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Research Article

Factors affecting the productivity of coffee in Gulmi and Arghakhanchi districts of Nepal

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ABSTRACT

Coffee is one of the major potential cash crops with lucrative export value grown in mid-hills of Nepal. Nepalese coffee production has suffered long by low productivity. Research was conducted from February to May, 2019 to analyze the factors affecting the productivity of coffee in Arghakhanchi and Gulmi districts of Nepal. These two districts were, purposively selected for this study taking account of comparative advantage and past studies recommendations for coffee sector. Altogether, 100 coffee growing households 50 from each, Arghakhanchi and Gulmi, were sampled by using multistage sampling technique. A pre-tested semi-structured interview schedule was used to collect the primary information while secondary information was collected reviewing the relevant publications. Ordinary Least Square (OLS) regression model was used to determine the factors affecting the productivity of coffee. The study revealed that the number of active family members involved in coffee production (0.000), adoption of income diversification through intercropping (0.005), training (0.072) and technical assistance (0.021) had positive and significant effect on coffee productivity. Encouraging the household to have coffee production as their primary occupation, providing technical assistance on rational land utilization and intercropping and strengthening the skill and knowledge of farmers through trainings could significantly support in increasing the productivity of coffee.

Keywords: Coffee productivity, multistage sampling, OLS regression model

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INTRODUCTION

Coffee (*Coffea arabica*) is a highly valued plantation crop consumed throughout the world belonging to family Rubiaceae (Daglia *et al.,* 2000). Coffee is important crop for the prospects beverage and it has high export value from Nepal (Chaudhary *et al.,* 2008). With the existence of favorable climatic condition together with characteristics of coffee plants that grow well on rainfed uplands less suitable to other crops, the smallholder farmers are being positively attracted toward coffee farming in Nepal (Shrestha *et al.,* 2008). Coffee provides five times more income than that of maize and millets and two-three times more yield than that of any other cash crop (Bajracharya & Pathak, 2003). The ecological settings in the Himalayan hills provide Nepalese coffee a unique opportunity to enter international specialty markets been exported as high altitude grown coffee produced by resource poor smallholders under organic conditions (Gautam *et al*., 2008; Poudel *et al.,* 2009)

The area of cultivation, total production and productivity of coffee in Nepal in the 2017 was 464 hectare (ha), 463.6 ton (t), and 0.99 t/ha respectively (MOALD, 2018). Gulmi and Arghakhanchi districts share only 6.5 % of national area under coffee cultivation and about 10.82 c of national production (MoAD, 2017). The area of cultivation, total production and productivity of the coffee in Gulmi district in the fiscal year[1] 2017/18 was 215 ha, 89 t and 0.41 t/ha respectively: while the area of cultivation, total production and productivity of the coffee in Arghakhanchi district in the fiscal year 2017/18 was 10 ha, 15t and 1.5t/ha (NTCDB,2019). The productivity of Nepalese coffee is comparatively lower than the productivity of coffee in global scenario (Tiwari, 2010). Nepalese agriculture has suffered long by low productivity; attributed due to lack of environment specific technologies, limited use of production inputs like irrigation, fertilizers and good quality seeds, and extension of cultivation to marginal land; very slow rate of technological dissemination and its limited impact on production (Panth & Gautam, 1990). The trend analysis shows that the total production of coffee is increasing at 22.59 times that of the previous year while the productivity is plummeting at the rate of 0.23 percent per year (NTCDB, 2019).

Productivity is a measure of the efficiency of a farming system in converting inputs to useful outputs. Nepalese agriculture has suffered long by low productivity mainly attributed to lack of environment specific technologies, limited use of production inputs like irrigation, fertilizers and good quality seeds, and extension of cultivation to marginal land; very slow rate of technological dissemination and its limited impact on production (Panth & Gautam, 1990). The quality organic coffee is fetching low market price in domestic market, however the productivity and the price of coffee is low which leads to low income to farmers. The study aimed to identify the major factors affecting the productivity of coffee.

