Farm Efficiency and Its Determinants in Different Farm Size and Altitude Categories: A Case of Organic Coffee Cultivation in Nepal

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ABSTRACT. Coffee farmers typically operate without knowledge of their actual and potential economic efficiency. Understanding the technical relationships between inputs and outputs is the key to increasing the efficiency of production. This research estimated the level of Technical Efficiency (TE), and the key factors affecting farm level efficiency, of organic coffee cultivation in the hill region of Nepal. TE of 280 organic coffee farms was related to farm size and farm altitude categories. Increasing returns to scale was observed in 43.21% of organic farms suggesting that greater efficiency could be achieved through enlargement. The mean technical efficiencies of small, medium and large farms were 84.7%, 90.7%, and 90.6% respectively and in low, medium and high altitude locations were 89.6%, 86.1% and 91.9% respectively. Approximately 46%, 43% and 39% of the coffee farms in low, medium and high altitude areas were found to be technically efficient. Similarly, about 43%, 50% and 56% of small, medium and large coffee farms respectively were technically efficient. Tobit regression revealed that the variation in technical efficiency was related to education, farm experience and training/extension services. (Q12; Q01; Q15)

I. Introduction

Agriculture and Livestock contribute 38.8 % of Gross Domestic Product (GDP) and provides 65.6% employment in Nepal (MOAC, 2009). Despite the large contribution, the average landholding size is less than 1.0 ha. (CBS, 2010). It also serves as the major sources of raw materials to most of the agro-based industries. Among the agricultural commodities, horticultural crops play a significant role in the agricultural

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development and economic growth of the country. Horticulture contributes 14% of the total agriculture GDP (CBS, 2010). The country is transitioning into intensification, diversification, and commercialization of agriculture crops. To achieve this, the production programs should be market oriented. In order to achieve this the agricultural program seeks to raise AGDP growth from 2.9% to 4.9% at the end of the plan, 2025 (APP, 1995). In the present context of growing economic and trade liberalization, the Nepalese farmers, traders, and other marketing agencies need to be efficient and competitive. Appropriate environment, institutional arrangements and relevant support must be created and provided to promote their effective and sustainable participation to make farming and agribusiness competitive. Since the third periodic plan (1965-1970) government is more attentive to the area of agricultural marketing and price policy. All subsequent plans have continued this focus but the outcomes have not been as hoped. Various types of buying and selling arrangements between the producers and traders are occurring but which mode of transaction is beneficial to the farmers and other actors has not been well explored.

Coffee is one of the high value horticultural cash crops. Coffee has been popular among Nepalese farmers for the last few decades. Coffee cultivation has spread to over 39 districts in the middle hill region of Nepal (NTCDB, 2009). Coffee can be produced commercially in many parts of the country. However, there is great potential in the mid hills region for organic coffee production. This will increase the income of the rural farmers as well as other businesses involved in coffee processing and marketing (ITC, 2007). Coffee plantations cover productive area of 1400 ha with the involvement of more than 5000 farm families (MOAC, 2009).

The Government of Nepal has already given priority to coffee through its long term perspective (APP 1995/96). This crop is economically more (nearly three times) profitable compared to other cereal crops (Bajracharya, 2003). The climate and soil quality is adequately favorable to organic production of coffee in mid hills region of Nepal (Nepal, 2006). Farmers are accelerating the production via converting land to coffee. With the current trend of production and productivity, Nepal will produce about 3290 and 9870 mt dry coffee cherry in 2011 and 2015 AD respectively (Shrestha, 2003). The coffee cultivation area and production is being increased by 24.8% and 18.27% respectively. The growth rate of area and production of organic coffee are

19.39% and 13.39% respectively (MOAC, 2009).

The way to increase profits of small scale farms is to use available resources efficiently. Production economics explains optimization of resources and optimization leads to efficient production. Bravo-Ureta and Reiger (1991) explained that efficiency measurement is important because it leads to a substantial resource savings. Efficiency measurement can be estimated using nonparametric and parametric approaches. Data envelopment analysis (DEA) is a nonparametric method. The nonparametric approach does not impose any parametric restrictions on technology and there is no need for a functional form for production relationships and is thus considered more flexible to calculate efficiencies (Ray, 2004). This study will explain efficient production planning in different altitude ranges and different landholding sizes of coffee farms.

II. Study area, sampling, data and variables

This study is an extension of earlier research done by Poudel et al. (2015) which compared organic and conventional coffee farming in the hill region of Nepal. The current study makes efficiency comparisons for farms in three different altitudes and landholding size categories using more observations (n=280) than in the previous study, and focuses on organic farms only. Gulmi district is in the western mid-hill region of Nepal and the only certified organic Arabica coffee producing district in Nepal. In this district coffee is produced at altitudes above 800 meters. Since 1998, all farms in this region have been certified by NASAA[1]. Group certification of this sort requires that members all maintain internal control systems (ICS[2]). The information is collected from 280 households out of 391 households from 12 Village Development Committee (VDC[3]) of Gulmi district.

