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FACTORS AFFECTING IMPROVED POTATO PRODUCTION IN CENTRAL ETHIOPIA: EVIDENCE FROM DUNA DISTRICT

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Abstract:
Improved potato production plays a vital role in improving agricultural production and yield enhancing policy in central Ethiopia, particularly in the Duna district. Improved potato is a globally produced cash crop and it accounts for fourth place in the world yield. Improved potato yield is key crop in improving potato growers' income, and nutritional status. In the agriculture, improved potato is an essential means to leave poverty and food insecurity for many cultivators. Despite the district's better environment and good yield enhancing condition for improved potato, the production is meager. Hence, this research investigates factors affecting improved potato production in central Ethiopia, using data from 189 respondents in the 2022/23 main potato growing season in the Duna district. Both primary and secondary data were used for the data analysis. Descriptive and binary logit methods were applied in this study. The findings of the logit model indicated education, age, off-farm activity, access to land, livestock holding, household soil fertility, fertilizer use, use of credit, access to extension service, provision of improved seed, and the distance to market were important factors influencing improved potato production. The results show that improved potato production at the household level reduces rural farm households' food insecurity and poverty due to improving the income of improved potato growers. Therefore, the agricultural sector should give a vital role and attention to improved potato production. This is the key option to boost improved potato production in the study district.

Keywords:
Agriculture; Improved potato; Production; Logit model; Duna district

1. Introduction
Agriculture is one of the most widespread and foremost powerful sectors to boost food security and prosperity in developing countries, particularly in Ethiopia (Alston and Pardey, 2014; CSA, 2019; Al-Zebari et al., 2021). The sector accounts for the largest portion of job creation and foreign exchange in Ethiopia (Anbes, 2020; CSA, 2018). However, agriculture in Ethiopia is highly dominated by rain-fed subsistence and backward technologies (FAO, 2014; Röder et al., 2018, Tekele and Negese, 2020). Therefore, the agricultural development policy in Ethiopia is most important for the improvement of production and quality (Alebachew et al., 2020; Ekin, 2019; Negese, 2022; Negese, 2020). However, the agricultural producers have not achieved and improved the required goals, because the sector is characterized by input management problems, poor extension and credit use, backward marketing and technologies, poor infrastructure, inappropriate inputs and policy use, and rain-fed subsistence agriculture (Cheng et al., 2017; CSA, 2019). Consequently, the sector generates Ethiopia's over 36% of the national GDP, 50% of GDP, 90% of export income, 85% of the country's labor force, and 73% of the inputs to the country's productive industries (Anbes, 2020; CSA, 2018). Hence, the production status of agriculture is generally lower than the world average due to the low position given to the sector (CIA, 2018; Lalisa et al., 2020; Teklu and Tefera, 2005). In whole parts of Ethiopia, household food availability depends on agriculture (CSA, 2017). Despite the conducive environment for potato production in Ethiopia, the majority of the population faces low potato yield CIA, 2018; CSA, 2018; Negese and Jemal, 2021; Wichrowska and Szczepanek, 2020). This low yield quality drives food insecurity and poverty (CIA, 2018; CSA, 2017; CSA, 2018; CSA, 2019). Therefore, high population, unemployment,

food insecurity, and poverty are major problems with low productivity (Berhanu and Negese, 2022; Islam et al., 2021; Obijekwu, et al., 2019; Schrama et al., 2018).

