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Adoption of Technology Upgrading by Rural Smallholders in the Nepalese Coffee Sector

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Abstract

The ecological settings in the Himalayan hills provide a unique opportunity to the resource-poor farmers in Nepal to sell their organically produced coffee as specialty coffee in the global market. However, there is little research about the cultivation methods and adoption of profitable technological upgrading in coffee cultivation in the country. Against such a back drop, this paper seeks to explore the factors that influence the small-scale coffee farmers' decision to adopt technological upgrading such as wet processing in the farming process. Semi-structured interviews as well as focus group discussions were conducted in selected coffee-growing rural regions of Nepal. The cost-benefit analysis of different modes of coffee processing shows that the adoption of wet processing has a large potential of increasing the profit margins of farmers. Results from an adoption model identify education, book keeping on coffee activities, training, and access to credit and household location as the key determining factors for the adoption of technology upgrading.

Keywords: Adoption model, cost-benefit analysis, upgrading, smallholder, coffee, Nepal.

1. Introduction

Among the different agricultural goods produced in and exported from Nepal, the competitiveness of coffee has quickly increased in recent years, thus contributing to the development of rural regions in Nepal. In the fiscal year 2006-07, a total of 181 tons of green beans coffee were produced in Nepal, almost five times the quantity produced in 2000-01. It is estimated that the coffee production area has expanded from around 425 ha in 2001-02 to 1,400 ha in 2006-07 employing around 12,800

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farming households (Osorio, 2002). Annually, total coffee production and area of production of coffee in Nepal is increasing by 35% and 28%, respectively (AEC/FNCCI, 2007)

The trend of exporting coffee from Nepal has been impressive. The share of coffee exports currently amounts to around 7% of the country's total 15% agricultural export share (FAOSTAT /World Bank, 2006). The total export of green beans coffee from Nepal has increased from 37 tons in 2004 to 114 tons in 2007. Around 55% of these 114 tons went to Japan, 34% to European countries, 3% to the USA and 8% went to other countries. The remaining 67 tons (37%) of green beans coffee were sold in the domestic market (Helvetas, 2007). The current expansion of coffee cultivation in Nepal shows that coffee could be one of the high-value niche products for export contributing to the development of rural areas in the country. Lewin et al. (2004) state that the specialty coffee segment has been growing at an annual rate of 5-10% in the world market.

Coffee has been found to be nearly three times more profitable than other crops in the present context (Bajracharya, 2003). But profitability crucially depends on the quality of the coffee produced which in turn not only depends on the coffee production management, but also on post-harvest processing management at village and processors' level. Current evidence from Indonesia, for example, shows that the farm-level price of coffee increases substantially with wet processing compared to coffee processed using dry processing (Susila, 2005). Until the year 2001, dry processing of coffee was also predominantly practiced in Nepal. However, since the shift from dry processing to wet processing, the income of smallholder coffee farmers has increased due to more consistent quality of coffee (Shrestha, 2005).

In the context of entering the global market, Nepalese coffee farmers face problems related to upgrading. Participation in international trade with the developed countries will offer great opportunities but, at the same time, these countries set very high standards related to quality and upgrading of agricultural products which Nepali producers in many situations fail to meet due to lack of financial and technical resources (Adhikari, Adhikari, & Network, 2005). Given the fact that wet processed coffee is high-priced possibly securing farmers a higher income, this paper aims at investigating the incentive mechanism that influences farmers' decision towards adoption of process upgrading.

The remainder of the paper is organized as follows. Section 2 presents a brief review of relevant literature while the methodology of this study is outlined in section 3.

Section 4 presents the empirical results, and the conclusions and policy implications are drawn in section 5.

2. Literature Review

In the value chain literature, upgrading is understood "as the process that enables a firm or any other actor of the chain to take on more value intensive functions in the chain, make itself harder to replace, and thus appropriate a larger share of the generated profits" (Stamm, 2004, p.27). The value chain literature focuses on the role of global buyers and chain governance in defining upgrading opportunities. Humphrey & Schmitz (2000) use the concept of upgrading to refer to three different shifts that firms might undertake. First, process upgrading - firms can upgrade either through transforming inputs into outputs more efficiently by re-organizing the production system or introducing superior technology; second, product upgrading - firms can upgrade by moving into more sophisticated product lines and third, function upgrading - firms can upgrade by higher value added. Kaplinsky & Morris (2002) added a fourth case, intersectional upgrading - where firms can upgrade by moving out of a chain into a new one.

