



Research Article

Constraints and Determinants of Coffee Processing Methods in Gulmi District, Nepal

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Abstract

Nepalese coffee is widely recognized as organic and specialty coffee due to its peculiar aroma and flavor. Altitude, geographical location, orchard management practices, post-harvest handling are the major factors that affect the coffee quality. Coffee quality is determined 40% in the field, 40% at post-harvest primary processing, and 20% at secondary processing. In Nepal, dry and wet methods are the most common coffee processing methods. Wet processed coffee is more preferred by the consumers in comparison to dry coffee and commands higher price. Main objective of the study was to know the most common processing method adopted in Gulmi district and to know the determinants and constraints of the processing method. 100 coffee growers from four different local bodies of Gulmi district were selected by the purposive sampling method for the household survey. Descriptive statistics, logit model and index score ranking method were used for the data analysis. Gender of household head ($p < 0.01$), education level ($p < 0.05$) and technical trainings ($p < 0.05$) were found to have significant effect upon the selection of processing methods. Due to several constraints all coffee growers were unable to adopt wet processing of coffee. Index score method was used to rank the constraints for adoption of wet processing methods. Lack of availability of hand pulpers was ranked as the major constraint by the coffee growers with an index score of 0.867 followed by unavailability of water, no access to transportation as other major constraints for adoption of wet processing method.

Introduction

Coffee which has a huge economic, social, spiritual and psychological impact (Teketay, 1999) is a highly valued plantation crop. Coffee is regarded as a noble tree. It has become a desired luxury of royalty and nobles thereby increasing its monetary value. Coffee is grown in around 70 countries of the world between 23°N latitude to 25°S latitude (Pinkert, 2004). Most of the coffee is consumed in USA, Europe and Japan. Brazil is the largest producer of coffee in the world. Its cultivation, processing, trading, transportation and marketing provide employment for

millions of people worldwide. Two species of coffee are popular, *Coffea arabica* and *Coffea canephora*, the former comprising 75% of world trade and the latter 25% (Pinkert, 2004). It is an important export commodity for Nepal. Coffee is a potential and emerging crop in context of Nepal. Coffee farming is one of the breakthroughs from traditional subsistence food crops to agro based industrial crop. Nepal doesn't have much longer history regarding coffee plantation. First time coffee was introduced in Nepal in the year 1995 BS by Hira Giri in Aapchaur, Gulmi. At present

coffee is cultivated in about 40 districts of central and western regions of Nepal years (MOAD, 2076). It has been growing commercially in about 23 districts of Hilly region. In 2017 the production of coffee in the world was 95.7 lakh ton and the demand were 97.7 lakh ton which shows there is still deficit of 2 lakh ton coffee in the world (NTCB, 2075). Brazil, Vietnam, Cambodia which have coffee as their major crop have productivity of 1000kg to 1400 kg per hectare. Nepal imported worth Rs 8,45,39,000 and exported 95 thousand kg worth Rs 5,04,05,000 (NTCB, 2075). According to NTCB (2073/74) coffee production in Nepal is 463 Mt ton Green Bean and the productivity of green bean is around 300 kg per hectare. Quality of coffee is determined by several factors among which the geographical location (Vaast *et al.*, 2005), management practices and post-harvest processing techniques are the prominent ones. Most of the coffee comes from small scale farmers in absence of quality standards and this has led to variation in coffee quality (Subedi, 2005). It is estimated that 40% of the quality of coffee is determined in the field, 40% at post-harvest primary processing, and 20% at secondary/export processing and handling including storage (Musebe, Agwanda, & Mekonen, 2007) . Nepalese coffee is distinguished in the international market for high quality and as an organic coffee. Dry and wet processing methods are the most common post-harvest processing methods being adopted. Postharvest processing methods are also considered to have impact upon coffee quality. Main objective of the study was to know the most common processing method adopted in Gulmi district and to know the determinants and constraints of the processing method. In order to maintain the quality, it is of utmost importance to adopt proper post-harvest processing methods at the farmer's level.

Materials and Methods

Research Area and Design

The research was conducted in Gulmi district also known as motherland for Nepalese coffee as coffee is not native to Nepal and was first time planted in Gulmi district in 1995 BS. Gulmi district is located at an altitude of 465masl to 2690 masl ranging from 27°55'N to 28°27'N latitude and 83°10'E to 83°35' E longitude. Malika rural municipality, Madane rural municipality, Isma rural municipality and Ruru rural municipality were selected for the study. Selection of site is due to active involvement of large number of farmers in coffee production in those areas. A total of 100 respondents, 25 from each local body of coffee producing households were surveyed and the sample was selected on the basis of purposive-random sampling (Fig.1).