Potato is a globally vital vegetable in agriculture (Al-Zebari et al., 2021; Tesfaye and Negese, 2021; Negese, 2023; Lalisa et al., 2020; Röder et al., 2018; Islam et al., 2021; FAO, 2021). Potato is the main cash crop cultivated in the world, particularly in Ethiopia (Alemayehu et al., 2020). Low production of potato cash crops is a major challenge in rural agriculture for Ethiopia (Bonsa et al., 2022; FAO, 2021; Jemal and Negese, 2022; Liu et al., 2018; Makani et al., 2020; Sanait and Negese, 2020). The contents of carbohydrates, vitamins, and proteins are very rich in potatoes [33-36]. Potato is a very crucial cash crop achieving food availability (Zierer et al., 2021; Awad et al., 2022; Zarzyńska and Pietraszko, 2015; Suh et al., 2014). Particularly, in Ethiopia, high population and low land access are the drivers of food insecurity and poverty (CIA, 2018; CSA, 2019; Workat et al., 2021; Pauline et al., 2021). In particular, potato is the fourth dominant vegetable in coverage globally (Alemayehu et al., 2020; Mystkowska, 2018). As their study (Tkachenko et al., 2021), particularly, potato was rank first in yield and coverage among vegetable, fiber, and root crops in the country. It is a nutritious household food security cash crop and it has high production with better nutritious values than cereal crops (Beals, 2019; Kanter and Elkin, 2019). Ethiopia has good potential to enhance the production of potato cash crops, particularly, in the highlands of Ethiopia (Alemayehu et al., 2020; Setu and Mitiku, 2020). According to their studies (Kinde and Asfaw, 2016; Setu and Mitiku, 2020), over 70% of the land has a good potential for potato yield; hence, lower than 2% of the country's potential has been exploited. The different literature indicated that annual potato production in Ethiopia is not more than 10 t ha-1 and 0.5 million tons (Deresseh et al., 2016; Taye et al., 2021; Zerga et al., 2017). The highest production of potato is16 t ha-1 produced particularly, in Shashemene, Ethiopia (Heverkot et al., 2012). Production of potatoes grown by 1 million growers in different parts of the country; however, about 9.25m tons of potatoes are grown from 7, 362 ha of land in the year 2019/20 (FAO, 2020). Potatoes have a high potential to contribute to increasing food security and leaving poverty (Alemayehu et al., 2020; Tiruneh et al., 2017). Crops must achieve food availability in Ethiopia (CSA, 2019; FAO, 2020; Tkachenko et al., 2021). Particularly, the yield level of potatoes was about 9.25m tons, which was lower than the mean yield of 26 tons in African countries (FAO, 2020). In addition, in the winter production of potato cash crops reached about 66, 926 ha, a yield of 921,403 tons by 1.2 million growers (Desalegn et al., 2016). In contrast, the country's yield of potato cash crops is lower at 13.8 t ha-1 than the world's mean of 19 t ha-1, and potential production is 40.2 t ha-1 (CSA, 2016). Generally, potato cultivator faces input management problems, poor credit and extension, poor application of fertilizer technology, inadequate marketing and potato growing technology, weak infrastructure, and agricultural productivity policies (Cheng et al., 2017; CSA, 2019).

The demand for potatoes increases more rapidly than for other cereal, tuber, and root crops (Mystkowska, 2018). It is a predominant crop in terms of yields, sales, and consumption in Ethiopia, particularly, in southern Ethiopia (Workat et al., 2021). Therefore, potato cultivating is becoming an increasingly major source of the labor force, foreign exchange, income, job creation, and inputs to different countries' productive industries (Anbes, 2020; CSA, 2018). The mean yield of potatoes is very unsatisfactory due to lack of disease resistance, rain-fed resistance, lack of input varieties, soil infertility, lack of yield with desirable market qualities, lack of appropriate infrastructure, limited knowledge of agronomic potato management, problems of poor harvest handling, and limited production technologies (Cheng et al., 2017; CSA, 2019).

Depending on empirical findings, improved potato production is key to achieving food availability in agriculture. Many empirical literature investigated factors affecting potato production (Al-Zebari et al., 2021; Alemayehu et al., 2020; Deresseh et al., 2016; Efa and Tura, 2018; Islam et al., 2021; Kanter and Elkin, 2019; Liu et al., 2018; Masuku and Xaba, 2013; Pauline et al., 2021; Setu and Mitiku, 2020; Singh et al., 2020; Taye et al., 2021; Tkachenko et al., 2021; Wassihun et al., 2019). Some of them do not investigate how factors affect improved potato production. Further, there is limited empirical literature and specific information on the yield practices of improved potatoes in the study district. Hence, this research aims to investigate the factors affecting improved potato yield in Duna district, Ethiopia. This empirical research was investigated depending on the conceptual framework in Figure 1 (Chaimiso et al., 2022). According to the conceptual framework in Figure 1, improved potato production is affected by socioeconomic, demographic, institutional, and social factors.