Upgrading is highly determined by its enabling environment and lead actors' interests for cooperation. Due to complex business environments and governance structures in the value chains, institutional issues should be further included in the definition of upgrading. These are related to managerial capacity of the cooperatives, organizational processes and services provided by chain actors (Kaplinsky & Morris, 2001; Laven, 2006). Upgrading can be the pre condition in order to get integrated into a value chain at all, or it becomes necessary to secure the position in or respectively of a chain (Schipmann, 2006). Grote & Stamm (2007) pointed out that developing countries can capitalize on their natural advantages on the one hand and generate employment and income opportunities through primary and secondary processing on the other. Global value chain analysis emphasizes that local producers learn a great deal from global buyers about how to improve their production processes, attain consistent and high quality, and increase the speed of response (Humphrey & Schmitz, 2002).

Approximately 125 million people in the developing world depend on coffee for their livelihoods and 70% of them are small-scale farmers (Osorio, 2002; Santos, 2003; Fitter & Kaplinsky, 2001). Heterogeneity among coffee varieties and cross origins allows roasters to produce differentiated products geared to tastes in specific markets and specific market sectors, and brands are often heavily promoted which may create barriers to the markets' entry (Gilbert, 2006). Even more problematic is the fact that

many firms indicate or believe that they sell sustainable coffee although they lack independent certification or verification (Ponte, 2004).

Coffee farmers generally lack economic incentives to improve their product and service quality because it does not give them a higher price (USAID, 2005). OXFAM (2002b, p.3) also reported that the low coffee price creates a buyers' market, leaving some of the poorest and powerless people in the world to negotiate in an open market with some of the richest and most powerful. "Changes in the international policy environment, new arrangements in supply and demand, technological changes and/or the asymmetrical character of power in the 'coffee value chain', have increasingly narrowed the opportunities for vulnerable economies to secure the benefits from coffee trade needed for economic development and poverty reduction" (Petit, 2007, p.225). According to Lewin et al. (2004), industry surveys indicate that quality and its consistency belong to the most important factors in order to become competitive in today's markets in the coffee sector. Additionally, increased information management and product definition regarding distinct quality attributes is important to enhance the bargaining power at production level and realize incentive schemes for quality production (Ponte, 2004). The poorest farmers often grow coffee in agro-ecological conditions that make it impossible for them to meet certain quality standards. Thus, Calo & Wise (2005) pointed out that quality is a significant barrier for the smallholders seeking to enter the niche markets and the smallest farmers often grow coffee in poor agro-ecological conditions with less care and management that make it impossible for them to meet increasingly high quality standards.

Households rank acquisition of technology indirectly through the characteristics various items possess, and a given technology embodies characteristics that influence adoption decisions (Somda et al., 2002). A number of studies have investigated the influence of various social, economic and institutional factors that affect the willingness of farmers to use new technology (Feder et al., 1985; Polson & Spencer, 1991; Somda et al., 2002; Lemchi et al., 2003; Heisey & Mwangi, 1993; Staal et al., 2002; Abebe et al., 2008).

3. Data and Methodology

In 2008, primary data was collected in the coffee sector in Nepal. A survey was conducted in two districts, namely Gulmi and Kavre from August to October (Figure 1). A total of 120 respondents were selected by a three-stage sampling procedure. In the first stage, Gulmi and Kavre districts were purposively selected on the basis that they are the two major coffee producing districts in Nepal. In the second stage, three

Village Development Committees (VDCs)[2] in each district were purposively chosen based on similar geographical characteristics. Finally, in the third stage, 20 farming households were randomly selected from each VDC.