Structured and pre-tested questionnaires were used for data collection. Coffee growers were personally interviewed to ensure accuracy and comprehension. Data was collected on a large number of variables, like age of the farmer, level of education, source of labor, land under coffee cultivation, resource endowment, technical trainings, water availability, access to market, crops grown, years of growing coffee, varieties grown, methods of coffee processing and constraints in coffee processing. Data was collected for the agricultural year 2020. Four focus group discussion (FGDs) and key informants' interview were also conducted.

Statistical Analysis

Data were analyzed by using IBM SPSS (Version-20.0), and MS-Excel 2013. The data collected were analyzed using descriptive statistics and regression analyses. Arithmetic means, percentages and frequencies were computed and compared. The analysis of the data primarily consisted of working out the averages for different variables to find out the difference.



Fig. 1: Location of study, Gulmi district, Nepal

A binary logistic regression model was used in the analysis to establish factors that influence choice of the coffee processing method.

The problems faced by the farmers were identified through FGDs and were ranked by using the index score method by using the formula,

$$I = \frac{\sum Sifi}{N}$$

Where,

I = Index Score ($0 < I < 1$)

S_i = score obtained

f_i = frequency

N = total number of the respondents

Results and Discussions

Coffee processing must begin immediately after the fruit is harvested, to prevent the pulp from fermenting and deteriorating. To obtain green beans, coffee fruits are subjected to two different types of postharvest processing namely Dry and Wet Processing Method, respectively. The choice of processing type depends upon the uniformity of fruit maturation, the local weather conditions at harvest time, and the availability of water at the production site (Achrya & Pun, 2016). The dry method involves sorting, cleaning and winnowing, sun-drying and mechanical drying of unpulped coffee.

The wet method involves pulp removal, then separation into mature and immature beans, followed by fermentation, washing and drying (Hicks, 2001). In general, Robusta and Arabica coffees grown in Brazil, Ethiopia, Haiti, Indonesia, and Paraguay are processed using the dry or natural method. This is the oldest, simplest, and cheapest method. First, the harvested berries are sorted and cleaned to separate the unripe, overripe, and damaged berries, and to remove dirt, soil, twigs, and leaves. During this process, the intact coffee fruits are dried in terraces or platforms of concrete, asphalt, or packed dirt. The fruits in the same maturity stage are placed on the threshing floor and remain there for about 15–20 days, depending on weather conditions to prevent them from being fermented. The fruits are raked daily so that they will dry evenly, and this process continues until they reach 11% and 12% humidity. Coffee that has been over dried will become brittle and produce too many broken beans during hulling (broken beans are considered to be defective beans). Coffee that has not been dried sufficiently will be too moist and prone to rapid deterioration caused by the attack of fungi and bacteria. This produces the so-called dry parchment, which are stored in burlap sacks until marketing.

In wet processing, firstly flotation or winnowing is used to physically separate defective berries on the basis of density and to remove twigs and stones. The beans are then separated from the skin and pulp by using a pulping

machine that squeezes the berries between fixed and moving surfaces. Wet processing gives rise to pulped, peeled, and demucilated coffees, depending on the processing procedure used. Countries such as Colombia, Kenya, countries in Central America and Hawaii perform this type of processing. The steps include selective harvesting of fruits at the maximum maturity stage (cherry), mechanical depulping (demucilation) and fermentation in tanks of water and subsequent drying.

De-pulped coffee beans are fermented for 24- 48 hrs during which the slimy layer of the berry is separated from its parchment-like covering, by natural enzymes. The coffee is then washed in quantities of water. Generally it requires about 100 L for 10 kg of coffee (Hicks, 2001). The disadvantage of wet processing is the high consumption of water used to pulp, ferment, and wash beans after fermentation.

After they are processed, the dried outer coverings of the bean and dried parchment layer are removed. This process is known as 'hulling' and is usually done just before the coffee beans are sold for exporting. Further processing includes blending, roasting and cooling. Roasted green beans will yield beverages that are softer, less viscous, and more acidic than natural (Ghosh & Venkatachalapathy, 2014).

After processing, the factors that affect the preservation of beverage quality are the physical storage conditions and the storage time (Subedi, 2005). Because the grains are stored for up to three years, they should be stored under constant temperature and relative humidity (RH) conditions to prevent the rehydration of the grain and postharvest reactions. The coffee bean embryos remain viable during processing but die after long periods of storage (usually after 6 months). After the death of the embryo, enzymes such as polyphenol oxidase and laccase can remain viable if the grain presents moisture above 20%; these would be inappropriate storage conditions and would allow the rehydration of the grains. The action of PPOs and laccase would cause the oxidation of phenolic compounds and decrease quality (Musebe *et al.*, 2007).