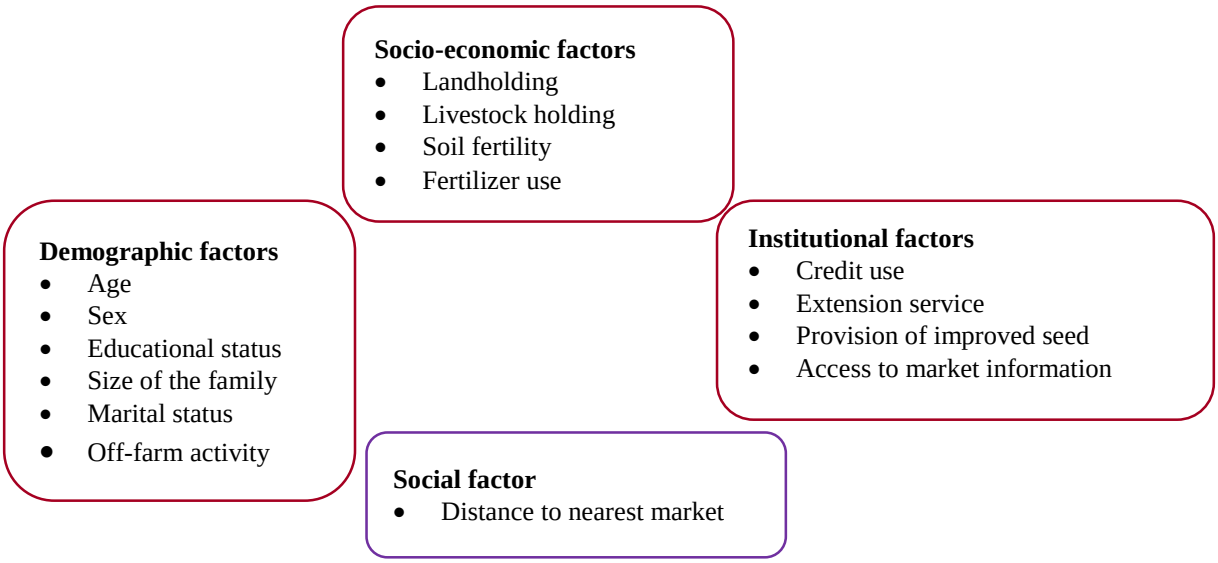

Fig. 1. Conceptual framework

2. Materials and Methods

2.1. Description of the study area

This study was conducted in Duna district, central Ethiopia. The total number of smallholder farmers in Duna district was 18,752 (100%), out of this 18,109 (95.57%) were male smallholder farmers and 643 (3.43%) were smallholder farmers. The total population in the study district is 148,566, the majority is male 75,383 and the remaining is female 73,183. The study district lies 270km south of Addis Ababa. Duna district was found at 7 0 37'19″ N and 37 0 37' 14″E. Agroecologically, the majority area of the district is Dega (85%) with a mean annual rainfall of 1500 to 1896 mm and an average yearly temperature of 19oc. The land coverage of the Duna district is 43,104 ha (222.57 s/ km), out of this 30,172.8 ha cultivated land. Agriculture is the main activity in the Duna district. Particularly, potato yield plays a major role in deriving food availability in the district (Negese and Jemal, 2021).