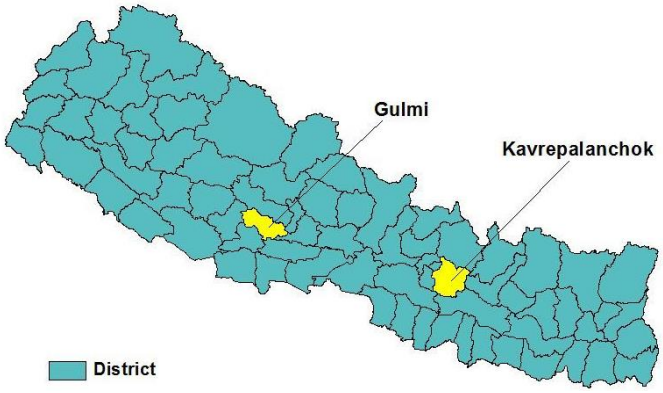

Figure 1: Map of Nepal showing the district where the research sites are located.

Before conducting the survey, the questionnaire was pre-tested with five farmers in Kavre district. The data were collected by trained enumerators supervised by the first author, using semi-structured questionnaires. To complement the household survey, a series of formal and informal focus group discussions with farmers were also conducted along with interviews of experts from the Coffee Cooperative Federation in Gulmi, two District Coffee Producers' Associations, and of three traders/exporters. The focus group discussions and expert interviews provided qualitative information for conducting a SWOT analysis highlighting the strengths, weaknesses, opportunities and threats of coffee production and marketing as well as contractual relationships between farmers and buyers (either cooperative or companies). This information helps to explain the finding of the econometric results.

The methodologies applied in this paper build on a two-step approach. First, a cost-benefit analysis is undertaken to ascertain the relative profitability of different modes of post-harvest processing such as fresh cherry, dry cherry and wet processing. Based on focus group discussions with 15 representative farmers, detailed costs and benefits of different modes of post-harvest coffee processing were collected for a period of 14 years. The objective of this exercise is to systematically analyze the relative profitability of wet processing of coffee vis-à-vis other methods.

[2] A VDC is the lowest administrative unit in Nepal comprising of small villages.

Second, an adoption model is estimated with the help of econometric tools to identify the determinants of farmers' decision to adopt wet process upgrading of coffee at farm level. Logistic regression is used to investigate the determinants of the farmers' decisions whether they adopt wet process upgrading of coffee or not. The decision may be influenced by a range of different variables including their characteristics, demographic, physical, economic and institutional factors. Thus, a logistic model is used for the analysis of binary responses and it allows one to examine how a change in any independent variable changes all the outcome probabilities (Hosmer & Lemeshow, 2000). In general, the results are reasonably robust to changes in the set of independent variables included in the regression. Thus the relationship between the discrete variable and a parameter is non-linear. In the basic model, let Y_i be the binary response of a coffee farmer taking one of two possible values: Y = 1 if the farmers decide to adopt wet process upgrading and Y = 0 if not. Suppose x is a vector of explanatory variables contributing to the adoption decision and β a vector of slope parameters, measuring the changes in x on the probability of the farmers' decision to adopt wet process upgrading and sale of dry parchment. The model can be written as follows:

While stratification in the sampling process can decrease the sampling variance

$$Y_i = \alpha + \beta_i \chi_i \qquad (1.1)$$

where, α and β_i are the unknown constant term and vector of regression coefficients to be estimated respectively.

The binary model used in the study is specified as follows:

$$E(Y_i = PROCESS) = \alpha + \beta_1 AGE_i + \beta_2 GENDER_i + \beta_3 EDUC_i + \beta_4 HHSIZE_i + \beta_5 LAND_i + \beta_6 SHARE_i \\ \beta_7 BOOK_i + \beta_8 CREDIT_i + \beta_9 TRAIN_i + \beta_{11} POOR_i + B_{12} NLOCAT_i \qquad (1.2)$$

For the logit regression model, explanatory variables need to be selected according to their relevance. Generally, the explanatory variables cover characteristics of the producers, characteristics of their farms, trading relations and marketing chains. Equation (1.2) hypothesizes that the farmer's decision to adopt or not to adopt wet processing of coffee depends on the ten explanatory variables in Table 1, which also summarizes the expected sign for the effect that they have on decision (PROCESS) for each case.

