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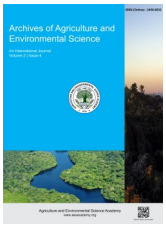

CASE STUDY

Coffee income and its determinants: A case of Deusa village, Nepal

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ABSTRACT

Understanding economic contribution of coffee production and influencing socioeconomic and environmental factors for coffee income are vital for its promotion. The primary aim of this study was therefore to assess the contribution of coffee income to the household total cash income and identify influencing socioeconomic and environmental factors for coffee income in Deusa, Solukhumbu district of Nepal. A semi-structured questionnaire survey gather data from 55 coffee-growing households. We used Ordinary Least Square regressions (OLS) for identifying influencing factors for coffee income. Household annual gross income, from farm and off-farm income sources, estimated was around NPR 161 thousand, and the median value was 57.4 thousand. On average, coffee farming contributed almost 9% of the total household income in the study area. The OLS regression showed that sufficient labor availability ($p<0.05$), access to coffee-related trainings ($p<0.05$), and access to irrigation facilities ($p<0.05$) significantly increased coffee earnings. Likewise, environmental variables - elevation (negatively, $p<0.05$)) and shade trees availability for coffee farming (positively, $p<0.05$) also influenced earnings from the coffee farming. We recommend provisions of trainings, improved irrigation facilities and tree saplings for shade management for sustainable coffee production in the study area.

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INTRODUCTION

Coffee is a major cash crop with considerable economic benefits. It's income is more valuable to economically vulnerable households compared to those with diversified income sources. People who cannot adopt alternative means for income diversification can make income from coffee (Wairegi *et al.*, 2018). Farmer's knowledge and skills are vital (Nguyen Thi Ngan and Bui Huy Khoi, 2019; Gezahagn Kudama, 2020; Nibret and Ayalew, 2020). Attracting young farmers to coffee production by setting up an appropriate condition for economic upliftment could take a practical move towards sustainable coffee production and income generation (Wairegi *et al.*, 2018). Accessibility to modern technologies, including improved sapling, irrigation facilities, and nutrient management techniques, abandoning agriculture and out-migration are the factors for increasing coffee production (Khanal *et al.*, 2019). Poor land management practices, lack of precipitation, unignorable biotic and abiotic constraints are effective causes to alter coffee productivity (Wang *et al.*, 2015). Most farmers face irrigation problems, infestation of insects and pests, lack of knowledge and information, skills in coffee production, and post-harvest handling (Kattel *et al.*, 2009). Eco-physical constraints like shading and altitudinal variations have a role to affect the productivity of coffee. The altitude is a fundamental factor that changes the quality of coffee (Vaast *et al.*, 2006). Farmer's revenue from coffee sales rises with the increment of household assets, like agricultural holdings, animal husbandry, total land owned, and farm experience (Negeri, 2017). Rural infrastructures like road, irrigation, imposing and governing laws linked to coffee, and trade policy also attract farmers to coffee farms (Andrew, 2012).

Acharya and Dhakal (2014) showed that farmers earn a profit of approximately NPR 93000 (US$948) per hectare from coffee

production in Nepal. Farmers mostly used the coffee income for children's education and livelihood improvement (Negeri, 2017). Nepal Tea and Coffee Development Board (NTCDB) has recorded around 27000 active smallholder farmers all over Nepal engaged in coffee production. Nepal exported coffee worth NPR 57.7 million ($0.52 million USD) and imported coffee worth NPR 118.7 million ($1.07 million USD) in the fiscal year 2019/2020 (NTCDB, 2020). The data showed high import than export, showing a significant demand for coffee within Nepal. According to NTCDB, 47 districts out of 77 districts are highly suitable for coffee production (NTCDB, 2018), however only 32 districts are taking commercial benefits (CBS, 2019). The climate in the mid-hills of Nepal from 800 to 1600 meters above sea level (masl) is remarkably favorable for coffee production (NTCDB, 2014). Farmers mostly cultivate coffee in marginal land and achieve a higher return than other common crops (Kattel *et al.*, 2009).

