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Research Article

Production Economics and Determinants of Potato Production in Nuwakot, Nepal

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Abstract

A study was conducted for comparative analysis of demographic, production economics and determinants of potato production between Kakani rural municipality and Bidur municipality of Nuwakot district. Altogether 120 potato producers, 56 from Kakani and 64 from Bidur were randomly selected. Pretested semi-structured questionnaire was administered to randomly selected farmers. Potato growers were interviewed using face to face interview method in the month of October 2018. All the data were entered into SPSS and Microsoft excel and analysis was done by using Microsoft excel, STATA and SPSS. Average productivity in the research area was 14.69 ton per hectare. Average cost of production and profit was Rs 8614.61 per ropani and Rs 6083 per ropani respectively. B/C ratio in the research area was 1.71. 10% increase in organic manure (FYM and poultry manure), pesticide and tuber resulted in 1.88%, 1.99% and 0.05% increase in income respectively. 10% increase in labor and chemical fertilizer resulted into 0.1% and 0.5% decrease in output. Labor and chemical fertilizer was over utilized resource for potato production. The probability of cultivation of potato in large scale was found to be 56.92% higher for those with access to extensive service and 47.89% higher for those who have received training. Most of the farmers don not use improved seed thus distributing improved seed, providing training and extension services help to increase profit of potato production in Nuwakot district. 100% increase in all the factor of production would result in 32.39% increase in potato production.

Keywords: Productivity; ropani; B/C ratio; improved seed

Introduction

Potato (*Solanum tuberosum*) is one of the important food crops of Nepal and is staple crop in hills of Nepal (Bajracharya and Sapkota, 2017). Nepal is one of top twenty countries where potato contributes significantly for human diet (Gairhe *et al*., 2017). Potato is cultivated from 100 m altitude in south to 4000 m altitude in north. Potato is now second most important staple crop after rice and per capita consumption of potato is 51 kg per year (Potatopro, 2018). Production of potato in year 2014-2015 was 2586287 metric ton which is lower than attainable productivity. Kavre, Dadeldhura Kailali, Nuwakot are major potato producing districts of Nepal (MoAD, 2015). Potato is an important vegetable crop in kitchen gardens and also cash crop for smallholder farmers in high hills of Nepal (Timsina *et al.*, 2011). Potato provides nutrients such as dietary fiber, carbohydrate, vitamins, minerals (potassium, magnesium, iron), beta-carotene, polyphenols. Color potatoes play an important role in defense system by providing antioxidants (Zaheer and Akhtar, 2016). Production of potato in developing countries has increased by 94.6% over last

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decade and out of four major food crops (rice, maize, wheat and potato) potato has greater potential to increase yield (FAO, 2010). Price of rice and wheat is nearly doubled from 2005 to 2008 and it is rising continuously. The main reason for this increment in price is due to increase in cost of bio fuel and fossil fuel. Fuel used in the production of potato is almost half that of wheat and poor farmers prefer to cultivate that crops which give more return at low cost. This may be the reason that the production of potato have risen sharply in developing country (Zaheer and Akhtar, 2016). Potato is preferred crop, especially in developing countries in terms of nutritional value, adaptability to diverse environments and yield potential (Tolno *et al.*, 2016). Nepal had imported 99.34 billion of agro products including Rs 9.71 billion of potato in both fresh and chilled form (Prasain, 2014). Price of potato has risen by 50% in 2008 and it is increasing at alarming rate (Potatopro, 2018). Thus there is great scope for potato growing farmers to earn huge amount of income. The main objective of the study is to figure out the production economics, and determinants of potato growing farmers of Bidur municipality and Kakani rural municipality of Nuwakot district.