Table 1: Description of variables for adoption model and à *priori* expectation

Variables	Description and type of variable	Expected Signs
Dependent Variable:		
PROCESS	Farmer decision to adopt wet processing of coffee and sale of dry parchment. Dummy (1=Yes, 0=No).	
Independent variables:		
AGE	Age of the smallholder farmer. Continuous (Years)	+/-
GENDER	Gender of the farmer. Dummy (1= Male, 0= Female).	+
EDUC	Education level of the farmer. Continuous (Years of schooling).	+
HHSIZE	Number of family members in household (Household size). Discrete (Numbers)	+
LAND	Land under coffee cultivation. Continuous (in ropani)	+
SHARE	Percentage of coffee income to annual household income. Continuous (%)	+
BOOK	Whether farmer keeps books on coffee activity. Dummy (1=Yes, 0=No).	+
CREDIT	Whether farmer receives credit from formal institution during last two years. Dummy (Yes=1, 0=No).	+
TRAIN	Whether household received training in quality-enhancing practices. Dummy (1=Yes, 0=No).	+
POOR	Whether per capita household member income is less than US $1.25 per day. Dummy (< US $1.25=1, 0= otherwise).	-
NLOCAT	Location of coffee farmer near the inputs market. Dummy (1=Kavre, 0=Gulmi).	+

Source: Own illustration

4. Results and Discussion

In the following, first the descriptive, then the cost-benefit analysis results, and finally the econometric results from the adoption model are presented

The summary of descriptive statistics is presented in Table 2. With respect to the socio-demographic characteristics, 9% of the 120 sampled respondents are illiterate or have not received any type of education. The average education level of producers is 6.3 years of schooling. Adopters of wet processed coffee have been found to have obtained on average 7.6 years of schooling as compared to 5.6 years of non-adopters. Notwithstanding, one third of the population of smallholder coffee farmers (34%) in the study area live below the poverty line. The majority of poor smallholders (39.5%) are non-adopters. Other demographic characteristics such as age of farmer, gender and

household size[3] do not seem to be statistically different between adopters and non-adopters.

Regarding farm characteristics, an average land holding is 0.81 ha per household in the study area. Adopters have slightly more land than the non-adopters, but there is not a significant difference between the two groups. Average land area put to coffee cultivation by smallholder farmers is 2.03 ropani (equivalent to 0.10 ha), ranging from 0.15 to 10 ropani. Adopters of wet processing of coffee are found to put more land area (2.68 ropani) to coffee cultivation than non-adopter (1.71 ropani). Regarding fresh coffee production in 2007/08, about 2.36 quintals (qq) are obtained per smallholder household, ranging from 4 to 24 quintals. Adopters have higher annual household coffee production (4.66 qq) as compared to non-adopters (1.26 qq). The average fresh coffee productivity is 1.19 quintals per ropani (equivalent to 23.8 quintals per ha). The mean coffee yield for adopters and non-adaptors is 1.79 quintals per ropani and 0.91 quintals per ropani, respectively. The variability of coffee productivity among the sampled farms may have been partly due to climatic differences and biennial yield patterns of coffee. The yield of coffee is influenced by the age of coffee trees (potential coffee yield after 7 years of tree age) and agronomical practices (including cultivation practices, varieties selection, shade tree management, irrigation and pruning). Further, annual income from coffee is on average Rupees (Rs.) 6,044 in the total sample, with wet process adopting farmers having higher shares of coffee income (Rs.11,627) as compared to the non-adopters (Rs. 3,562).

The farming system in Nepal is generally of a subsistence nature, with little commercialization in the coffee sector. The average share of annual household income from coffee is 14%. Adopters have a higher share of coffee income (20%) than the non-adopters (12%). Both the adopters and non-adopters have diversified their income sources with non-farm income contributing a significant proportion (around 43%) in both groups.

It is observed that the majority of adopters (51%) maintain records on coffee activities (book-keeping) as compared to the non-adopting farmers (20%). As far as access to credit is concerned, 51% of the adopters have reported to have access to credit from formal and informal institutions as opposed to only 20% of the non-adopters. The survey also reveals that most of the adopters (82%) have received training in coffee quality enhancing practices either from cooperatives or from development organizations like Winrock, Coffee Promotion Project/Helvetas (Helvetas, 2007)and other national NGOs as compared to 56% of the non-adopters.