A number of interconnected factors determine coffee production, however, we developed a simple conceptual framework (Figure 1) that explains possible factors influencing coffee income. We assume that higher return from coffee farming encourages farmers to reinvest back in coffee plantation in the long-run (Minai *et al.*, 2014). In our study area, land suitability analysis showed 517 ha of land suitable for coffee production (NTCDB, 2018) in Thulung Dudhkoshi Rural Municipality. However, just 5 ha of the area in the whole Solukhumbu district was under coffee plantation and that contributed about 2 metric tons (MT) of coffee in 2019/2020. There is a significant scope for area expansion for coffee plantation in the study area. However, the contribution of coffee income at the moment to total household income has remained unexplored in Deusa village of the municipality. We have limited studies on the assessment of coffee income determinants in Deusa. This study thus aimed to estimate the coffee income and its contribution to total household income, and to identify factors influencing coffee income.

MATERIALS AND METHODS

Study area

We conducted the study in wards 7 and 8 of Deusa village (24.48 km^2). It lies in Thulung Dudhkoshi Rural Municipality (144.6 km^2) of the Solukhumbu district of Nepal (Figure 2). As per the national Census 2011 (CBS, 2011), 875 households (see Table 1) were living in the village. The study area lies in the upper tropical to subtropical region. It experiences sparse rainfall and faced towards south aspect. Here, a local NGO, Deusa Agro-Forestry Resource Center (DAFRC), reintroduced coffee recently after some of the earlier adopters (farmers) initiated mass destruction of their mature coffee bushes around 2013 due mainly to the lack of markets and limited understanding on the coffee plantation.

Sampling and data collection procedure

Sampling design: We created a comprehensive list of coffee growing households from a discussion with DAFRC staff. We then adopted snowball sampling technique to select households for the survey. We interviewed 55 households who had planted over 10 coffee plants, and later DAFRC re-verified these households.

Data collection method

Household survey: In January 2020, we carried out a semi-structured questionnaire survey using the KoBo toolbox to collect data associated with coffee production and income. The questionnaire survey aimed for securing household information of coffee farmers including, sources of income in the households including farm and off-farm income. We collected information on other factors that could also affect coffee income, including farmers' knowledge and skills, as well as a personal reflection on coffee production. Among many others, the most notable variables are elevation of the households, shade availability for coffee plantation, access to coffee-related trainings and irrigation facilities, coffee processing tools, total coffee plants, and yield.