METHODOLOGY

The study was conducted in Arghakhanchi and Gulmi district from February to May 2019. Purposive sampling was used to select districts and sub-locations considering the potentiality of coffee where, 25 farmers from each two local bodies within Arghakhanchi and Gulmi districts were selected randomly from the population of 150 and 300 registered farmers

[1] Nepalese fiscal year begins from 16th July

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respectively in coffee super zone. Secondary data were collected from various national and international publications, government reports, proceedings, books and websites. Descriptive analysis was done using SPSS and qualitative analysis was done in STATA. OLS regression model as given by Hayes and Matthes (2009) was used to analyze the factor affecting productivity, expressed as in Equation 1;

$$Y= b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5x_5+ b_6x_6 + u \quad \textit{Equation 1}$$

Where, Y= Productivity of coffee (kg/ha); b0= Regression coefficient; b1, b2… b6= regression coefficient; X1= Gender of household head (Male = 1, Otherwise=0); X2= Income Diversification (Yes = 1 and No = 0); X3= Members Abroad (Yes =1 and No =0); X4= Active members involved in coffee production (continuous); X5= Training Received (Yes =1 and No=0), X6= Technical Assistance (Yes=1 and No=0) and u = error term
Regression diagnostics:

The explanatory variables used in models were tested for multicollinearity through the estimation of Variance Inflation Factor (VIF). The VIF value of 10 is recommended as the maximum level.

Five-point scaling technique was used to measure the relative severity of production problems. Farmers' perception on the importance given to the different production constraints was analyzed by using 5 point scale of constraint indicating major factor or problem (1) to minor factor or problem (0.2).
The index was calculated using following formula:

$$I = \sum \frac{S_i f_i}{N} \quad \textit{Equation 2}$$

Where,
I = Index ($0 < I < 1$)
S_i = Scale value at i^{th} severity
f_i = frequency of the i^{th} severity
n = total number of respondents = $\sum f_i$

Subedi *et al.* (2019a) used the scaling technique to identify the constraints associated with the potato production in Terai region of Nepal. This above formula was also applied by Shrestha and Shrestha (2017) to rank the problems associated with maize seed production. Subedi *et al.* (2019b) used this technique to explore the problems associated with wheat production.

RESULTS AND DISCUSSION

Description of important socioeconomics and demographic characteristics

As illustrated in Table 1 among the major socioeconomic variables family type, ethnicity, training, technical assistance and gender role in decision making was found statistically significant at either 1 percent or 10 percent level of significance. The majority 81 percent of households were male headed, about 53 percent of total HH[2] belonged to nuclear family.

[2] HH = Household

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Majority of the households were Brahmin/ Chhetri (75%) followed by Dalit (13%) and *Aadibasi/Janajati* (12%) and the result was statistically significant among the study districts. About 40 percent of the respondents had secondary level education followed by primary level (24 %), high school (19%) and illiterate (12%). Majority (84%) of the HH practiced income diversification with fruit plantation, forage and beekeeping to cope risk. Almost, 76 percent of the household had male decision maker regrading coffee cultivation. Majority, 97 percent had access to the loan, 98 percent had access to mass media, 94percent household were involved in any institution.

Table 1. Socioeconomic and demographic characteristics (categorical variable) with districts

Variables	Arghakhanchi(n=50)	Gulmi(n=50)	Overall(N=100)	Chi-square
Gender of HHH				
Female	10(20)	9(18)	19(19)	0.07
Male	40(80)	41(82)	81(81)	
Family Type				
Joint	17(34)	30(60)	47(47)	6.784***
Nuclear	33(66)	20(40)	53(53)	
Ethnicity				
Brahimin/Chhetri	28(56)	47(94)	75(75)	
Aadibasi/Janajati	12(24)	0	12(12)	20.583***
Dalit	10(20)	3(6)	13(13)	
Education Level				
Illiterate	8(16)	4(8)	12(12)	
Primary	11(22)	13(26)	24(24)	
Secondary	21(42)	19(38)	40(40)	2.274
High School	8(16)	11(22)	19(19)	
University level and above	2(4)	3(6)	5(5)	
Training				
No	36(72)	5(10)	41(41)	39.73***
Yes	14(28)	45(90)	59(59)	
Technical Assistance				
Not received	12(24)	2(4)	14(14)	9.50***
Received	38(76)	48(96)	86(86)	
Income Diversification				
No	7(14)	9(18)	16(16)	0.298
Yes	43(86)	41(82)	84(84)	
Gender role in decision making				
Male	35(70)	43(86)	78(78)	3.73*
Female	15(30)	7(14)	22(22)	
Access to loan				
No	2(4)	1(2)	3(3)	0.34
Yes	48(96)	49(98)	97(97)	
Access to mass media				
No	1(2)	1(2)	2(2)	0.00
Yes	49(98)	49(98)	98(98)	
Institutional development				
No	4(8)	2(4)	6(6)	0.71
Yes	46(92)	48(96)	94(94)	