Materials and Methods

The research was conducted in Nuwakot district. The district was purposefully selected because it is one of the major potato producing districts with identifiable potato growing farmers. It is a part of province no 3 of Federal Republic of Nepal. It lies in Bagmati zone with coordinates of 27º5" N to 85º26". Climate here ranges from tropical, subtropical temperate, subalpine, alpine but subtropical is dominant. 120 respondents were selected using Simple random sampling among the farmers cultivating potato since last two years. 64 respondents from Bidur municipality and 56 respondents from Kakani rural municipality were selected. Face to face interview method was used to collect primary data using pretested semi-structured questionnaire in the month of October 2018. Data about socio-economic and demographic information, variable cost incurred for potato production and income were collected during survey. Focus group discussion, key informant (long term potato producers, technical assistance, local leaders, Officer from DADO) interview were conducted to validate information obtained from respondents. Data analysis and comparisons were made to derive results. The data were entered in SPSS and Microsoft Excel and analysis was done by using SPSS, STATA and Microsoft excel.

Cobb-Douglas Model

Large number of research has accomplished in agriculture by using Cobb-Douglas model (Prajneshu, 2008). Cobb-Douglas functional form of production function is widely used to represent the relationship of an output to inputs and it gives good approximation to actual production (Yuan, 2011). This model was used to determine resource use efficiency of potato production.

$$Y=aX_1^{b1}X_2^{b2}X_3^{b3}X_4^{b4}X_5^{b5}e^u$$

Y is income of potato production in ropani (Nrs), X_1 is cost of labor per ropani, X_2 is cost of chemical fertilizer per ropani, X_3 is cost of tuber per ropani, X_4 is cost of pesticide per ropani, X_5 is cost of organic manure per ropani. e is error term and b1 to b5 is coefficient to be estimated. The above equation was linearized in logarithmic function.

$$\ln Y= \ln a+ b1\ln X1+ b2\ln X2+ b3\ln X3+b4\ln X4+b5\ln X5+u$$

Where, ln= natural logarithm, a= constant and u is random disturbance

Return to scale

It gives technical property of production that examines changes in output subsequent to proportional change in all inputs. It is summation of coefficients (Bajracharya and Sapkota, 2017). If output increases by the same proportional change, there is constant return to scale. If output increases by more than that proportion then it is referred as increasing return to scale. If output increases by less than that of proportional change, there is decreasing return to scale (Tan, 2008).

Probit model

Probit model was used to determine the factors that influence farmers to cultivate potato in larger area in Nuwakot district. For categorizing size of farm, average of farm size of 120 farmers was calculated. Farmers with the land less than the average were considered as smallholder potato producer and more than that was considered as commercial potato producers. Farmers of Kakani were commercial potato producers. Probit model is statistical probability model with two categories in the dependent variable (Liao, 1994). Probit model is based on the cumulative normal probability distribution. The binary dependent variable, y< takes on the values of zero and one (Aldrich and Nelson, 1984). In binary probit model, Farmers cultivating potato more than 2 ropani is taken as 1, while those cultivating less than that is taken as zero. It is assumed that the i^{th} farmers obtains maximum utility, it has commercial cultivation preference over small holder. The probability Pi of choosing any alternative over not choosing it can be expressed by following equation, where φ represents the cumulative distribution of the standard normal random variable (Uzunoz and Akcay, 2012).

$$P_i= \text{prob}\,[Y_i=1\ \text{lxl} = \int_{-\infty}^{xi'ß}(2\,\pi^{\frac{-1}{2}}\exp(-\frac{t^2}{2})dt = \varphi(x_i'ß)$$

Benefit Cost Ratio

Benefit cost analysis was performed by using formula:

$$B/C=\frac{Grossreturn}{Total\ variable\ cost}$$

Result and Discussion

Majority of household head were male, 43(67.20%) of household head of Bidur municipality and 44(72.50%) of household head of Kakani rural municipality were male. Majority of household of both the area was dominated by Brahmin and chhetri. 62.50% husehold of Bidur and 78.60% household of Kakani were Brahmin/chhertri, 18.8% household of Bidur and 21.40% of household of Kakani were Janajati, 6.20% household of Bidur were dalit and 12.50% household of Bidur belong to other ethnicity. 20(31.20%) household of Bidur and 12(21.4%) household of Kakani live in joint family. 75% household head of Bidur and 60.70% household head of Kakani follow agriculture as main profession. The difference was significant at 10% level of significance. Most of the household head were literate, 56.20% household head of Bidur and 50% household head of Kakani were literate. 75% household of Bidur and 14.30% household of Kakani have at least one member abroad. Highly significant result was obtained for migration status as shown in Table 1.