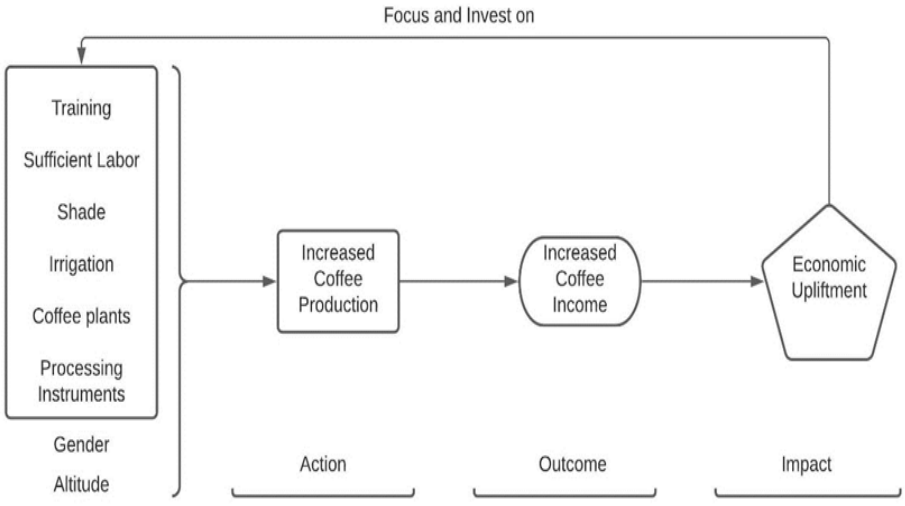

Figure 1. *Conceptual framework of the study.*

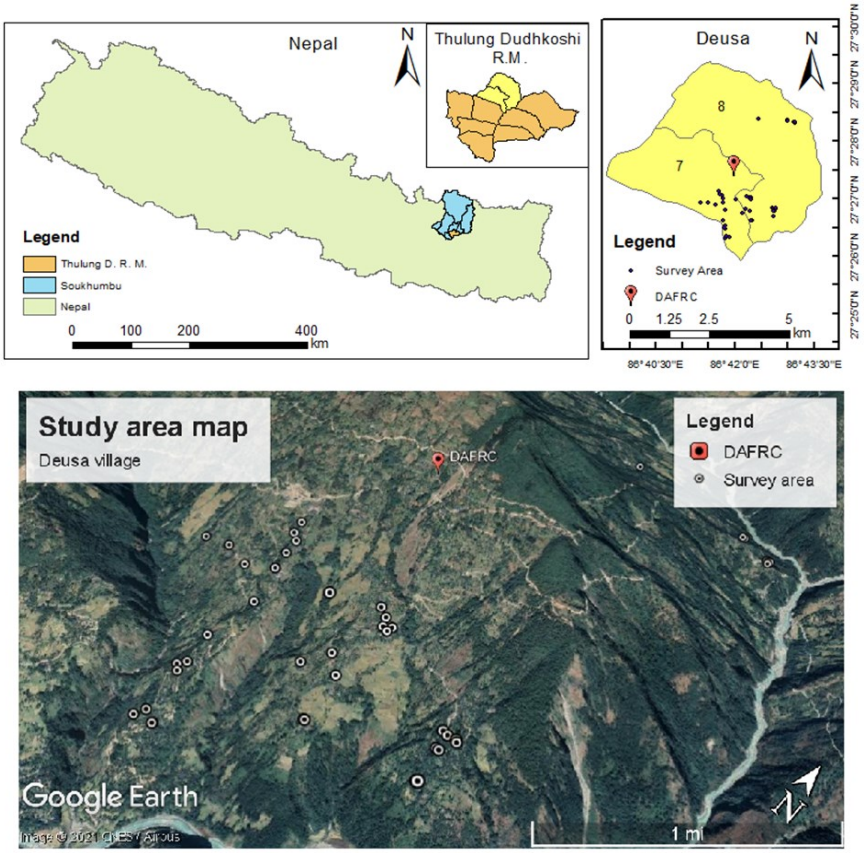

Figure 2. *Location map of the study area.*

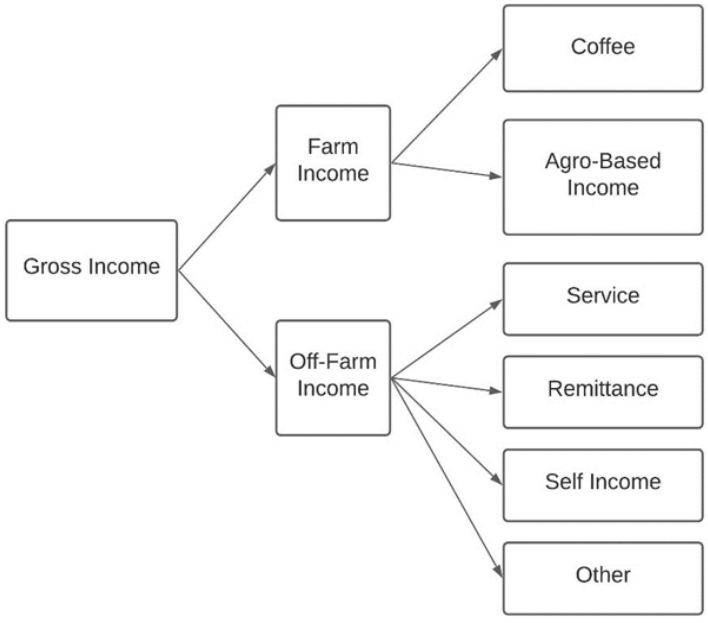

Figure 3. *Categories of income sources.*

Table 1. Household, population composition, and area of Deusa Ward 7 and 8.

Ward	Area (km^2)	Household	Male	Female
7	9.4 km^2	426	980	1038
8	15.08 km^2	449	1022	1090
Total	24.48 km^2	875	2002	2128

For analyzing coffee income share to gross income, we separated coffee income from farm income due to research interest and categorized gross income sources into a farm and off-farm income. The farm income includes all the income gained through agricultural production. Off-farm income includes income generation activities besides agricultural production (Figure 3 for detailed income categories).

Key Informant Interview

We interviewed with some responsible local farmers adopting the coffee as Key Informants (KII), interviewed the staffs of DAFRC, and EcoHimal Nepal for collecting the reliable data related to coffee adoption and income by using semi-structured questionnaire as they are the major coffee promoters and collectors in the study area.

