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The Analysis of Profitability of Smallholder Potato Growers in Bore District, Guji Zone, Oromia Regional State, Ethiopia

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Abstract
This study analysis the profitability of smallholder potato growers in Bore district. Due to various chronic constraints the profitability of smallholders are low. Data were collected by Questionnaire to a total of 192 sampled respondents. The collected data were analyzed by mean standard deviation and percentage. The mean of productivity, total costs and gross margin of potato was 109.95 qt/ha, 10938.38 birr/ha and 10930.97 birr/ha respectively. The mean of net farm income from potato was 10090.45 Birr/ha. The results of Ordinary Least Square showed that sex, improved variety, fertilizer, experience, access to extension, harvesting time, nature of access to land, access to irrigation schemes affect profitability of smallholder potato growers. To improve the profitability of smallholder potato growers the provision of improved seed, use of fertilizers and chemicals as recommendation should be used by the smallholders. In addition, the smallholders should conserve their soil and harvest potato as soon as it matured.
Keywords: Bore, Potato, Smallholder, Profitability.

1. Introduction

Potato (*Solanum tuberosum* L.) is one of the most important tuber crops in Ethiopia having the potential of improving the livelihood of smallholder farmers. Potato has been considered as a strategic crop by the Ethiopian government aiming at enhancing food security and economic benefits to the country. As the population grows rapidly, increased productivity of potatoes can improve the livelihood of smallholder potato producers and is required to meet the growing demand (Gildemacher, 2012; Habtamu, 2015).

There are about 13 million smallholder farmers accounting for 95% of total production in Ethiopia (Dawit, 2012). Fan (2013) differentiate small farms according to their profitability within the agricultural sector (subsistence farmers without profit potential, subsistence farmers with profit potential, and commercial smallholder farmers) and the different stages of economic transformation (agriculture based, transforming, and transformed economies). Profitability is a measure of the relationship between the levels of profits earned during production and the level of resources committed to earn those profits. According to Parkin (1998) the major objective of the firm is profit maximization. Profit maximization is considered as a rational behaviour of equilibrium assumption where marginal revenue is equated to marginal cost.

Even though smallholder farmers are increasingly being recognized as important contributors to enabling global food security, the profitability smallholder's production is fraught with a multitude of challenges, including low yields, low quality of crops, lack of access to markets and credit. Securing capital to purchase inputs, invest in machinery and pay for transport to sell outputs is a challenge that smallholder farmers face every harvest season (Yuko, 2014).

2. Materials and Methods

2.1. Description of Study Area

Bore is 385 km from Addis Ababa. The district is bordered by Hula district of SNNPR in the North, Ana Sora district in the South, Bona district of SNNPR in the East and Dama district in the West. Bore is divided into 33 rural kebeles and 3 town kebeles (BoARDO, 2015).The major agro-ecology of the district is highland (90%) and midland (10%). Annual average of temperature of the district is 16.05 ^{0}C.

Root crops such as potato, carrot and onion and vegetable crop like cabbage could be grown throughout the year but majority of smallholders commonly produce these crops during *belg* (February to May) season. At Bore district, cattle, horses, sheep and bee keeping are the dominant livestock. Selling of milk is one of income generating activity for rural women. Bore is also well known by its 'white honey' which is produced from different vegetation distributions found in the district. Most rural youth and male farmers of Bore district migrate to extract minerals namely gold in order to maintain their income during off season.

2.2. Sampling Technique and Sample Size

Bore district has 33 *kebeles* out of which 14 *kebeles* are major growers of potato. In the first stage, seven *kebeles* were selected randomly from 14 *kebeles* of major growers of potato and the number of respondents were determined by using probability proportional to size. Simple random sampling technique was employed to select the size of the sample smallholders from each kebele. From 3428 household heads producing potato in the district

a total of 192 household heads were selected by simple random sampling method.

2.3. Data collection Methods

Questionnaires and Focus Group Discussions were used to collect primary data from the smallholders. Secondary data such as literature review, district report on potato work and number of smallholders participating on potato farming was collected from reports of the district.