2.2. Sampling technique

In this study, multi-stage sampling was used. Firstly: the study district was selected purposely depending on improved potato production. Secondly: improved potato production sample kebeles such as Ajarena (K_1), Kashira (K_2), Dabiyago (K_3), and Barkuncho (K_4) were selected depending on improved potato production. Thirdly: a total number of respondents was selected from 2455 smallholder farmers in 2022/23. The respondent size was investigated in (Yamane, 1973).

$$n = \frac{N}{1+N(e2)} = \frac{2455}{1+(2455)0.07^2} = 189$$

189 samples were selected from each stratum by applying proportionate sample selection methods.

$$ni = \frac{Ni}{N}(n)$$

Where ni is the total sample size from each i^{th} kebele, Ni is the total of smallholder farmers from the i^{th} kebele, N is the total of smallholder farmers in four kebeles, e is an acceptable error margin, and n is the total respondent size. To this end, 189 samples were selected from each kebeles by conducting simple random sampling methods, because to diminish the data bias (Table 1) (Negese and Sanait, 2023; Negese, 2023).

Table 1: Sample of households based on the level of potato production status (n = 189)

Selected Kebeles	Total smallholder farmers (N_i)	A sample size (n_i)
Ajarena (K_1)	558	43
Kashira (K_2)	621	48
Dabiyago (K_3)	694	53
Barkuncho (K_4)	582	45
Total	2455	189

Note: n_i = total respondents i (i = 1, 2, 3, 4, 5); N_i= total smallholder farmers

2.3. Types and sources of data

Primary and secondary data were used for the data analysis. Primary data was collected from socio-economic, demographic, social, and institutional factors. To achieve the objective of the study data was collected from 189 respondents in the study area in the 2022/23 academic potato growing season. Secondary data was collected from different sources like the internet, literature, articles, and books. For data collection, all respondents received a detailed purpose of the study. The collection was kept confidential and ethical guidelines.

2.4. Data analysis

The data analysis was investigated by applying descriptive and binary logit models. Therefore, this research employed an appropriate logit model to analyze the data and to show factors that affect improved potato production (Gujarati, 2004). For this study dependent variable is improved potato production, which is dummy variable 1 if smallholder farmers produce improved potatoes and if 0 not produced improved potatoes. The logit model was applied to evaluate the factors affecting improved potato production (Gujarati, 2004). Hence, this research mainly focuses on evaluating the factors affecting improved potato production. The probability of improved potato production is

$$Pi = Z\ (y = \frac{1}{xi}) = \alpha + \beta i\ xi \quad (1)$$

Representation of people produced

$$Pi = F\ (Z) = \alpha + \sum_{i=1}^{n} \beta ixi = \frac{1}{1+e^{-(\alpha+\sum \beta ixi)}} \quad (2)$$

Where Pi is the probability status of the ith respondent not produced, e is the base of natural logarithms (2.718), Xi is the dependent variable, n is the number of dependent variables, i = 1, 2, 3 …, n, and α and βi are parameters to be estimated.

$$1\text{-}Pi = \frac{1}{1+e^{-Zi}} = \frac{e^{z}}{1+e^{z}}\text{, where } zi = \alpha + \beta i\ xi \quad (3)$$

If Pi is the probability status of the produced and (1-Pi) is the probability of not producing.

$$\text{Thus, } 1\text{- pi} = \frac{1}{1+e^{zi}}\text{, then } \frac{Pi}{1-Pi} = \frac{1+e^{Zi}}{1+e^{Zi}} = e^{Zi} \quad (4)$$

The formula of natural logarithm

$$\left(\frac{Pi}{1-Pi}\right) = \left(\frac{1+e^{Z}}{1+e^{Z}}\right) = e^{(\alpha + \sum_{i=1}^{n} \beta ixi} \quad (5)$$

Binary logistic regression model

$$Z = \ln\left(\frac{Pi}{1-Pi}\right) = \alpha + \beta 1\ X1 + \beta 2\ X2 + \ldots. + \beta n\ Xn \quad (6)$$