The major inputs that were being used are tuber, FYM (Farm Yard Manure), poultry manure, chemical fertilizer (urea, DAP, Potash). The average amount of potato tuber applied by farmers of Bidur was 71.25kg and that of Kakani was 68.59kg but the difference was statistically non significant. Recommended amount of tuber for potato cultivation in Nepal is 75-100 kg (MoAD, 2075). Potato grower of Bidur apply higher amount of FYM than Kakani and this difference was significant at 10% level of significance. Farmers of Bidur apply 18.83 kg whereas farmers of Kakani apply 18.07 kg, the dose of FYM was lower than recommended (JICA, 2016). Potato growers of Bidur apply 0.895kg and farmers of Kakani apply 0.711kg poultry manure. This difference was significant at 1% level of significance. Potato grower of Bidur apply higher dose of poultry manure than potato grower of Kakani because it is difficult to get large amount of poultry manure in the research area. Potato grower of Kakani apply higher amount of urea (6.37kg) than potato grower of Bidur (6.35kg) but the difference was statically non-significant. The recommended dose of Nitrogen for potato cultivation is 7kg (MoAD, 2075). Potato growers of Bidur apply higher dose of DAP than potato grower of Kakani but the result was statistically non-significant (Table 2). Potato growers of Bidur apply 4.93 kg whereas potato growers of Kakani apply 4.75 kg. Recommended dose of DAP is 5.5 kg (JICA, 2016). Potato growers of Kakani apply 4.32 kg of MOP and potato growers of Bidur apply 3.88kg. This result was statistically significant at 5% level of significance. The dose of MOP is nearly consistent with recommended dose (JICA, 2016; MoAD, 2075).

Table 1: Demographic characteristics of potato growing farmers of Nuwakot

Variables	Potato grown Area			
	Bidur	**Kakani**	**Chi-Square value**	**p-value**
Gender Of HHH(male)	43(67.20)	44(72.50)	1.941^{ns}	0.164
Ethnicity				
Brahmin/Chhetri	40(62.50)	44(78.60)	11.709***	0.008
Janajati	12(18.80)	12(21.40)		
Dalit	4(6.20)	0(0)		
Other	8(12.50)	0(0)		
Family type (Joint)	20(31.20)	12(21.40)	1.473^{ns}	0.225
Occupation of HHH(Agriculture)	48(75.00)	34(60.70)	2.817^{*}	0.093
Education Of HHH (Literate)	36(56.20)	28(50.00)	0.469^{ns}	0.494
Migration status (Migrated)	48(75.00)	8(14.30)	44.23***	0.000

Figure in parenthesis indicate percent. * and *** indicate 10% and 1% level of significance

Table 2: Amount of Inputs per ropani used in potato production

Variables	Potato grown Area			
	Bidur	**Kakani**	**t- value**	**p-value**
Tuber	71.2526(0.988)	68.5997(1.389)	-1.584^{ns}	0.116
Farmyard Manure	18.8281(0.340)	18.0729(0.232)	-1.783^{*}	0.077
Poultry manure	0.8958(0.049)	0.7119(0.0196)	-3.303^{***}	0.001
Urea	6.3464(0.150)	6.3658(0.0773)	0.11^{ns}	0.912
DAP	4.9323(0.157)	4.7515(0.0848)	-0.973^{ns}	0.333
Potash	3.8802(0.156)	4.3250(0.1129)	2.257^{**}	0.026

Figure in Parenthesis indicate standard error of mean. *,** and *** indicate 10%, 5% and 1% level of significance

Labor is another major input required for potato cultivation. Labor required was calculated in labor per ropani. It was found that more labor was required to plant potato for potato growers of Bidur compared to potato growers of Kakani and the difference was significant at 10% level of significance. Potato growers of Bidur required 1.145 whereas potato growers of Kakani required 1.0313 labors for planting. 1.255 labors were required to apply fertilizer for farmers of Bidur whereas 1.041 labors were required for potato growers of Kakani. The difference was statically highly significant at 1% level of significance. Labor required to perform intercultural operation was significant at 5% level of significance. 1.22 labors were required to perform intercultural operation for potato growers of Bidur but 1.051 was required for potato growers of Kakani. Labor required for harvesting of potato was statically non-significant but potato growers of Bidur required more labor for harvesting of potato (Table 3).