Data analysis

We used IBM Statistical Package for Social Science Software (SPSS ver.26 PC) for data analysis. Besides descriptive statistics, we fit an Ordinary Least Square (OLS) regression for annual household coffee earnings (Eq. 1) with a few independent variables that are provided in Table 2. We performed the statistical test at the 95% confidence level. We listed the factors affecting coffee income and their expected hypothesis in Table 2.

$$Y = \beta_0 + \beta_1 ALTITUDE + \beta_2 SHADE + \beta_3 IRRIGATION + \beta_4 LABOR + \beta_5 TRAINING + \beta_6 PLANTS + \beta_7 CONSTRAIN + \beta_8 GENDER + \varepsilon \quad (1)$$

Where,

Y = dependent variable, coffee income per household (in thousands)

β_0 = y- intercept, constant

β_i = slope coefficients for each independent variable

ε = error term of the model, residual

Table 2. Factors affecting coffee income along with their expected hypothesis.

Factors	Explanation	Expected Hypothesis
ALTITUDE	Household geographical location, data received from mobile-based KoBo software (masl). A higher elevation has low production and yield compared to a lower elevation (Anhar *et al.*, 2021) because of altitudinal effect might show a negative effect on production and earning.	-
SHADE	Presence or absence of shading plants for coffee, measured in dummy (if Yes = 1; 0 otherwise). Muschler (2001) found that the shade increased the quality of beans with higher weight and larger size. The maintenance of intermediate shade with regular pruning of branches, pest control, and soil conservation practices increases productivity (Sarmiento-Soler *et al.*, 2020).	+
IRRIGATION	Availability of water and irrigation facilities, measured in dummy (if Yes 1; 0 othrwise). Lack of irrigation-induced water stress that affect the node formation that lowered flower formation and opening, therefore reducing coffee productivity (Alvim, 1960), and earning.	+
LABOR	Number of individuals in the households during the survey period. Bhattarai *et al.* (2020) found the number of active members and technical help improved the coffee productivity; hence, increased earning of the households.	+
TRAINING	Whether respondent received training on the coffee plantations or not, measured in dummy (if the respondent received trainings 1; otherwise 0). Khanal *et al.* (2019) observed improved coffee productivity of farmers after provisions of trainings.	+
PLANTS	Total number of coffee plants in the household. Higher the number of coffee plants, higher will be the production, and coffee earnings.	+
CONSTRAIN	Limited access of households to processing facilities (for example pulping machine), measured as dummy (if insufficient processing facilities 1; 0 otherwise). Insufficient processing facilities do not motivate farmers to expand coffee farm.	-
GENDER	Gender of the respondents. Males are energetic and laborious, so likely to have higher coffee income (male =1, otherwise = 0)	+

Table 3. Respondent characteristics of sample population (N = 55).

Characteristics		Count	Percentage
Gender	Male	35	63.6%
	Female	20	36.4%
Age	Average age of respondents (years)	46	
Ethnicity	Janajati (Rai)	53	96.4%
	Brahmin / Chhetri	2	3.6%
Education level	Informal education	17	30.91%
	Primary (Grade 1 to 5)	10	18.18%
	Secondary (Grade 6 to 10)	23	41.82%
	High. Sec and above (above Grade 10)	5	9.09%

RESULTS AND DISCUSSION

Sample characteristics

We provided respondents' characteristics of the sample population in Table 3. Approximately 64% were males. Age ranged from 26 to 74 years with an average age of 46 years. We observed the dominance of Rai community, which occupied 96% of an overall sample population. We classified the academic experience of respondents into four specific classes; i) informal education, ii) primary level (grade 1 to 5), iii) secondary level (grade 6 to 10) and iv) higher secondary school level and above (above grade 10). The secondary level has the strongest composition (42%) followed by informal education (31%), primary education (18%), and higher secondary level and above (9%). The result shows that 31% of respondents haven't achieved formal education and struggle to read and write.

Income sources and coffee share

We provided descriptive statistics of income sources in Table 4. Every household had a farm-based income source. Off-farm income sources included are services (7%), self-employment (27%), remittances (20%), and other sources (35%). Here, other sources included are the earnings from social security funds like pensions, widow allowance, elderly age allowance, periodic wage activities. Approximately 73% of households had off-farm income sources. Fifteen households (27%) had a dependency on only the farm-based sources for incomes. On average, a household earned NPR 66.5 thousand from the farm sources, 130 thousand from the non-farm sources, and 161 thousand combined (median income was 57.4 thousand). The average coffee income estimated for a household was around five thousand six hundred. The share of coffee income to gross household income was just 9%. It ranged from <1% to 35%.