Notes: Figures in the parentheses indicate percent. ***, ** and * indicate 1 percent, 5 percent and 10 percent levels of significance respectively.

Among the farmer involved in various institution, 47.87 percent involved in farmers group and cooperative while 4.26 were members in *Aama Samuha*. Overall, 59 percent of the HH

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had received training and 85 percent received technical assistance from various sources related to the coffee cultivation and were found to be statistically significant at 1 percent level of significance. The major source of training were governmental organizations, INGOs/NGOs and cooperatives. The technical assistance received by coffee growers in Arghakanchi and Gulmi districts were 74 percent and 96 percent respectively. The major source of technical advice and assistant was local progressive farmer (47.10 %) followed by AKC (34.1 %), INGO/NGO (9.4%), Agrovet (8.2%) and least from others (1.2%).

Average age of HH head was 54.15 years and that of respondents was 47.80 years. Average age of the HH head of Gulmi (58.66 years) was higher than that of Arghakhanchi (49.64 years). The distribution was found to be statistically significant. The household size was significant among Gulmi district (6.38) and Arghakhanchi district (5.68) at 10 percent level. Average family size of the study area was 6.03. In the Table 2 the average number of economically active population (15-59 years age group) was 4.15. It was found to be higher in Gulmi (4.44) than in Arghakhanchi (3.86) and was statistically significant at 5 percent level of significance. The overall average dependency ratio was found to be 0.55. The average total land holding was found to be 19.76 ropani[3]. The average total landholding of coffee grower in Gulmi (22.11 ropani/HH) was statistically significant to that of Arghakhanchi (17.40 ropani/HH) at 10 percent level of significance. The total irrigated land per household was 4.88 ropani. The average irrigated land holding in Gulmi district (7.20 ropani/HH) was found to be statistically significant to the average irrigated land holding of coffee growers in Arghakhanchi district (2.56 ropani/HH) at 1 percent level of significance. The overall average livestock holding (LSU)[4] among coffee grower of study area was 3.33. The average area under coffee cultivation in the study area was 0.88 ropani.

Table 2: Socio-demographic characteristics of the study area (Continuous)

Variables	Arghakhanchi (n=50)	Gulmi (n=50)	Overall (N=100)	Mean Difference	t-value
Age of HH	49.64 (11.67)	58.66 (10.450)	54.15 (11.91)	-9.02***	-4.071
Household size	5.68 (1.66)	6.38 (2.28)	6.03 (2.01)	-0.7*	-1.76
Economically active member	3.86 (1.57)	4.44 (1.33)	4.15 (1.47)	-0.58**	-1.2
Dependency ratio[5]	0.63 (0.57)	0.48 (0.40)	0.55 (0.45)	0.15	1.38
Total land holding (ropani)	17.40 (10.74)	22.11 (15.39)	19.76 (13.41)	-4.71*	-1.78
Irrigated land (ropani)	2.56 (2.140)	7.20 (6.63)	4.88 (4.426)	-4.64***	-4.71
Livestock holding (LSU)	3.42 (1.50)	3.24 (1.48)	3.33 (1.48)	0.18	0.59
Coffee area (ropani)	0.81(0.35)	0.95(0.53)	0.88(0.45)	-0.14	-1.56
No of plants/ropani	36.97(12.02)	89.01(24.01)	62.99(32.26)	-52.04***	-13.7
No of plants/HH	27.50(10.83)	78.24(34.80)	52.87(36.10)	-50.740***	-9.88
Productivity(kg/ropani)	6.84(2.10)	10.15(6.44)	8.50(3.49)	-3.75*	-1.9

Notes: Figures in the parentheses indicate standard deviation. ***, ** and * indicate 1 percent, 5 percent and 10 percent levels of significance respectively.

