own saved seed it is easier for them to plan for production. The other most important sources of seed are neighboring farmers and local markets in study area but neither of the two sources ensures clean seeds. However, obtaining seeds from neighbors may be slightly preferable especially where farmers obtain potato seeds from neighbors with potato fields in proximity after monitoring their growth.

4. Conclusions and Recommendations

To increase the smallholder farmers' income and reduce rural poverty, subsistence agriculture needs improvement through increasing production and productivity of potatoes. Therefore, improving the smallholder farmers' potato production is required, in order to improve access to food and sustainable livelihoods. This study has identified household level determinants of potato production in Shashemene district, West Arsi zone, Oromia region, Ethiopia.

An average household heads had enough family labor for their farm operation and attended formal education that enables them to read, write and understand agricultural instruction provided by extension workers. The district average potato yield is 10.8 ton/ha which is low compared to national average yield 13.7 ton/ha. Therefore, some relevant policy implications can be drawn from the findings of this study that can help to design proper intervention mechanisms to improve the smallholder farmers' potato production in the study area.

Regression analysis linear model (OLS) indicated that sex of household heads, potato farming experience, land area allocated under potato, access to input supply and participation in off/non-farm income activities are significantly determining the quantity of potato produced. Therefore, these variables require special attention if farmers quantity of potato production is to be increased.

The size of land allocated for potato affected the smallholder potato production positively and significantly. However, increasing the size of land cannot be an option to increase potato production since land is a finite resource. Therefore, intervention aims to increase productivity of potato per unit area of land through proper utilization of land resource in the district. Increasing the productivity of potato per unit area of land through promoting and delivering technology packages (like improved seed varieties, chemicals and fertilizer) to farmers that would increase productivity will be a better alternative for potato producers.

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Appendices

Appendix Table 1. Multicollinearity Test

Variables	VIF	Tolerance
Sex of household heads	1.81	0.553
Education status	1.75	0.571
Potato farm experience	1.65	0.604
Family size	1.54	0.651
Land allocated under potato	1.50	0.666
Access to input supply	1.39	0.721
Number of oxen	1.10	0.908
Market information	1.32	0.755
Access to extension service	1.19	0.841
Access to credit service	1.14	0.884
Participation in off-farm income activities	1.09	0.920
Mean VIF	**1.48**	