2.4. Data Analysis

Descriptive statistics like means, percentages, standard deviation and frequencies were used in analyzing socio-economic characteristic of respondents. Following Sadiq *et al.* (2013) and Ogisi *et al.* (2013), Net Farm Income (NFI) was used for this study to determine profitability of smallholder potato growers. Profit calculation model was as follows:

GM=YxP– TVC……1

GM= TR – TVC……2

NFI (JI) = GM – TFC……3

Where, Y=yield in quintals/hectares of potato, P=price of yield in units of birr/quintals; TVC=Total Variable Costs, TFC= Total Fixed Cost is the cost of land rent for potato production. NFI = Net Farm Income, JI = profitability. Total cost is the summation of variable and fixed costs. YxP is called Total Revenue (TR).

In this study ordinary least square (OLS) was used to analyze factors affecting profitability because the OLS estimator is known as best, linear, unbiased estimator (BLUE) under the validity of a particular set of assumptions. The underlying OLS assumptions are as follows: (1) the variance of independent variables is the same all over the ranges; (2) the variance of error term value is approximately the same over all ranges of independent variables; (3) the expected value of each disturbance (error term) is equal to zero. However, when these assumptions are violated, this would weaken the validity of the results obtained from the regression (Fred *et al.*, 2012). The result of multicollinearity test, contingency coefficient, Shapiro test and specification error test showed that the assumption of OLS fulfilled, hence the result was unbiased for conclusion (Appendix Table 1-4).

Following Obasi *et al*. (2013) and Osondu and Ijioma (2014), four (4) functional forms of production namely linear, semi-log, double-log and exponential were fitted using OLS technique under the assumption that the data fulfilled the assumptions of the multiple regression models. The lead equation was chosen based on a prior theoretical expectations, magnitude of the coefficient of multiple determinations (R^2) and statistical significance of the coefficient. Four functions were regressed on Net Farm Income (NFI) in order to analyze factors affecting profitability of smallholder potato growers. The explicit forms of factors affecting profitability model were as follows:-

NFI = β0+ β1X1 + 2βX2 + β3X3 + β4X4 + ……...+ β16X16+ et (Linear) ……....4

ln NFI = β0 + β1lnX1 + β2lnX2 + β3lnX3 + β4lnX4 + ….+ β16X16+et (Double-Log)… ..5

NFI = β0 + β1lnX1 + β2lnX2 + β3lnX3 + β4lnX4 + .. + β16X16+ et (Semi-Log)…….....6

ln NFI = β0 + β1X1 + β2X2 + β3X3 + β4X4 + ……+ β16X16+ et (Exponential)…….....7

Where, NFI = Net Farm Income, ln = natural logarithm, β0 = constant, βi = estimated coefficients of the explanatory variables, $X_{i\text{-}16}$ = independent variables: age of household head, sex of household head, education level of household head, potato farming experience of farming household head, household size, seed variety, fertilizer, farm size, soil conservation, harvesting time, access to extension, credit, market, irrigation, nature of access to land and selling price, et = error term.

3. Results and Discussion

3.1. Cost and return analysis of potato production in Bore district

Potato production is not only used for the purpose of satisfying the household food need. The smallholders may be interested in selling their output to raise income and fulfil their livelihood. Profitability refers to the capacity of an enterprise to generate more revenue through the sale of its products than its costs to produce those products. Thus, the like any other business oriented entrepreneurs the smallholders would be interested in the profitability of the farm enterprise. For this reason, efforts were made to determine the cost associated with potato production and the revenue that gone to the smallholders. Table 1 shows that the average costs and returns of potato production in Bore district. Revenue of potato was considered as the average potato harvested from the land including consumed and tuber seed used for planting purposes. The average amount of potato produced by smallholder and the farm gate price of potato was 109.95 qt/ha and 191.22 birr/qt respectively. The productivity of potato during study season seems to low compared to productivity in 2013 which was 137 qt/ha (BoARC, 2013). This low productivity potato was due to influence of diseases during study period. The mean total cost of potato production was 10938.38 birr while gross margin and net farm income from potato production in the study area was 10930.97 birr and 10090.45 birr respectively. The result of NFI analysis as a measure of profitability smallholder potato growers had the positive values of NFI (10090.45 birr) obtained by smallholder potato growers confirmed to the

fact that smallholder potato growers were able to cover their operating expenses with a significance level of NFI obtained from the study area. Thus, potato production is profitable for smallholders in Bore district.