The area under coffee cultivation in Gulmi and Arghakhanchi was 0.95 and 0.81 ropani/HH respectively. The average number of plants/ropani was 62.99 and plants/HH was 52.87. The

[3] 1 hectare=20 ropani

[4] Livestock standard unit (LSU) = 1(cow/bull) +1.5(buffalo) +0.6(swine/pig) +0.4(goat/pig) +0.2(poultry) (Adhikari, 2000)

[5] Dependency ratio = Dependent members/Economically active members (CBS, 2014)

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number of plants/ropani in Gulmi district (89.01) was found to be statistically significant at 1 percent level to the number of plants/ropani in Arghakhanchi district (36.97).

The number of plants per HH in Gulmi and Arghakhanchi districts were 78.24 and 27.50 respectively and was highly significant. The average productivity of coffee was 8.50kg/ropani. The productivity of coffee growers in Gulmi district (10.15 kg/ropani) was statistically higher than that of Arghakhanchi district (6.84 kg/ropani).

Factor affecting productivity of coffee

The value of R^2 in the model indicates that around 53 percent of the variations in productivity of coffee was explained by the explanatory variables in the model. The value of adjusted R^2 indicates that when the degree of freedom is taken into account, about 50 percent of the variations in the dependent variable (productivity) is explained by explanatory variables in the model. The statistically significant F value implies that the explanatory variables included in the model are important for the explanation of the variation in the dependent variable. The mean VIF was 1.52 and none of the VIF value is greater than 1.93, which showed the significantly low multicollinearity.

The number of family members actively involved in coffee production, adoption of income diversification through intercropping, training, and technical assistance had positive and significant relationship in coffee productivity. Number of active family members in coffee production was found significant at 1 percent level and has positive relationship with productivity of coffee. The findings revealed that with every single additional active member, the productivity of coffee increased by nearly eleven units if all other variables constant (Table 3). This finding is quite similar to the findings of the research done in Ethopia by Temesgen (2017) who revealed that with the increase in number of active family member, the productivity significantly increases. The active member in the family provides intensive care, which is required for the coffee plant which results higher productivity. The significance of number of active family members in coffee production highlights the importance of farm labour as an important factor affecting coffee productivity.

Adoption of income diversification through intercropping in coffee was found to have positive and significant relationship with productivity of coffee at 1 percent level of significance. Table 3 revealed that the productivity of coffee is nearly twenty units more for the farmers adopting income diversification through intercropping compared to farmers practicing sole cropping. Similar results were obtained by Khanal *et.al.* (2019) where they found that intercropping in coffee farm increases the productivity of the coffee. Higher coffee yield was reported by Bote (2011) when coffee was intercropped with various shade plant. The major intercrops with coffee in Gulmi and Palpa were onion, ginger, turmeric and chilly while the major shade crops were fruit trees such as *Musa spp, Psidium guajava*, *Citrus spp* and *Litchi chinensis* and fodder trees such as *Leucaena spp* and *Ficus spp* (Khanal *et al,* 2019).

Participation in training programs by various institutions had positive and significant effect on the productivity of coffee at 10 percent level of significance. The study revealed that the productivity of the coffee among training received farmers' was nearly nine and half units more than the farmers devoid of training, keeping all other factors constant.

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Technical assistance also played a major role in the productivity of the coffee in the study area. Technical assistance was found to have positive and significant result with productivity of coffee at 5 percent level of significance. The study shows that the productivity of coffee among technical assistance receiving farmers was nearly sixteen units more than the productivity of farmers without any technical assistance, keeping all other factors constant. According to Khanal et al., (2019) various factors like adoption of intercrops and shade crops, and access to irrigation facilities affected the productivity of coffee in western hills of Nepal. Training from various institution and technical assistance received through various means viz. progressive farmers, agrovet were also pivotal factors affecting the productivity of coffee. Coffee cultivation needs continuous care and strenuous labour. Thus, growers must spend more on labour (Pokhrel, 2016). The number of active members positively influence the agricultural productivity of commodity (Croppenstedt & Muller, 2000).