The income share of this study is slightly lower than other studies done in Nepal, however quite lower than studies done elsewhere. For example, in Nepal, Acharya and Dhakal (2014) estimated around 10% share of coffee income to total household gross income in Palpa district; whereas Sharma *et al.* (2016) estimated 16% share of coffee income to household gross income in Parbat district. However, a study in Kenya (Wairegi *et al.*, 2018) reported 25-50% of household income share of the coffee plantation. The minimum share of coffee plantations to household earnings at the moment was because of the transition period of the farming system in Deusa village. Households in the village are now transitioning from traditional fodder tree-based agroforestry systems to newly introduced coffee-based agroforestry systems (Kattel *et al.*, 2021). Coffee plant at least requires 2 to 3 years to provide the first yield (Wintgens, 2004).

Coffee income determinants

We provided descriptive statistics of the independent variables used in the regression analysis in Table 5. Altitude ranged from 935 to 1485 meters above sea level. 55% of households had their coffee plants under sufficient shading. 45% of households had irrigation facilities. A household contained on average 6 members. 62% of households had received training(s) on coffee plantation. A household at least planted 10 coffee plants and, at maximum, up to 1000 coffee plants. 35% of households stated insufficient processing units in the conventional areas.

Regression analysis (Table 6) showed that some of the socioeconomic and environmental factors we included affect coffee earnings. Significant socioeconomic factors influencing coffee income are the irrigation facilities, sufficient labor, and training. Likewise, environmental factors significantly affecting coffee income are the elevation and shade availability. We observed that the provision of training and irrigation facilities considerably affects household coffee income. Likewise, elevation and shade availability are also vital for coffee income. Table 6 further showed that altitude negatively determined coffee income, whereas shade availability, irrigation provisions, household family size, and trainings positively determined coffee income.

Table 4. Annual household incomes from different sources (in NPR 1000).

Income Categories	Income Sources	N	N%	Min	Max	Mean	Median	St. Dev
Farm Sources	Agriculture	55	100	3	350	61	30	79.24
	Coffee	55	100	0.6	21	5.6	4.5	4.57
	Sub-total (farm)	**55**	**100**	**3.6**	**360**	**66.5**	**37.6**	**80.41**
Off-farm Sources	Service	4	7.3	20	340	195	200	161.14
	Self-Employ	15	27.3	2	188	45.6	20	61.23
	Remittance	11	20	70	500	231	200	132.4
	Other*	19	34.5	4	312	62.6	25	80.61
	Sub-total (off-farm)	**40**	**72.7**	**2**	**530**	**130**	**50.8**	**152.3**
Total		**55**	**100**	**5.6**	**810**	**161**	**57.4**	**185**

* It includes Social Security allowances and periodic earnings from labor wages.

Table 5. Descriptive statistics of coffee income determinants.

Independent variables	Min	Max	Mean	Standard deviation
ALTITUDE	935	1485	1191.6	139.0
SHADE	0	1	0.55	0.503
IRRIGATION	0	1	0.45	0.503
LABOR	1	10	5.49	2.227
TRAINING	0	1	0.62	0.490
PLANTS	10	1000	139.7	221.1
CONSTRAIN	0	1	0.35	0.480
GENDER	0	1	0.64	0.485

Table 6. OLS regression analysis for factors affecting coffee income.

Independent Variables	Coefficient	Std. Error	t-value	p-value
Constant	7248.9	4330.74	1.674	.101
ALTITUDE	-8.07	3.65	-2.211	.032
SHADE	2208.3	1030.45	2.143	.037
IRRIGATION	2433.9	982.67	2.477	.017
LABOR	546.5	234.03	2.335	.024
TRAINING	3803.8	1128.79	3.370	.002
PLANTS	3.834	2.45	1.560	.126
CONSTRAIN	-1407.1	1070.64	-1.314	.195
GENDER	415.4	1054.81	.394	.696

N = 55, R^2 = 0.494, Adjusted R^2 = 0.406, Std. Error of Estimate = 3523.805, Durbin-Watson = 2.08, $p<0.05$, F test = 5.61.