[3] A household is often defined as a group of people who live together and eat from one pot (Bellon, 2001).

Table 2: Means of factors affecting adoption of wet processing of coffee at farm

Variables	**Total sample (n=120)**	**Adopters[+] (n=39)**	**Non-adopters (n=81)**	**Test of Significance[++]**
Characteristics of farmers				
Age (Years)	45.9 (13.73)	45.7 (14.72)	46.2 (13.32)	0.179
Gender (Male=1)%	58.3	64.1	55.6	0.791
Education (Years)	6.3 (5.86)	7.7 (5.31)	5.6 (6.13)	2.409**
Household size (Numbers)	7.0 (3.12)	6.9 (2.66)	7.1 (3.33)	-0.143
Poor[4] (Yes=1)%	34.2	23.1	39.5	-3.159*
Characteristics of farms				
Total cultivation land (Ropani)	16.2 (13.23)	16.5 (14.43)	16.1(12.49)	0.182
Land under coffee (Ropani)	2.0 (1.85)	2.7 (1.19)	1.7 (1.75)	2.727***
HH coffee production (qq)	2.4 (3.63)	4.7 (5.13)	1.3 (1.81)	5.329***
Productivity of coffee (qq/ropani)	1.2 (1.14)	1.7 (1.34)	0.9 (0.90)	4.118***
Income from coffee sector (Rs.)[5]	6,044(9117)	11,627(12065))	3,562(6048)	4.821***
Income share by coffee (%)	14.33(20.23)	19.84 (21.48)	11.68 (19.18)	2.097**
Income share by off-farm	43.2(37.10)	41.6 (34.75)	44.1 (38.36)	0.342

[4] Poor is calculated as total annual household income (income from both farm and off-farms) divided by total number of members in household. The per capita household income below US$ 1.25 is defined as poor. Purchasing Power Parity (PPP) exchange rate, which was US$ 1 (equivalent to Rs. 26.01) for 2007/08, was used to calculate the poverty line (ADB, 2008). National poverty incidence is 31 % (in 2007).

[5] Rs. is the currency of Nepal (Nepalese Rupees). The exchange rate at the time of the survey was approximately 71 Rs. /$US).

(%)[6]				
Documentation and Services				
Book keeping (Yes=1)%	30.8	51.3	20.0	11.329***
Access to credit (Yes=1)%	41.7	59	33.3	7.121***
Training received (Yes=1)%	64.2	82.1	55.6	8.038***

Cost-benefit analysis of post-harvest processing in the coffee value chain

The major actors participating in the coffee value chain in Nepal are the inputs suppliers, the smallholder farmers, pulper operators, producers' associations, cooperatives and private companies. The pulper operators at the village level are the coffee farmers who have a pulper machine on their farm. High quality green beans are exported while low and medium quality coffee is sold in the domestic market either as roasted beans or filter/ground coffee through retailers in hotels and major city markets. The domestic marketing channel for coffee was found to be very short; the producers either sell to the pulper operators or to a group (association of producers, cooperative or private company).

The coffee at the farm level is mainly sold in three forms: fresh cherry, dry cherry or dry parchment. Out of the total 120 sampled smallholders, 45% smallholders sell their coffee immediately after harvest to the village level pulper operators as fresh cherry, 22.5% smallholders process their coffee to dry cherry meaning drying the cherry under the sun. The remaining 32.5% smallholders sell their coffee in the upgraded form of dry parchment after wet processing. On average, 40% of the smallholders from the Kavre district sell their dry parchment after wet process upgrading to the private company as compared to 25% of the smallholders from the Gulmi district who sell their dry parchment to the cooperative[7]. Regarding the average prices received, the survey reveals that the smallholders receive around Rs.28/kg for fresh cherry, Rs.70/kg for dry cherry, and Rs.156/kg for dry parchment (Table 3).

[6] Several studies have reported that non-farm income also constitutes a significant proportion of total income for agricultural households in other developing countries (e.g. Chin, 1997; Shand, 1987).