This binary logit model becomes

$$PP_i = \alpha + \beta X_i + u_i \quad (7)$$

Where PP_i is the potato improved production level of smallholder farmers i, X_i is independent variables or factors that affect improved potato production (Table 2); u_i is the stochastic term of the model $u_i \sim N(0, \sigma^2)$; and α and β are parameters to be investigated. The dependent variable of this study is dichotomous; binary logistic models are the most commonly used models to investigate potato production and its determinants.

$$PPi = \alpha + \beta 1\text{Age} + \beta 2\text{Sex} + \beta 3\text{Fsize} + \beta 4\text{Edu} + \beta 5\text{Mas} + \beta 6\text{Ofa} + \beta 7\text{Lah} + \beta 8\text{Lih} + \beta 9\text{Sof} + \beta 10\text{Feu} + \beta 11\text{Acc} + \beta 12\text{Exs} + \beta 13\text{Pis} - \beta 14\text{Dnm} + \beta 15\text{Ami} + u_i \quad (8)$$

Code of the explanatory variables or factors applies for the logit model is given as Age is the age of smallholder farmers, Sex is the sex of smallholder farmers, Fsize is the family size, Edu is education level, Mas is marital condition, Ofa is off-farm activity, Lah is landholding, Lih is livestock holding, Sof is soil fertility, Feu is fertilizer use, Acc is credit use, Exs is extension services, Pis is the provision of improved seed, Dnm is the distance to nearest to market, and Ami is access to market information.

2.5. Description of explanatory variables

The description of independent indicated that logit model was applied to evaluate the factors affecting improved potato production. Dependent variable for this is improved potato production, is dummy variable 1 if smallholder farmers are produced improved potato and if 0 not produced improved potato. The independent variables for this study is Age, Sex, Fsize, Edu, Mas, Ofa, Lah, Lih, Sof, Feu, Acc, Exs, Pis, Dnm, and Ami affect improved potato production (Table 2).

Table 2: Description of variables

Variable name	Variable Category	Description and measurement	Expected Sign
Age smallholder farmers	Continuous	In year	+
Sex smallholder farmers	Dummy	Male = 1, Female = 0	+
Family size	Continuous	Family members	+
Educational status	Dummy	Literate = 1, illiterate = 0	+
Marital status	Dummy	Married = 1, not married = 0	+
Off-farm activity	Dummy	If 1 = Yes, 0 = otherwise	+
Landholding	Continuous	Hectare	+
Livestock holding	Continuous	TLU	+
Soil fertility	Dummy	If 1 = Yes,0 = otherwise	+
Fertilizer use	Continuous	Kilograms/hectares	+
Access to credit	Dummy	If 1 = Yes, 0 = otherwise	+
Extension services	Dummy	If 1 = Yes, 0 = otherwise	+
Provision of improves seed	Continuous	Kilograms/hectares	+
Access to market information	Dummy	If 1 = Yes, 0 = otherwise	+
Distance to nearest market	Continuous	Km	-

Source: Authors hypothesis 2022/23

3. Results and Discussions

3.1. Descriptive analysis

Table 3 shows a descriptive analysis of the improved potato production in the Duna district. Of the total smallholder farmers 189, the majority of smallholder farmers 113 were non-producers of improved potatoes. According to descriptive results relatively lower potato producers 76 (40.21%) than those who did not produce 113 (59.79%) during the 2022/23 potato growing season. According to Table 3, there is low potato cash crop production due to applying backward potato production technology in the study area. The descriptive result reveals that the main problems for low production, like low potato production knowledge/awareness, are input management problems, inappropriate extension services, poor credit use, backward marketing, traditional agricultural technologies, poor infrastructure, inappropriate inputs, and policy use, and subsistence of agriculture. Furthermore, there are no appropriate inputs and outputs markets to improve the low-level smallholder farmers' improved potato productivity.