Table 1. Cost and return analysis of potato production in Bore district

Elements of costs and returns	Mean	Std. Dev.	% share
1.Potato yield obtained per hectare in quintals **(Q)**	109.95	19.28	
2. Price of potato sold per quintals in birr **(P)**	191.22	17.33	
3. Total Revenue (TR) = QxP	21024.64	4023.06	
4. Variable costs			
4.1. Seed cost per quintals in birr	4300.52	1448.51	42.59
4.2. Family labour costs of management practices in birr	1935.36	593.77.	19.17
4.3. Labor cost other than family (hired labour) in birr	556.67	443.43	
4.4. Cost of oxen during land preparation and during harvesting in birr	879.08	431.86	
4.5. Fertilizer cost for potato production in birr	1233.54	743.23	
4.6. Pesticides cost in birr	28.07	60.24	
4.7. Marketing costs (costs of transportation, store and sack)	1164.94	458.29	
4.8. Total Variable Costs (TVC)	10098.22	2994.75	92.32
5. Fixed Cost (FC)			
5.1. Land rented in birr	840.16	154.86	
5.2. Total Fixed Cost (TFC)	840.16	154.86	7.68
6. TC= TVC+TFC	10938.38	2992.63	
7. GM = TR-TVC	10930.97	1568.99	
8. NFI= GM-FC	10090.45	1544.15	

3.2. Factors affecting profitability of smallholder potato growers in Bore district

The OLS results of the variables that are expected to affect profitability potato are presented in Table 2. Linear function was chosen based on theoretical, prior hypothesis, number of significant of independent variables. The R^2 of the model was 68.72 and. The R^2 (68.72%) indicates that variables entered into the model are explained NFI by the selected independent variables with the remaining 31.28% due to random error in the model. The test of significance of the R^2 produced an f-value of 35.01 which was significant at 1%, implying that the linear function gave a good fit to the data. The linear function was therefore chosen as the lead equation and used for discussion.

In the study area sex of household head significantly affect profitability similar to the study of Berihun *et al*. (2014). Female headed households were more profitable than male headed households in the study area. This could be due to in the study area most male headed household were migrant but female households stay at home and could well manage their farm than male headed households. When male headed household migrate their potato management could be declined resulted to lower profit. Age of household head affect profitability of smallholder positively and significant at less than 1%. All else equal, 1 year increase of age household head led to increase in the profitability by 29.52 birr. The implication is that older respondents could have more resources that help them to maximize their profit than youngsters.

Educated farmers are more likely to apply modern technologies and information that can raise the farm value addition process which can result in higher profitability. However, in this study an increase in attaining educational level led to decrease the profitability of smallholders by 174.75 birr. Thapa (2010) reported that more educated people prefer working on off-farm activities, probably due to the low wages and returns from the agricultural sector. Despite educated people have knowledge and skills on farm activities they were mostly busy by different activities and have no enough time for managing potato farm that led to poor management practices which in turn led to lower return from their farm.

Though smallholder are generally considered as own shortage of land resulted to low profit the result of this study revealed that farm size affect profitability of smallholder in the study area. The result in consonance with Berihun *et al*. (2014) and Singh (2016) who found that farm size affect productivity and profitability of potato. The coefficient of farm size was significant at 10%. When other variables are held constant, an increase of 1 hectare of farm size increase profitability of smallholders by 1021.38 birr. Potato farming experience directly affect the profitability of potato at less 1% of level of significance. As the number of years of potato production increases by 1 year, the profitability of smallholders increase by 251.49 birr, being all the other factors constant.

Potato varieties used by smallholder affect profitability. Other variables are held constant, improved seed varieties resulted high profit. The amount of fertilize used by smallholder affect profitability of potato. Even though smallholder use fertilizers beyond the recommended, amount of fertilizer had a direct relationship with profitability of potato in the study area. Like other vegetables, potato is a seasonal crop could be harvested at different time. To get high price or for other reasons, smallholder harvest potato at certain time. The implication is that

smallholder harvest their produce as soon as it matured and use their land for other cropping purposes to maximize their farm returns.

The aim of the extension service is to introduce smallholder farmers to new and improved agricultural inputs in order to improve production and productivity in turn increase marketable supply which has a positive effect on profitability. Extension services affect profitability of potato at 10% level of significance and the study contradict with Olawale and Noelle (2015). Being other variables were held constant, an increase of access to extension services on potato increase profitability of potato by 67.25 birr. This implies access to extension influences farmers' profitability as farmers become equipped with agricultural information from extension agents.