Cost of tuber required per ropani was higher in Bidur than compared to Kakani and the difference was statically significant at 1% level of significance. Cost required for tuber in Bidur was Rs 2955.78 and that of Kakani was Rs 2757.67. Cost of FYM required for one ropani in Bidur was Rs 1360.98 and that of Kakani was Rs 1249.68. Cost of FYM was statistically highly significant at 1% level of significance. Cost incurred for poultry manure per ropani in Kakani was lower than that of Bidur and the difference was statically significant at 1% level of significance. Cost incurred for poultry manure per ropani in Bidur was Rs 134.375 and that of Kakani was Rs 106.785. Cost incurred for urea per ropani was found statistically non-significant. Cost required to apply DAP in one ropani was statically significant at 10% level of significance. Cost incurred for Potash per ropani in Bidur was Rs. 194.865 and that of Kakani was Rs 219.404. Cost required to apply Potash in one ropani was statically significant at 5 % level of significance (Table 4).

Cost required for land preparation was higher in Bidur than compared to Kakani and the difference was statically significant at 10% level of significance. Cost required for land preparation in Bidur was Rs 975.00 and that of Kakani was Rs 952.083. Cost of planting potato in Bidur was Rs 916.6667 and that of Kakani was Rs 825.00. Cost of planting per ropani was statically significant at 10 % level of significance. Cost incurred for fertilizer application per ropani in Kakani was lower than that of Bidur and the difference was statically highly significant at 1% level of significance. Cost incurred for fertilizer application in Bidur was Rs 502.083 and that of Kakani was Rs 416.547. Cost required for intercultural operation in one ropani was statically significant at 5% level of significance. Cost incurred for intercultural operation per ropani in Bidur was Rs. 477.083 and that of Kakani was Rs 420.714. Cost incurred for harvesting per ropani was found statistically non-significant (Table 5).

Table 3: Number of labors per ropani required in potato production

Variables	**Potato grown Area**			
	Bidhur	**Kakani**	**t- value**	**p - value**
Planting	1.1458(0.042)	1.0313(0.449)	-1.867*	0.064
Fertilizer application	1.2552(0.051)	1.0414(0.342)	-3.104***	0.002
Intercultural operation	1.2240(0.0479)	1.0518(0.046)	-2.59**	0.011
Harvest	1.1771(0.053)	1.1068(0.026)	-1.14ns	0.256

Figure in parenthesis indicate standard error of mean. *, ** and *** indicate 10%, 5% and 1% level of significance

Table 4: Cost of inputs per ropani for potato production in Nuwakot

	Potato grown Area			
Variables	Bidur	Kakani	t- value	p-value
Tuber	2955.7865(41.786)	2757.6667(54.964)	-2.909***	0.004
Farmyard Manure	1360.9894(23.982)	1249.6868(12.458)	-3.951***	0.000
Poultry	134.3750(7.376)	106.7857(2.934)	-3.303***	0.001
Urea	164.5990(3.8526)	161.547(2.015)	-0.673ns	0.502
DAP	256.4792(8.168)	239.5982(4.490)	-1.742*	0.084
Potash	194.8646(7.214)	219.4048(5.829)	2.598**	0.011
Pesticide	975.00(10.125)	952.083(6.282)	-8.788***	0.000

Figure in parenthesis indicate standard error of mean. *, ** and *** indicate 10%, 5% and 1% level of significance

Table 5: Cost of different agronomic practices per ropani for potato production in Nuwakot

Variables	Potato growing Area			
	Bidur	**Kakani**	**t-value**	**p- value**
Land Preparation	975.00 (10.125)	952.083(6.283)	-1.86*	0.065
Planting	916.6667(33.531)	825.00(35.887)	-1.867*	0.064
Fertilizer application	502.083(20.194)	416.547(33.532)	-3.104***	0.002
Intercultural operation	477.083(17.893)	420.714(18.155)	-2.204**	0.029
Harvesting	470.833(21.201)	442.738(10.302)	-1.14^{ns}	0.256