Although literature suggests many factors that alter coffee production, we discuss here some of the significant variables observed in our study. Based on the literature review (Bote and Struik, 2011; Vaast *et al.*, 2006; Nygren and Ramírez, 1995; Khatiwada *et al.*, 2017) and our study findings, we developed a causal link diagram (Figure 4) that provides a relationship between the significant determinants and coffee income. This study revealed that (i) coffee income decreases as the elevation of the households increases; and provisions of (ii) shade trees, (iii) irrigation facilities, (iv) sufficient household labor, and (v) trainings increased coffee income.

The rise in elevation decreased the earning from the coffee probably because of the minimum production. Anhar *et al.* (2021) have also stated similar relationship. The distribution of coffee plants declines with the rising elevation. The local people, especially in KII, stated that coffee farming was not fruitful in the greater altitude of Deusa with comparatively lower production. Some coffee growers at higher altitude had bitter experience with coffee - i.e., because of unavailability of coffee market in the past, they destroyed their matured coffee bushes.

Shade management is an essential aspect of coffee farming. The finding of significance between shade availability and earnings is coherent with other studies. Muschler (2001) discovered that the shade increased the quality of beans with greater weight and wider size. Shade cover also reduces the fluctuation of yearly fruit bearing in coffee (Vaast *et al.*, 2006). Similarly, coffee-banana inter-crop had a high yield related to open coffee, where the fruit-bearing, yielding branches and weight of cherries decreased with an increase in shade cover (Sarmiento-Soler *et al.*, 2020) but reduces the alternate bearing of fruits and provides consistency in production (Vaast *et al.*, 2006). The maintenance of optimum shade with proper pruning of the branches increases coffee productivity (Sarmiento-Soler *et al.*, 2020). The Deusa community also had bananas as the prevailing shade-providing plants. Ranjitkar *et al.* (2016) noted that inter-cropping of coffee with bananas reduce the production threats and maintains a convenient habitat to produce coffee by providing shade and reducing the surrounding temperature. The expansion of shade-providing plants having monetary values like bananas might encourage the farmers of Deusa to bring in extra income and gain economic resilience.

Our study also showed that household size and access to irrigation facilities are crucial for coffee earning. Bhattarai *et al.* (2020) stated that family members, when provided with technical support, boost their productivity. Lack of irrigation induces water stress that often affects the node formation, lowering flower formation and opening, and thus reducing coffee yield (Alvim, 1960; Cannell, 1971). Even though coffee is not a water demanding crop, proper water supply is a must for the maximum production for coffee income. Training is one of the most important factor for skill enhancement for rural agricultural communities for higher return and reducing poverty (Khatiwada *et al.*, 2017).