Table 3: Sample potato production status

Potato production status	Frequency	Percent	Cumm. Percent
Potato producers	76	40.21	40.21
Potato non-producers	113	59.79	100
Total	189	100	

Source: From own field survey data 2022/23

A descriptive statistical summary showed all of the independent variables were significant at a 1% significance level Table 4. The family size, access to landholding, livestock holding, fertilizer use, provision of improved seed, education level, off-farm activity, marital status, soil fertility, access to credit and extension, and distance to market are largely associated with smallholder farmers' improved potato production. The majority of smallholder farmers are educated (65.27%). This result is similar to that of (Röder et al., 2018; Islam et al., 2021). The average family size was (5.42) per smallholder farmers. This result is similar to that of (Kanter and Elkin, 2019; Liu et al., 2018; Masuku and Xaba, 2013). The mean access to landholding is 2.39 ha. In addition, the average (58.34%) of off-farm activity indicates that there is an important average difference between potato growers and non-growers of households. Furthermore, the descriptive summary results showed that the average livestock holding was 10.62. The majority (65.53%) of sample smallholder farmers was married and faced 3.5 km nearest to the market on average. Credit use (51.46%) and extension services (69.36%) on average were for smallholder farmers. This finding is similar to that of (Alemayehu et al., 2020; Deresseh et al., 2016; Efa and Tura, 2018; Islam et al., 2021). As mentioned, (56.38%) on average, soil fertility, on average 100 Kilograms/hectares fertilizer use, and an average of 82 Kilograms/hectares provision of improved seed were used. This result is similar to that of (Deresseh et al., 2016; Efa and Tura, 2018).

Table 4: Descriptive results of variables

Continuous Variables	Mean	Std. Dev.	Min	Max	P-value
Age	56.20	11.24	25	83	0.612
Fsize	5.42	1.58	2	9	0.000***
Lah	2.39	0.38	1.25	3	0.000***
Lih	10.62	3.18	2.8	18.2	0.000***
Feu	100	2.86	50	200	0.000***
Pis	82	2.88	75	100	0.000***
Dnm	3.5	0.54	2	4.5	0.000***
Dummy Variables	Mean	Std. Dev.	0 (%)	1(%)	P-value
Sex	0.70	0.46	29.96	72.28	0.306
Edu	0.68	0.56	36.82	65.27	0.000***
Ofa	0.53	0.32	32.65	58.34	0.000***
Mas	0.60	0.45	37.86	65.53	0.000***
Sof	0.81	0.74	46.58	56.38	0.000***
Acc	0.52	0.49	49.37	51.46	0.000***
Ami	0.76	0.57	31.65	70.48	0.251
Exs	0.73	0.67	34.21	69.36	0.000***

Note: Source: From field survey data 2022/23.

3.2. Econometric results

The logit model result indicated, of 15 variables 11 variables significantly associated with improved potato production. Among all significant explanatory variables education status of the household head, off-farm activity, livestock holding, soil fertility, fertilizer use, credit uses, and access to extension service affect potato production at a 1% statistical significance level. Potato production is also significantly influenced by age, landholding, provision of improved seed, and distance to the nearest market at a 5% statistical significance level. The potato production elasticity concerning age, education status, off-farm activity, landholding, livestock holding, soil fertility, fertilizer use, use of credit, access to extension service, and provision of improved seed shows that as all listed explanatory

variables increase, potato production will increase. Potato production increases access to extension service, education status, soil fertility, credit use, fertilizer use, livestock holding, and off-farm activity on average for potato production by 1%, they can increase the status of potato production by 34.38%, 34.18%, 32.83%, 31.63%, 30.21%, 27.35%, and 23.65%, respectively. In addition, increasing the distance to the nearest market, on average, will decrease the decision to participate in the production of potatoes. This reveals that there is a high potential for potato production in the study district (Table 5).