Table 3: Factor affecting productivity of coffee

Productivity	Coefficient	Std. error	t	P > |t|
Total active members involved in coffee production	11.17***	2.52	4.44	0.000
Income diversification through crop rotation[a]	19.89***	6.94	2.87	0.005
Training[a]	9.46*	5.19	1.82	0.072
Technical assistance[a]	16.01**	6.84	2.34	0.021
Gender of HH head[a]	-9.11	6.44	-1.41	0.161
Member abroad[a]	-0.76	5.07	-0.01	0.988
Constant	32.09***	8.72	3.68	0.000
Observation				
F (6, 93)	17.47***			
R^2	0.5299			
Adj R^2	0.4996			

Notes: ***, ** and * indicates significance at 1 percent, 5 percent and 10 percent respectively and a Indicates dummy variable

Production constraints of coffee production

Incidence of disease and pest was identified to be the most daunting problem with an index value of 0.81. High attack of white stem borer and incidence of coffee rust has posed some threat to growing coffee subsector. The second major problem as ranked by farmers was found to be lack of irrigation with index value of 0.80. There was no any established irrigation infrastructure for the coffee farms. Farmers were found to carry water in buckets to irrigate newly planted coffee saplings. Moreover, water sources in the study area were located distantly. The coffee farming was found to be very dependent on natural precipitation, which was intermittent and insufficient. The success rate of coffee transplantation was also found to be minimal due to unavailability of irrigation water.

The third major problem in coffee production was identified to be poor technical knowledge regarding coffee farming (0.56). Coffee farming being an entirely different enterprise as compared to subsistence farming of food crops, farmers lacked information and skills about

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coffee cultivation and improved orchard management practices. Farmers were found adopting faulty farming practices due to their ignorance. As a result, coffee cultivation was found to be of primitive type.

The unavailability of labour was identified as the fourth major problem in coffee production in the study area with index value of 0.45. Labour drain was one of the burgeoning problems of the mid hills. The few among the remaining migrates to terai in the search of job and further employment opportunities. This has posed lack of labour in the mid-hills, which can be the reason behind plummeting coffee production.
Lack of quality saplings was ranked fifth major problem with index value (0.39). The mother plants from which the seed is to be extracted must be greater than 8 years old, however, ignorant farmers grew the sapling from the seed extracted from younger plants, which results poor sapling quality.

Table 4: Production constraints of coffee production

Production constraints	Index Value	Ranking
Incidence of disease and pest	0.81	I
Lack of irrigation	0.80	II
Poor technical knowledge	0.56	III
Unavailability of labour	0.45	IV
Lack of quality saplings	0.39	V

CONCLUSION

The main purpose of the study was to analyze factors affecting productivity of coffee in Arghakhanchi and Gulmi districts of Nepal. The finding explored that higher number of active members of family members involved in coffee production and income diversification through crop rotation improves the coffee productivity. Moreover, technical assistance and trainings have significant contribution in increasing the productivity of coffee. Incidence of disease and pest, lack of irrigation, poor technical knowledge, unavailability of labour and lack of quality saplings were identified as the major problems in coffee production. In addition to its productivity improvements attribute, the identified problems need to be addressed soon with the major concern form the responsible governmental institutions. Since, the coffee of the study area has comparative advantage in international market, it would be a good cash crop to fetch the foreign currency; also increasing the share of agriculture in national GDP. No doubt, taking concern on productivity attributes and addressing the production problems, the increased coffee productivity can bolster the economic status of small land holding farmer as well as increases the national income through foreign exchange.

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Authors' contributions

C. Bhattarai Design and performed experiment analyzed data, wrote and edited paper
D. Bhandari Performed experiment and helped in data recording
BK Sapkota Performed experiment and helped in data recording
S. Bhandari Helped in experiment and data recording

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B. Khatri	Helped in experiment and data recording
K. Bhusal	Helped in data recording, analysis and edited article
A. Srivastava	Supervised entire research and manuscript preparation

Conflict of interest

The authors declare no conflicts of interest regarding publication of this manuscript.

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