The analysis of survey showed that 85% of farmers practiced wet processing of coffee and 15% sun-drying of unpulped coffee. Coffee processed by wet method is preferred over dry method as dry cherry contains pulp and mucilage in contact with green beans for longer time period so that it needs sufficient drying period with more light intensity in order to reduce the moisture level. Wet process gives better aroma as compared to dry-processing. The preference for wet-processing of coffee was higher than sun-dried coffee.

Out of total household surveyed, 60% household head were male and the average education level of household head was up to primary level. Gender of household head and

education level had relations with the adoption of processing methods. Male household head with education level at least upto primary level were found to adopt wet processing method in comparison to sun dried coffee. As wet processing method is labor intensive and yields quality coffee, hence gender and education level had impacts upon the selection of processing methods.

Among 100 coffee growers interviewed, only 40% mentioned that they had hand pulpers. Rest 45% who practiced wet processing method pulped the ripe cherry in pulpers operated by the cooperatives. Respondents mentioned that due to economic factors, they were unable to have their hand pulpers on their own. However, being a member of cooperative, they didn't face problem in coffee processing. In this matter, cooperatives have been playing a great role in uniting people and assisting them in several technical and financial aspects. As per survey report 90% farmers were involved in co-operatives. The support from co-operatives is not only in coffee processing. Besides assisting farmers in mass pulping, co-operatives collect dry parchment from the farmers and thereby ensure market for coffee. Some coffee collected in the districts by the co-operatives undergo further processing within the districts and come in packed form whereas a large portion of dry parchment collected goes to Kathmandu and even to foreign countries.

Very few farmers, only 15% had shade house for drying the parchment. After pulping the parchments are left for 24 hours in water for removing the mucilage known as fermentation and then the beans are washed with water. The washed coffee beans are then dried in shade. A large number of coffee growers, 65% dried the coffee beans in raised platform in their home. Only 20% sun dried the coffee in the ground. It is not preferred to dry the coffee on ground as the smell of ground or soil affects the coffee quality (aroma and flavor). Hence coffee drying in shade house and raised platform is recommended for obtaining quality coffee.

Coffee processing requires technical knowledge for obtaining high quality coffee. Only 60% reported to have technical knowledge and had taken part in some coffee related trainings. Coffee pulping, shade drying and further processing requires technical knowledge. Farmers with no technical knowledge practiced dry method of coffee

processing. Coffee produced from dry method is not considered of higher quality.

Access to road transportation and market had also significant impact upon the selection of processing methods. Not every farmer has the hand pulpers. Ripe cherries harvested need to be pulped within 24-48 hrs. Those farmers with access to road transport and collection centers practiced wet processing of coffee. Dry method of coffee processing was practiced by farmers with very poor and no access to road and collection centers. As sun dried coffee are not damaged quickly and can be stored for long time, hence such farmers preferred sun dried coffee. They stored the parchment in their houses and at appropriate time when they had access, they sold. Average distance to nearby collection center was reported to be 2.4km.

Similarly, the availability of water sources is also one of the determining factors for the selection of coffee processing methods. Farmers with availability of water facilities practiced wet processing of coffee. 85% farmers reported to have water facilities through the lifting system as the local government had placed the availability of water source as the top priority in the district. Generally, hill districts face shortage of water. However, in case of Gulmi district, water shortage was not a major problem.

Though wet processing methods involved several processing steps and was costlier than dry processing methods, wet method yielded high quality coffee. Subedi (2011) also reported dry method of processing to be less costly than wet- processing method. The type of processing method adopted determines the quality of coffee. The metabolic changes are the factors that determine the sensorial differences between the coffee processed by the dry and wet- processing methods (Knopp, Bytof, & Selmar, 2006).

A binary logistic regression model was used in the analysis to establish factors that influence choice of the coffee processing method. The dependent variable, processing method, is a binary variable with 0 representing sun-dried processing and 1 representing washed coffee processing method. Age of the farmer, level of education, land under coffee cultivation, technical trainings, water availability, and access to market were the explanatory variables (Table 1).