Table 5: Estimates of determinants of potato production (n = 189)

Variables	Robust coef.	Std. Err.	Z-value	P > | z |	dF/dx
Age	0.237**	0.135	1.12	0.023	0.0843
Sex	1.415	0.254	0.67	0.472	0.0516
Fsize	1.516	0.227	1.96	0.433	0.0693
Edu	0.438***	0.248	0.21	0.000	0.3418
Mas	1.648	0.342	2.42	0.328	0.0191
Ofa	0.682***	0.211	1.12	0.003	0.2365
Lah	0.613**	0.431	1.62	0.027	0.2573
Lih	0.528***	0.743	1.16	0.000	0.2735
Sof	0.646***	0.928	0.56	0.000	0.3283
Feu	0.738***	0.474	0.52	0.006	0.3021
Acc	0.623***	0.437	1.29	0.000	0.3163
Exs	0.437***	0.384	0.92	0.000	0.3438
Pis	0.571**	0.213	1.24	0.025	0.2356
Ami	0.872	0.734	1.78	0.281	0.0672
Dnt	-0.514**	0.463	-1.25	0.032	0.2487
Constant term	4.673***	1.268	2.36	0.000	-

Note: Source: Computed from own survey data 2022/23; total observations = 189; LR chi2 (15) = 59.79; probability > chi2 = 0.0000; log-likelihood = -74.459; Pseudo R2 = 0.542; ***, **, and * represent 1%, 5%, and 10% significance level, respectively.

According to Table 5, from a total of 15 independent variables, eleven independent variables, such as age, education status, off-farm activity, landholding, livestock holding, soil fertility, fertilizer use, use of credit, access to extension service, provision of improved seed, and distance to the nearest market, were found to have a strong association with the status of potato production. Specifically, the age of the household head was indicated to have a better positive association with potato production. Therefore, keeping all other things constant, an extra year of sample household head age is expected to be found in an 8.43% increase in the probability of potato production ($P < 0.01$). Moreover, producers who are on average 10 years old are 84.3% more likely to produce potatoes in the study area than young, and age is a scientific driver of potato production. This binary logistic regression result is similar to those of (Alemayehu et al., 2020; Deresseh et al., 2016; Efa and Tura, 201). As mentioned, the important reasons for producers are the elderly household head's experiences, knowledge, information, physical capacity, skills, and ability increase at the older age of the household head. All these above-listed characteristics of the older age growers such as experiences, knowledge, information, physical capacity, skills, and ability were found to have a strong positive relationship with potato production and quality.

As a binary logit result, all independent variables such as age, education status, off-farm activity, landholding, livestock holding, soil fertility, fertilizer use, use of credit, access to extension service, and provision of improved seed are expected to have strong positive associations with potato production and mostly affect potato production. Keeping all other things constant, the marginal effect of the regression shows that all significant independent variables range from 7.43% to 35.72% on average in the study area. Moreover, all else being constant, the marginal effect of the 1% significant explanatory variables ranges from 23.65% to 34.38% higher probability of potato production, on average. Furthermore, access to extension services and educational status are expected to be 34.18% and 34.38% higher, respectively, than those of non-producers. Education and extension service are key drivers of

potato production and quality in terms of product needs by solving food security problems. People with more education and extension services in a given season are expected to have higher productivity rates than their counterparts. Specifically, there is a positive correlation between the extension service and potato production at a 1% probability significance level. This result is similar to that reported by (Efa and Tura, 2018; Setu and Mitiku, 2020; Wassihun et al., 2019). Soil infertility, degradation, agricultural production, and quality loss are also considered problems reducing smallholder farmers' income in the study district. Therefore, soil fertility is the base for enhancing the production and income of a household in the agricultural sector, especially, in potato production. This result is in line with that of (Deresseh et al., 2016; Kanter and Elkin, 2019; Liu et al., 2018). Landholding was found to be positively associated with potato production at the 5% probability significance level. An average landholding increase at the household level increases the potato production status by 25.73%, all other things being constant. This binary logistic regression result is similar to those of (Taye et al., 2021; Wassihun et al., 2019). The regression results indicate that there is a positive significant relationship between soil fertility and potato production status in the study district and variables significant at the 1% significance level. The binary regression model expected that household head soil fertility would increase by 1% on average, and members of households would produce 32.83% more than infertile areas. Therefore, in the study area, producers were more likely to be affected by soil infertility problems than non-producers. Soil infertility is also considered a problem due to the inability to produce adequate agricultural production, which is a key issue in ensuring food security and poverty alleviation. This result is in line with those of (Taye et al., 2021; Wassihun et al., 2019).