The result of the study showed that nature of access to land influence the profitability of smallholder potato growers. This result is also agree with Lighton *et al.* (2014) who stated contract farming affect profitability of smallholder out growers tea and disagree the study of Berihun *et al*. (2014) who stated land ownership could not influence farm income. Smallholder farmers use different land arrangement like own, contract and share to maximize their profit.

Access to irrigation schemes influence the profitability of smallholder potato growers. This result agree the study of Singh (2016) who studied irrigation has impact on profitability farm. Irrigation scheme affect profitability of potato at 10% level of significance. However, the magnitude of coefficient of access to irrigation was negative indicating reverse relationship between irrigation and profitability. One reason could be since the study area is highland and obtained enough rainfall additional use of irrigation lead to over loss of product. This implies use of inputs beyond and above optimum level affects the profitability of smallholder farmers.

In the study area, selling price of potato influence profitability of smallholder potato growers. This result is supported with Almaz *et al*. (2014) who found that a selling price affect profitability of vegetables in Ethiopia.

Table 2. The OLS result of determinants of the Net Farm Income (NFI) of smallholder potato growers

	Functional forms											
Independent Variables	Linear (L)			Double log			Semi log			Exponential		
	B	Robust Std.err	T	B	Std. Err	T	B	Std.err	T	B	Std.err	t
Sex	-250.12***	45.21	-5.53	-0.06***	0.01	-5.84	-645.85***	120.01	-5.38	-0.023***	0.004	-5.51
Age	29.52***	8.79	3.36	0.1***	0.03	3.14	1122.84***	360.31	3.12	0.003***	0.001	3.24
Hhsize	-22.78	22.52	-1.01	-0.01	0.01	-0.98	-267.07	168.94	-1.58	-0.0006	0.002	-0.29
Education	-174.75***	47.75	-3.66	-0.03***	0.01	-3.2	-299**	117.8	-2.54	-0.019***	0.004	-4.58
Seedvarity	82.92**	41.38	2	0.02**	0.01	2.43	211.07*	113.51	1.86	0.01**	0.004	2.45
Farmsize	1021.38*	531.2	1.92	0.05***	0.02	3.07	598.48***	176.08	3.4	0.08**	0.035	2.26
Experience	251.49***	52.43	4.8	0.06***	0.01	4.42	745.76***	161.05	4.63	0.02***	0.004	4.89
Fertilizer	10.5***	2.82	3.73	0.09***	0.02	4.95	990.54***	199.47	4.97	0.001***	0.001	4.3
Conservation	124.73	119.88	1.04	0.03	0.02	1.45	346.42	217.52	1.59	0.01	0.008	1.38
Harvetime	317.26**	150.88	2.1	0.05***	0.02	2.62	558.1**	222.85	2.5	0.3**	0.013	2.17
Extension	67.25*	34.71	1.94	0.01*	0.01	1.86	189.46**	88.81	2.13	0.01*	0.003	1.7
Credit	15.91	34.63	0.46	0.006	0.01	0.76	80.37	87.08	0.92	0.001	0.003	0.34
Mrkt	-10	33.49	-0.3	-0.0004	0.01	-0.05	-9.82	87.39	-0.11	-0.001	0.003	-0.25
Nattureland	156.03**	68.76	2.27	0.005	0.01	0.46	377.02***	135.93	2.77	0.002	0.006	0.32
Irrigation	-90.26*	52.55	-1.72	-0.02*	0.01	-1.81	-264.27**	112.5	-2.35	-0.01	0.004	-1.4
Outputprice	6.65*	3.64	1.83	0.14**	0.07	2.01	1233.82	759.68	1.62	0.001**	0.001	2.13
_cons	5735.56***	956.56	6	7.85***	0.38	20.71	-4274.32	4273	-1	8.87***	0.08	107.09
R^2= 68.72, F=35.01***				R^2=67.21, F =22.42***			R^2 =68.25, F= 23.51***			R^2= 68.68, F=23.99***		
				Adjusted R^2= 64.21			Adjusted R^2 = 65.34			Adjusted R^2 =65.82		

Source: Own Data, 2015. L= shows Lead equation. Symbol ***, ** and * shows the significant level at 1%, 5% and 10% respectively

4. Conclusion

The mean of gross margin of potato production was 10930.97 Birr/ha while the mean of NFI from potato was 10090.45 Birr/ha. Despite the most constraints of potato such as disease, lack of good farm gate price, lack of improved seed and low yields in the study area potato is still profitable crop for smallholder since the measure of profitability of Net Farm Income of potato is positive.