[7] In the wet processing, the coffee is pulped by a pulper, fermented, washed and dried to produce dry parchment at the village level, which requires the use of specific equipment and substantial amounts of water. At the end of fermentation, the wet processed beans are washed and dried. The final product is a "washed" or "parchment" coffee (Smith, 1985).

Table 3: Forms of coffee sales in the study area

Item sold:	**From Kavre (n=60)**		**From Gulmi (n=60)**		**Total in %**
	% Farmers	To whom		To whom	**(N=120)**
Fresh cherry	60 (36)	Pulper operaters	30 (18)	Pulper operaters	45 (54)
Dry cherry	-	-	45 (27)	Cooperative	22.5 (27)
Dry parchment	40 (24)	Private company / Farmers' Association	25 (15)	Cooperative	32.5 (39)

Note: *Figures in parentheses indicate the number of sampled farmers.*
Source: Own field survey, 2008.

The cost and benefit streams are calculated from the 14 years of period. For the initial three years, farmers do not harvest coffee but rather they harvest some intercrops from their coffee orchards. The cost components in coffee production include fixed costs like opportunity cost of marginal coffee land and fencing. Variable costs include fertilizers and bio-pesticides (only organic; no one used inorganic fertilizer and pesticides in their coffee farm), and costs of labor used in different intercultural operations like plantation, manuring, pruning, weeding, mulching, harvesting, grading, communication and additional value adding costs at farm level.

The findings show that the average benefits from fresh coffee cherry, dry cherry and dry parchment production per ropani (508.72 m²) per year at farm are Rs. 5153, Rs. 2449 and Rs. 9998, respectively. Table 4 shows that the average total cost of production of fresh cherry, dry cherry and dry parchment is Rs. 13.8, 14.8 and 15.8 per kg respectively. The gross margins of coffee cultivation thus, are Rs.11, Rs.5 and Rs.22 per kg of fresh cherry in the different processing forms, namely fresh cherry, dry cherry and dry parchment, respectively. Thus, it is clearly shown that if a farmer sells only dry parchment (wet processed), he/she could get around 75% and 49% higher profits compared with sales of dry processed cherry and fresh cherry respectively per kg of fresh cherry. The overall benefit cost ratio (BCR) of coffee cultivation is found to be 1.81 (if fresh coffee is sold), 1.36 (if dry cherry is sold) and 2.37 (if dry parchment is sold), which are obviously higher than 1 required for an enterprise to be just profitable. Table 4 shows that the BCR at farm is higher for dry parchment (wet processed) as compared to the sales of dry cherry and fresh cherry. Thus, wet processing at farm is relatively more profitable for the smallholder coffee producers in Nepal.

Table 4: Cost of coffee production, gross return and gross margin

Item sales	**Costs/ropani** (Rs.)	**Revenue/ropani** (Rs.)	**Benefit/ropani** (Rs.)	
Fresh Cherry (FC)	6383	11536	5153	
Dry Cherry	6845	9294	2449	
Dry Parchment	7306	17304	9998	
	Costs/kg of FC (Rs.)	**Revenue/kg of FC** (Rs.)	**Gross margin per kg of FC** (Rs.)	**BCR**
Fresh Cherry	13.83	24.99	11.17	1.81
Dry Cherry	14.83	20.14	5.31	1.36
Dry Parchment	15.83	37.50	21.67	2.37

*Note**:** The annual cost-benefit was calculated for the 14 years of coffee cultivation period.*
1 US $ = Rs. 71.06 (at the survey period, 2008).
Source: Own field survey data, 2008.

The cost-benefit analysis of Nepalese coffee has shown that wet process upgrading of coffee at farm level is more profitable (in term of prices and net benefits) than dry processing and sales of fresh cherry. Thus, our empirical model is used to identify factors determining farmers' decision to adopt wet process upgrading of coffee.

Findings from the adoption model

The econometric analysis focuses on the 120 smallholder coffee producers spread in the two district clusters. The Wald test shows that the model has good explanatory power at the 1% level. The overall predictive power of the model (80%) and explanatory power (33 %) are quite high. The Hosmer-Lemeshow' goodness-of-fit yields a chi-square with a large P-value indicating that the model presents a good adequacy and fits the data well (Table 5).