Distance to the market was associated with potato production and negatively significantly related to potato production. The binary logit result indicates that greater distance to potato farms and markets decreased production by 24.87%. This result is similar to that of (Al-Zebari et al., 2021; Liu et al., 2018; Pauline et al., 2021; Setu and Mitiku, 2020; Singh et al., 2020; Taye et al., 2021; Tkachenko et al., 2021). Further, fertilizer use is positively significant at the 1% related to potato production. Therefore, the logit result shows that citrus paribus, the marginal effect shows that the fertilizer use increases by 1% on average at (30.21%) potato production in the study district. This logit model result is similar to those of (Al-Zebari et al., 2021; Röder et al., 2018). Rural credit is a vital component of the potato growing activity in terms of improving potato cultivators' needs by alleviating capital problems. Potato cultivators who have more access to credit at a given growing year are expected to have more (31.63%) potato production than those who did not get credit, keeping all else constant. This finding is similar to that of (Workat et al., 2021; Pauline et al., 2021). The binary logistic regression result implies that potato growers' participation in off-farm activity would increase by 1% on average, and the potato growers' would produce more (23.65%) potatoes than non-participants in the off-farm activity. In addition, livestock holding and provision improved seed of are other significant variables that influence potato production in the study district. Particularly, there is a direct relationship between livestock holding and provision of improved seed, and potato production at a 1% and 5% significance respectively. Furthermore, citrus paribus, livestock holding, and provision of improved seed would increase by 1% on average; the potato growers' would produce more (27.35%) and (23.56%) potatoes respectively. This result is in line with that of (Deresseh et al., 2016; Liu et al., 2018). According to the logit results, the remaining variables, such as sex of the household, size of family, marital status, and access to market information did not relate to potato production in the research area.

4. Conclusions and Policy Implications

4.1. Conclusions

Improved potato production is a plays an essential role in deriving food availability in many parts of central Ethiopia, particularly, in the research location. In this study, to improve the improved potato growers' living standards and to leave poverty, agriculture needs enhancement by improving the production of improved potatoes. Improved potato yield is key crop in improving potato growers' income, food availability, and nutritional status. In the agriculture, improved potato is an essential means to leave poverty and food insecurity for many cultivators. For the data analysis the primary and secondary data were employed. The primary survey data was collected from 189 respondents during 2022/23 academic production year. The descriptive and logit model were used for the data analysis. The logit model data analysis showed that improved potato production was influenced by age, education levels, off-farm activity, access of landholding, livestock holding, soil fertility, fertilizer use, use of credit, access to extension use, provision of improved seed, and distance to the nearest market. The result of the current study implies that enhancing improved

potato production through best agronomic practices was an important option to improve improved potato cultivators welfare. Therefore, the agriculture should pay an important attention to boost improved potato production, which is a base for driving food availability in the research area.

4.2. Policy implications

Given these current study findings, several recommendations could emerge from our analysis. Improved potato production is relatively low in the Duna district due to low attention given to the improved potato production in the agricultural sector. Particularly, education has a strong relation with improved potato cash crop production. To this end, enhancing improved potato growers' awareness or knowledge through education is the key instrument to enhance improved potato production, and leave poverty and food insecurity. In addition, extension service, credit use, fertilizer use, livestock holding, soil fertility, and off-farm activity are crucial recommended variables in terms of enhancing improved potato yield practices, which in turn, enhance improved potato production and further, enhance household food security. Therefore, concerned bodies should facilitate and create a conducive environment in education, extension service, credit use, fertilizer use, livestock holding, soil fertility, and off-farm activity, thus, helping to boost improved potato production. The result of this research brings a better enhancement to improved potato cash crop growers. Enhancing potato cultivation through different technologies and best agronomic practices is a key option to increase potato production.

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