The results of Ordinary Least Square (OLS) of linear function of profit analysis showed that gender, age, educational level of household heads, farm size, seed variety used, experience on potato farm, amount fertilizer applied and harvesting time affect the profitability of smallholder potato growers in Bore district. Despite numerous challenges of women in rural kebeles, in this study, female headed households were more profitable than male headed due to male household were migrant so less profitable from potato farm than female household heads who stay and well manage their farm. Moreover, the profitability of smallholder potato growers were influenced by institutional services such as access to extension services, nature of access to land, access to irrigation scheme and output price. Like economic theory of profit as a function of quantity and price, in this study output price of potato affect profitability of smallholder potato growers.

5. Recommendations

Smallholder potato growers should use the improved seed to increase their potato profitability. Extension services

have to widely reach the smallholders in the usage of fertilizers and other recommended packages to increase their potato profitability. Since postponed harvesting led to loss of profit the smallholder should harvest their potato as it matured.

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8. Appendix

Appendix Table 1. The result of multicollinearity test

Continues Variables	**VIF $(1-R^2)^{-1}$**	**Tolerance(1/VIF)**
Fertilizer	2.24	0.447212
Experience	2.08	0.481103
Seed cost	1.8	0.556981
Age	1.47	0.67827
Farm size	1.35	0.741998
Hhsize	1.23	0.810397
Mean VIF	1.70	

The larger the value of VIF, the more collinear is the variable Xi. As a rule of thumb if the VIF greater than 10 the variable is said to be highly collinear (Gujarati, 2003). Multicollinearity of continuous variables can also be tested through Tolerance. Tolerance is 1 if Xi is not correlated with the other explanatory variable, whereas it is zero if it is perfectly related to other explanatory variables. There is no problem of multicollinearity in this model because the VIF is less than 3 in all cases.

Appendix Table 2. Contingency coefficients for dummy variables

	Gender	Educ	Varity	Soil	Hartime	Exten	Credit	Mrkt	Nausela	Irrig
Gender	1									
Educ	0.216	1								
Varity	0.340	0.147	1							
Soil	0.086	0.064	-0.050	1						
Hartime	-0.200	0.062	-0.254	-0.196	1					
Exten	0.081	0.161	0.123	-0.073	-0.021	1				
Credit	0.047	0.025	-0.060	0.051	-0.133	0.026	1			
Mrkt	0.109	0.089	0.071	0.118	-0.046	0.170	0.038	1		
Nausela	-0.070	0.057	0.105	-0.109	0.003	-0.050	-0.099	0.093	1	
Irrig	0.054	-0.139	0.103	-0.016	-0.084	-0.186	-0.0008	-0.008	-0.125	1

Appendix Table 3. Shapiro-Wilk W test for normality of residuals
Ho: There is normality of residuals
Ha: There is no normality of residuals

Model		Obs.	W	V	Z	Prob>z	Decision
Profitability	Residual	192	0.98792	1.74	1.271	0.10184^{NS}	Accept Ho

NS = Not Significant at 5%. The null hypothesis residuals variance is homogenous. Therefore, if the p-value is less than 5% probability, we would have to reject the hypothesis and accept the alternative hypothesis that the variance is not homogenous. Based on the rule we can conclude that there is no problem of heteroskedasticity in the model.

Appendix Table 4. Linktest of specification error in dependent variables
Ho: No specification error
Ha: There is specification error

NFI	Coef.	Std. Err.	T	P>t	Decision
_hat	1.493236	0.550161	2.71	0.007	Since -hatsq is not significant at 5% there is no specification error
_hatsq	-2.4E-05	2.67E-05	-0.9	0.369	
_cons	-2489.67	2811.146	-0.89	0.377	

Linktest creates two new variables, the variable of prediction, _hat, and the variable of squared prediction, _hatsq. The model is then refitting using these two variables as predictors. _hat should be significant since it is the predicted value. However, _hatsq should not, because if our model is specified correctly, the squared predictions should not have much explanatory power. That is we wouldn't expect _hatsq to be a significant predictor if our model is specified correctly. So we checked at the p-value for _hatsq.