Table 1: Binary logit regression of factors affecting the adoption of coffee processing methods

| Variable | Coeff. B | Std. error | Sig. | Exp (B) |
|--------------------------------------|----------|------------|--------|---------|
| Gender of household head | 1.321** | 0.121 | 0.002 | 3.747 |
| Education level | 1.12* | 0.232 | 0.043 | 3.064 |
| Availability of water resource | 2.32** | 0.038 | 0.001 | 10.177 |
| Distance to nearby collection center | 0.037 | 0.431 | 0.538 | 1.037 |
| Technical trainings obtained | 2.21* | 0.182 | 0.023 | 9.115 |
| Area under coffee | 0.32 | 0.023 | 0.272 | 1.377 |
| Constant | -2.108 | 1.027 | 0.0832 | 0.121 |

Note: * and ** indicate significance at probability levels of 0.05 and 0.01 respectively

No significant relationship was found between distance to nearby collection center and selection of processing methods. Similarly, area under coffee plantation also didn't have significant impact upon the choice of processing methods.

However, gender of household head, education level, availability of water resource and technical trainings were found to have significant impact upon the selection of processing methods. Household with male as head were 3.747 more likely to adopt wet processing method than with females. This can be related with rural societal structure of Nepalese community as male members are more involved in labor based works. Similarly, education level of household head also had significant impact upon the choice of processing methods. Household head with education level of at least primary level were 3.064 more likely to adopt wet processing method. Water is the most important prerequisite for adoption of wet processing method. Farmers with water availability were 10.176 times more likely to adopt wet processing method. Wet processing method is somehow complex process and requires some technical knowledge regarding fermentation, shade drying and hence yields better quality coffee. Wickramasinghe *et al.* (2001) also stated that the wet-processing method yields higher quality coffee than dry-processing method. It was found that technical trainings had significant impact upon selection of processing method. Musebe *et al.* (2007) also reported educational level, technical trainings, and distance to nearby washing stations to be the major determining factors for the selection of processing methods.

Constraints of Adoption of Wet-Processing Method of Coffee

There are several factors that govern the selection of processing methods of coffee. Although, wet processing method yields higher quality of coffee (Musebe *et al.*, 2007), however due to several constraints, every coffee growers were not adopting wet- processing method of coffee. Index score method was used to rank the constraints of adoption of wet-processing method of coffee (Table 2).

Table 2: Constraints on adoption of Wet-processing method of coffee

| S.N. | Constraints on adoption of wet-processing method | Index Score | Rank |
|------|--|-------------|------|
| 1. | Lack of availability of hand-pulpers and other machinery | 0.867 | I |
| 2. | No water availability | 0.734 | II |
| 3. | No easy access to transportation | 0.687 | III |
| 4. | More labor intensive | 0.354 | IV |
| 5. | Lack of technical know how about the method | 0.312 | V |

Lack of availability of hand-pulpers and other machinery equipment was the major constraint for the adoption of wet processing method with an index score of 0.867. Due to poor economic condition, all coffee growers are not able to purchase hand-pulpers on their own. Hence, they prefer to sundry the harvested coffee as it doesn't require any machines and is easier. Government and non-governmental organizations must focus on providing subsidies and financial aid to the farmers. Lack of water availability was ranked as the second major constraint for adoption of wet processing method with an index score of 0.734. Coffee are grown in hilly and slopy areas which face water shortage during dry periods. As wet processing requires, large amount of water either during density sorting, pulping or washing parchment after fermentation. In case of Gulmi, most of the areas had access to water sources from the lifting system managed by the local levels and hence the adopters of wet processing method were comparatively larger. Similarly, lack of easy access to transportation was ranked by the coffee growers as the third major constraint. Wet- processing method being a labor intensive method people didn't prefer it. Lack of technical know how about the method was ranked as the fifth major constraint on adoption of wet-processing method. Musebe *et al.* (2007)] also reported lack of coffee processing facilities, lack of technical know-how to be the major constraints for adoption of wet processing of coffee.

Conclusion

Coffee growers need to possess the knowledge on importance of coffee quality. As high-quality coffee fetches better price, this would encourage farmers to produce good quality coffee. Consumer preference for washed coffee is more than sun dried and commands higher price. Original aroma and flavor of coffee is affected by sun drying and drying on ground. Lack of machines, equipment and water were the major constraints for not adopting wet processing method. Government and other agencies need to provide financial assistance to the growers regarding purchase of machines and other materials required for wet processing. Besides, farmers need to be encouraged to carry out the works through co-operatives. This would reduce the economic burden on individual farmers and collectively they can manage different resources. Assistance need to be provided to farmers in purchasing hand-pulpers, providing water facilities and transportation facilities. As education level and technical trainings were found to have significant effect upon the adoption of wet processing method hence providing knowledge to farmers about proper handling of harvested coffee, maintaining coffee quality and the methods of processing is of utmost importance.

Authors' Contribution

Both authors contributed equally in all stages of research work and finalization of the manuscript.

Conflict of Interest

The authors declare that there is no Conflicts of Interest in the present publication.

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