Table 6: production, cost and B/C ratio of potato production in Nuwakot

Variables	Potato grown Area			
	Bidur	**Kakani**	**t-value**	**p- value**
Total Production	748.75(18.41)	719.122(7.057)	-1.426^{ns}	0.156
Total cost	9010.843(109.05)	8161.77(92.481)	-5.848***	0.000
Total returns	14975.00(368.28)	14382.44(141.149)	-1.426^{ns}	0.156
Benefit/cost	1.66(0.0383)	1.77(0.0265)	6.46^{**}	0.023

Figure in parenthesis indicate standard error of mean. *, ** and *** indicate 10%, 5% and 1% level of significance

Table 7: Potato production in Nuwakot district

	Average	**maximum**	**minimum**
Productivity (ton/ha)	14.69	24	10
Area (ropani)	2.61	5	1
Total cost (Rs/ropani)	8614.61	11126	6263.75
Total Income (Rs/ropani)	14694.47	24000	1000
B/C ratio	1.71	2.76	1.1

Total production of potato per ropani in Bidur was 748.75 kg and that of Kakani was 719.122 kg. Total cost incurred for production of potato was higher in Bidur than Kakani and the difference was statically highly significant at 1 % level of significance (Table 6). Total cost incurred for potato production in Bidur was Rs 9010.843 than that of kakani was Rs 8161.77. Total return from selling of potato was higher in Bidur than that of Kakani but the difference was statically non-significant. The benefit cost ratio (B/C) was computed as total returns to the total cost incurred in potato production. B/C ratio for potato grower of Bidur (1.53) is lower than Kakani (1.77). B/C ratio of farmers in Bidur is low because of higher cost of production. B/C ratio is statistically significant at 1% level of significance this indicates that farmers of Kakani made more profit than farmers of Bidur municipality. Average B/C of the research area is 1.71. B/C ratio of research area is higher than B/C ratio of Baglung (Bajracharya and Sapkota, 2017) but lower than Taplejung (2.9) (Timsina *et al.*, 2011). Average productivity of potato in the research area is 14.69 ton/ha which is nearly equal to national average but lower than Nuwakot district (MoAD, 2016).

The average area of potato cultivation in the research area was 2.61 ropani. Average cost, income and B/C ratio in the research area was Rs. 8614.61, Rs 14694.47 and 1.71 respectively. Price of potato in nuwakot varies, during study period price of potato was Rs 20 per kg (Table 7).

Production Functional Analysis

F value (7.71) was statistically highly significant at 1% level of significance which shows that the model has good explanatory power; that is, all the explanatory variables explained the variations in output. The R- squared value was 25.27%, indicating that 25.27% of the variation in income of potato was explained by the independent variables included in the model. Cost of organic manure was statically significant at 10% level of significance and cost of pesticides was significant at 1% level of significance. 10% increase in organic manure (FYM and poultry manure) and pesticide resulted in 1.88% and 1.99% increase in income. 10% increase in FYM resulted into 1.90% increase in output (Bajracharya and Sapkota, 2017). Similar result was obtained in potato production of Guinea (Tolno *et al.*, 2016) and cauliflower production of Dhading, Nepal (Ghimire and Dhakal, 2014). 10% increase in labor and chemical fertilizer resulted into 0.1% and 0.5% decrease in output. Labor and chemical fertilizer is over utilized resource for potato production (Bajracharya and Sapkota, 2017; Tolno *et al.*, 2016). 10% increase in tuber resulted in 0.05% increase in output, although the result was non-significant but it is positive with potato production of Palpa district (Bajracharya and Sapkota, 2017). The sum of coefficients was 0.323 which is less than 1 implied decreasing return to scale, similar result was obtained in potato production in western hills of Nepal (Bajracharya and Sapkota, 2017). 100% increase in all the factor of production included in this model would result in 32.39% increase in potato production.