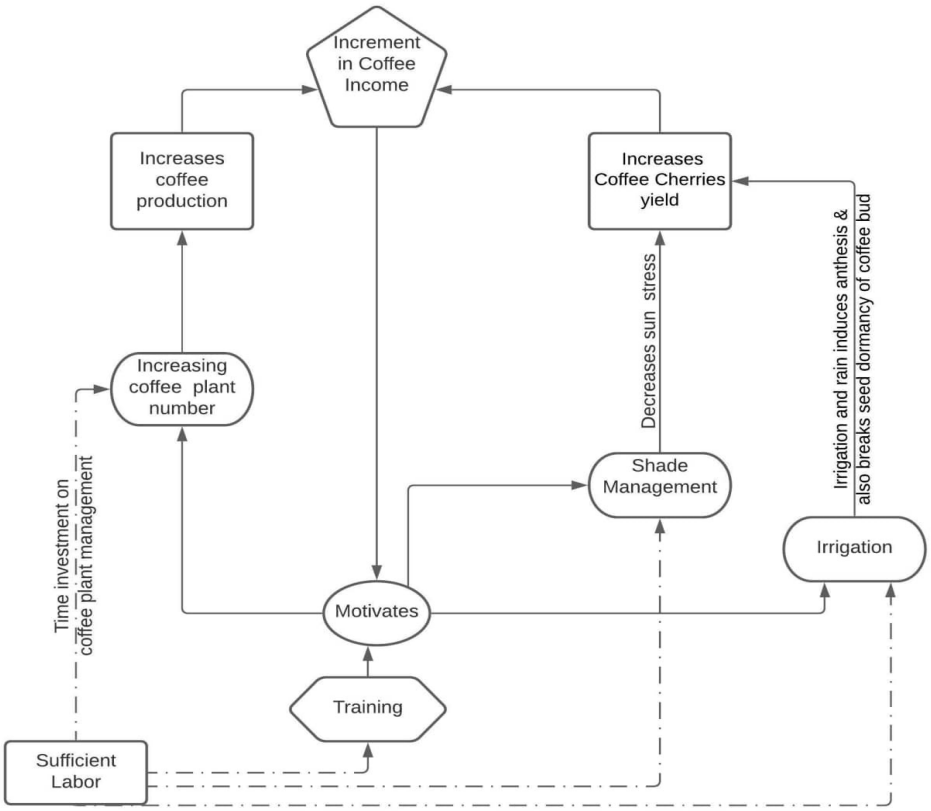

Figure 4. *Causal relationship between coffee income determinants.*

Trainings in our study included are the nursery and farm management practices, cherries harvesting and processing techniques, and suitable area selection for coffee plantation. During the survey, we examined that the farmers who received training had a comparatively greater number of coffee bushes compared to farmers who didn't receive training on the coffee. Nguyen Thi Ngan and Bui Huy Khoi (2019) also identified the income from coffee associated with farmer's knowledge gained through trainings. Trainings upgrade farmers' knowledge and skills that motivate them not only to adopt coffee but also better care and management of coffee farms—ultimately resulting more earning. Lack of trainings is a challenge for empowering youths in the sector of agriculture. Farmers have reported employment outcomes because of skill-enhancing trainings in agriculture (Maïga *et al.*, 2020).

Coffee income is often more important for poor people to make their livings. The elderly and underprivileged who cannot spend in alternative means for income diversification can also somehow generate income from coffee plantation. Youths are not interested in coffee production, as they are more likely to depart from farmings (Wairegi *et al.*, 2018) for foreign labour employment. Labour outmigration and land abandonment is a serious issue in rural hills and mountains of Nepal. At present, because of the COVID-19 health pandemic, there is an increasing number of migrant returnees. Coffee plantation could be one option for the youths that not only restore the degraded land but also support household earnings. Concerned stakeholders working on the coffee sector and policy makers should come up with a suitable policy and working strategies to support youths and migrant returnees. These youths and returnees are more of business-oriented mentality, especially in agricultural business. Providing supports to young farmers for coffee production by creating favorable conditions may lead a sustainable coffee production in the long run. Participation of active and youth farmers could bring a visible change in the production pattern because of the investment of time and capital compared to that of the elderly and poor (Wairegi *et al.*, 2018).

Finally, we note here a few limitations of the study. Because of the COVID-19 global health pandemic and travel restriction, we had to complete fieldwork within limited time period. The study area showed a kind of recent transition from a traditional farming system to the coffee-based agroforestry system and a very few households recently started full harvest of the coffee plants (Kattel *et al.*, 2021). Because of this transition, our estimates particularly that of coffee income might have resulted in lower values (just 9% income share for example) compared to other areas where the full harvest of coffee is possible, so generalization of findings to other areas may not be fully justifiable. However, our study showed a few developmental factors that need to be considered in the study area and the income share may translate a transition dynamic of the coffee-based farming systems and could be a baseline for future research. Like our study, prior studies also stated that access to training opportunities, availability of shade providing plants, irrigation equipment have an important relation with coffee production (Khanal *et al.*, 2019), henceforth, future trainings and development programs should focus more on this aspect.

Conclusion

Many factors determine coffee income in the hills of Nepal. The most vital factors in Deusa are the elevation, provision of shading tree species, irrigation facilities and trainings, and family size. Total household annual gross earnings from both farm and non-farm income sources was around NPR 161 thousand, and the percentage share of coffee income made up around 9% of the total. This study provides further evidence that access to training opportunities, availability of shade-providing plants, irrigation facilities could enhance coffee earnings. We thus recommend support to coffee farmers, especially provisions of shading trees seedlings and the awareness programs of the shading in coffee plants, development of small-scale irrigation systems, and more skill-enhancing training on coffee-based activities. Plantation of bananas along with coffee plants, for example, would enhance shading for coffee, and earn extra income from the shade tree - so that the coffee-based farming system would be more resilient.

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Conflict of interest

The authors do not have any conflict of interest. The result presented here are unbiased and do not consider or support the view of an organization.

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