A perusal of the estimates shows that the education level of respondent (EDUC) has a positive impact on farmers' decision to adopt wet process upgrading. Holding other factors constant, when education increases by 1 year, there is an increase of 3% in the probability that farmer will decide to adopt wet processing. This is consistent with previous research results by Lin (1990) and Abebe et al. (2008). Numerous studies

have found that farmers' education plays a positive role in the adoption of new agricultural practices (Lin, 1990; D' Souza et al., 1993). Education increases the access to information and thereby possible knowledge of wet processing regarding coffee. It also increases the understanding of the value adding technique leading to benefits from process upgrading at farm level and facilitates its application. Lemchi et al. (2003) noted that technological change is achieved through formal education. This may be because relatively higher educated farmers are able to assess the value adding technique and benefits from process upgrading at farm.

The variable 'share of coffee to annual household income' (SHARE) has also a positive and significant impact on the adoption decision, with 1% increase in the share of coffee income to total household income resulting in an increase of the probability of adopting wet processing of coffee by 0.5%.

The variable 'book keeping' on coffee activities (BOOK) has a positive and significant impact on the decision to adopt process upgrading. 50% of the adopters keep book records on coffee production and marketing activities at farm level. In the case study, we asked, "why are you keeping record on coffee activities?", an adopting farmer said, "It provides information about coffee production and prices in the past years, so I am able to calculate costs of inputs' use and benefits from process upgrading". This result is according to our expectations, since book keeping allows a closer monitoring of input use, timing and a better understanding of the value adding system which increases the efficiency level of farmers towards wet processed adoption. The probability of adopting wet processing increases by 43% if a farmer keeps record on coffee production and marketing activity.

Access to credit (CREDIT) plays a significant role in enhancing the technology adoption. As anticipated, credit affects adoption decisions positively and significantly in our sample with the marginal probability of 29%. The result is supported by Abebe et al. (2008) who found that adoption of improved box hives by smallholder beekeepers has a highly significant and positive correlation with access to credit. Feder & Umali (1993) also mentioned that access to credit is the most important factor in influencing farmers' decision of technology adoption. About 59% of the adopters have received credit from local level saving and credit cooperatives and the Agricultural Development Bank in the study area. The focus group discussions revealed that the majority of farmers had difficulty to receive a loan from the bank due to stringent and inflexible requirements for loan application; unfavorable repayment terms and the lack of collaterals. One adopting male farmer in Kavre district indicated that he had received a loan from the Agricultural Development Bank in minimum and nominal interest rats of 14%, while a female farmer in Gulmi district said that she got credit from a village level saving and credit cooperative in minimum and nominal

interest rates of 12%. In many cases the credit is used for immediate consumption needs, like food or medicine and only partially invested in the farm.

The variable 'training dummy' (TRAIN) has a positive impact on farmers' decision. The probability to adopt wet process upgrading increases by 20% when a farmer has received training in quality-enhancing practices. The argument is that formal and informal training has the potential to increase the rate of adoption by directly increasing awareness, imparting skills to better understand the value chain system and increasing knowledge on the new technology.
The variable POOR has a negative significant effect on the processing decision at a confidence level of 5%. For those farmers whose households' income is below US$1.25 per member, the probability to adopt wet processing at farm decreases by 18%. This negative relationship can be explained by the fact that poor farmers are less likely to adopt due to financial limitations and the fact that they may need money immediately after the coffee harvest. Poor farmers also have low coffee yields, leading again to a low income and most of the household income is spent on household consumption and little for farm investment.

The econometric estimates reveal that the location dummy (NLOCAT) has a positive and significant impact on smallholders' decision to adopt wet process upgrading. Those farmers who live near the central input market i.e. in the Kavre district are 42% more likely to adopt wet process upgrading on their farm as compared to those who live far from the central input market i.e. in the Gulmi district. A reasonable explanation could be that the central inputs market provides better inputs access, research and extension facilities. Furthermore, it may be due to the frequent contacts with service providers and development organizations. A review of technology adoption studies in Africa by Heisey & Mwangi (1993) also showed that factors influencing adoption differed by location.