Table 8: Production function analysis of potato production

Variables	*Coefficients*	*Standard Error*	*t Stat*	*P-value*
ln(Labor)	-0.01013196	0.050038132	-0.20248	0.839899
ln(fertilizer)	-0.05962913	0.096687686	-0.61672	0.53865
ln(tuber)	0.005423822	0.073113001	0.074184	0.940994
ln(pesticide)	0.199807327***	0.04040856	4.944678	2.65E-06
ln(organic manure)	0.188452342*	0.112152515	1.680322	0.095633
Constant	7.478022316***	0.88530335	8.446847	1.1E-13
R Square	0.252753429			
Adjusted R Square	0.219979457			
F-value	7.712016914***			
Return to scale	0.323922403			

Note: *,** and *** indicate 10%, 5% and 1% level of significance

Table 9: Determinants of commercial potato production in large scale

Variables	**Coefficient**	**Standard Error**	**Z**	**pl> Zl**	**dy/dx**
Age of HHH (years)	-0.209262	0.0145407	-1.44	0.15	-0.00695
Gender of HHH(@)	0.2326948	0.2929657	0.79	0.427	0.077267
Schooling of HHH (@)	0.4291822	0.2871032	1.49	0.135	0.142474
Occupation of HHH (@)	-0.5230019	0.2908024	-1.8	0.072	-0.17362
Access to Extension (@)	0.5692451	0.2599432	2.19	0.029	0.18897
Training Received (@)	0.4789511	0.2517839	1.9	0.057	0.158996
Member of cooperatives (@)	0.3498259	0.2529826	1.38	0.167	0.116131
Member of Farmer group(@)	0.2866794	0.2610951	1.1	0.272	0.095168
Family type (@)	-0.364839	0.2614159	1.4	0.163	-0.12111
Constant	0.0234798	0.689458	0.03	0.973	

Probit Model

Probit model was used to assess the factor influencing the commercial cultivation of potato in large scale. Good explanatory power of the model was revealed through likelihood ratio Chi-square (LR chi^2) which was found statistically significant at 1% level. The Pseudo R^2 was 0.1562. Among nine variables studied under the model occupation of household head, access to extension worker and training received was found to be statistically significant. It has been found that farmers who have received training and access to extension service were more likely to cultivate potato in large area compared to those without training and access to extension service. Agriculture as main occupation and training received was significant at 10% level of significance whereas access to extension was significant at 5% level of significance. The probability of cultivation of potato in large scale was found to be 56.92% higher for those with access to extensive service as compared to those without access because visit of the extension service provide technical guidance to farmers as compare to who do not have access. Access to extension service helps to adopt agricultural technology (Feder and Slade, 1986). The probability of cultivation of potato in large scale was found to be 47.89% higher for those who have received training. The other variables such as gender of household head, schooling of household head, and member of cooperatives and farmers group had positive relation with commercial cultivation of potato while none of them were found statically significant. Some variables like occupation of household head, family type and age of household had negative relation with commercial cultivation of potato. Household head with agriculture as main occupation was unlikely to cultivate potato in large area by 52.30%.

Summary statistics	
Number of Observation	120
log likelihood	-69.958264
LR chi^2 (9)	25.91
prob>chi^2	0.0021
pseudo R^2	0.1562

Conclusion

Majority of household head of research area was male. Brahmin/Chhetri was major ethnicity and agriculture was main profession in the research area. Average productivity of potato was 14.69 ton/ha which is still lower than national average. The low productivity was mainly due to use of local varieties and disease infestation. Average cost of production and profit was Rs 8614.61 per ropani and Rs 6083 per ropani respectively. B/C ratio in the research area

was 1.71. The low B/C ratio was due to higher cost of labour and over utilization of chemical fertilizer especially in bidur municipality. Return to scale was 0.323 which indicates that, 100% increase in all the factor of production would result in 32.39% increase in potato production. 10% increase in organic manure (FYM and poultry manure), pesticide and tuber resulted in 1.88%, 1.99% and 0.05% increase in income respectively. 10 % increase in labor and chemical fertilizer resulted into 0.1% and 0.5% decrease in output. Labor and chemical fertilizer was over used resource for potato production in Nuwakot district. Probability of cultivation of potato in large scale was found to be 56.92% higher for those with access to extensive service and 47.89% higher for those who have received training. The research suggests policy makers and concerned bodies to distribute improved varieties and provide extension and training to farmers.

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