Table 5: Logit regression results on the adoption decision of wet process upgrading

Variables [a]	Coefficients	Robust Std. Error	z	dy/dx [b]
Constant	-5.533***	1.639	-3.38	-
AGE	0.010	0.029	0.34	0.002
GENDER	0.105	0.830	0.13	0.020
EDUC	0.167**	0.069	2.42	0.032**
HHSIZE	-0.063	0.087	-0.72	-0.012
LAND	0.109	0.150	0.73	0.021
SHARE	1.028**	0.012	2.38	0.005**

[1] Data collected through multistage sampling design (District level and then village level) with households clustered within villages, deviate from the standard assumptions. Hence, clustering (location dummy) is taken into account for the analysis, using robust standard errors (Carlson, 1998; Huber, 1967).

BOOK	2.051***	0.675	3.04	0.433***
CREDIT	1.453***	0.535	2.71	0.288***
TRAIN	1.112*	0.577	1.93	0.195**
POOR	-1.053**	0.528	-1.99	-0.184**
NLOCAT	2.273***	0.615	3.69	0.419***
Number of observations (n) = 120 (39 adopters and 81 non-adopters).				
Pseudo R^2 = 0.3368.				

Note: Statistical significance at the 0.01(***), 0.05(**) and 0.01(*) level of probability.
[a] Definitions for variables as Table 1.
[b] Marginal change in probability (dy/dx) evaluated at the sample means.
Source: Field survey, 2008, own calculations.

There are a number of variables which were found not to be significant. More in detail, AGE has been found to play no role in the adoption decision. There are other studies which have shown that age of the farmer can be related to adoption decisions. Polson & Spencer (1991) found that farmer's age and adoption of technologies were negatively related, while Hossain et al. (1992) revealed that the probability of adopting new farming practices increased with age among farmers in Bangladesh. Thus, the results in the literature are also ambiguous. GENDER and household size (HHSIZE) were found to be also insignificant. There is one study by Staal et al. (2002) showing that gender does play a role as male-headed households are more likely to have access to information and services and hence be innovators. The same authors also found that family size may be significant. Large family size implies that more labor is available for labor intensive activities (Staal et al., 2002). The adoption of technologies is considered as positive in reducing the labor constraints faced by farms. However, these results were not supported by our model.

5. Concluding Remarks

This paper provides insights into the production methods, marketing channels, and farmers' attitude towards technology upgrading in producing one of Nepal's fastest growing agricultural crops, namely coffee. In recent years, Nepalese coffee has grown to an important cash crop; however, the quality of the coffee is still under scrutiny. Considering that quality improves significantly with certain post-harvest process upgrading such as wet processing of the fresh coffee cherry, we have first assessed the cost benefit analysis of wet processing. It is obtained that the benefit cost ratio of wet processing is way above the break-even point of one and moreover the former is higher than the benefit-cost ratios of other forms of coffee such as fresh cherry and dry processing. In the second step, we have estimated a logistic regression model to identify the determining factors that lead farmers to adopt wet processing. The results from the regression model reveal that level of education, share of coffee income in total household income, book keeping on coffee activity, access to credit, training and location play a significant and positive role in farmers' decision to adopt wet process

upgrading of coffee at farm level. Also the variable 'poor' plays a significant and negative role in the adoption decision. Farming households below the poverty level have been found to be less likely in adopting technologies like wet processing. They are trapped in a poverty cycle as their poor quality coffee is less likely to fetch higher prices which would have been reflected in higher income which again would allow to invest in farming activities. These findings point towards developing both institutional support such as credit delivery to needy farmers and provision of training and extension programs and individual farm level farm management practices like book keeping. Of course, the latter is also a part of the training that farmers need to learn in order to be able to manage their own accounts.

In light of the above discussions, this study concludes that there is a need for strategic investment in both product and process upgrading of coffee in Nepal to improve production management. Moreover, increased research in the coffee sector and extension of institutional support are necessary to improve the livelihoods of the smallholder coffee producers in some rural parts of Nepal.

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