The VDCs selection was purposive to ensure the diversity in farm acreage and altitude range. Research envisaged understanding the economic differences in respect to variation in farm size and altitude. These selected VDCs are predominantly coffee producing and have similar topography, soil type and irrigation environments. The surveyed areas ranged between 800 to 1410 m above sea level. Organic farms were classified according to farm size and farm altitudes. A farm with planted coffee areas of less than 10 ropani (n=186), less than 20 ropani (n=62) and 20 ropani or greater (n=32) were classified as small, medium and large size farm respectively. Likewise, a farm located in 800-1000 meter (n=76), 1001-1200 meter (n=132) and 1201-1400 meter (n=72) or more were classified as low, medium and high altitude farm respectively.

TABLE 1. Variable definition and measurement

Variables	Unit	Defnitions (...for farm j)
Farm size (X_{1j})	Ropani*/farm	Area of the organic coffee farm
Labor (X_{2j})	Man days/farm	Total number of labor employed for coffee production
Fertilizer (X_{3j})**	Rs/farm†	Cost incurred for organic fertilizer in coffee production
Capital (X_{4j})	Rs/farm†	Pesticides, equipment and irrigation devices etc.
Output (Q_{1j})	Kg/farm	Quantity of green bean produced
Inter/shade crops (Q_{2j})	Rs/farm†	Value of intercrops and shade crops in coffee farm
Coffee tree (Q_{3j})	Number	Total number of fruit bearing coffee trees
Household size (Z_{1j})	No. of persons	Number of individuals in a family
Education (Z_{2j})	1,0	1 if the farm manager is literate, 0 otherwise
Sex (Z_{3j})	1,0	1 if the farm manager is male, 0 otherwise
Training/Extension (Z_{4j})	1,0	1 if the farm manager received training, 0 otherwise
Age (Z_{5j})	Year	Age of farm manager
Farm Experience (Z_{6j})	Year	Years of coffee cultivation
Labor cost (X_{5j})	Rs/person-day	Labor cost during production management

*One Ropani = 511.14291 m^2. **Farm Yard Manure (FYM), †As variables X_3, X_4, X_5, and Y_2 are expressed in value terms and measured in local currency unit. Rs, Rupees, a Nepalese currenty and Rs1 = $US (1/74).

Primary data were obtained through face-to-face interviews with pre-tested semi-structured questionnaires in January to May 2011 and February to April 2012. Besides, Rural Participatory Appraisal (PRA) tools such as Focus Group Discussion (FGD) and Key Informant Survey (KIS) were also deployed to assess and observe general understanding that were not captured in questionnaire. The secondary data were used from the publication of Ministry of Agriculture and Cooperative (MOAC). The detail of notations and definitions of variables used in the analysis are shown in Table 1.

III. Analytical Framework

To achieve productivity growth, either technological innovation or the more efficient use of available technologies or a combination of both is inevitable. Empirical evidence suggests that small farms are desirable not only because they reduce unemployment, but also because they provide a more equitable distribution of income as well as an effective demand structure for other sectors of the economy (Bravo-Ureta and Pinheiro, 1997). During the last few decades, major technological gains stemming from the green revolution have been effective across the developing world. This suggests that attention to productivity gains arising from a more efficient use of existing technology is justified. In developing countries, most new agricultural technologies have only been partially successful (Xu and Jeffrey, 1998). It will be more cost effective to motivate farmers in improving efficiency rather than grafting new technology if farmers are not efficiently using existing technology (Belbase and Grabowski, 1985). TE defined as the ability of a farm to either produce the maximum possible output from a given set of inputs and a given technology, or to yield the given level of output from the minimum possible quantity of inputs. Färe and Lovell (1978) defined technical efficiency as the "degree to which the actual output of production unit approaches its maximum". Färe et al. (1994) have proposed the input oriented DEA approach to illustrate TE via linear programming (LP) method. Farrell (1957) proposed this piece-wise-linear convex hull approach to frontier estimation. This paper used DEA in constant return to scale (CRS) model. Assuming that, the farm is assumed to have N inputs and M outputs for each of I farms. Inputs and output vectors of i^{th} firm then becomes N*I input matrix of **X** and M*I output matrix of **Q**. Ratio of output to overall inputs is estimated under DEA approach by assigning optimal weights by solving a mathematical programming problem. We followed Coelli et al. (2005) in formulating the solving equation and we used DEA Excel Solver 2.0 computer program. Here, u= M*I vector of output weights and v= N*I vector of input weights.

$$\begin{aligned} &\max_{u,v} && [\mathbf{u}'\mathbf{q}_i/\mathbf{v}'\mathbf{x}_i] \\ &\text{st} && [\mathbf{u}'\mathbf{q}_j/\mathbf{v}'\mathbf{x}_j] \leq 1, \quad j = 1,2, \ldots, I, \\ & && \mathbf{u}, \mathbf{v} \geq \mathbf{0} \end{aligned} \tag{1}$$

Equation (1) involves solving for u and v, such that the efficiency measures for the i^{th} firm is maximized subject to the constraints that efficiency value be less than or equal to 1. To overcome the problem of infinite number of solutions from this specific ratio formulation, we impose the constraint $\mathbf{v}'\mathbf{x}_i = 1$, then

$$\begin{aligned} &\max_{\mu,v} && [\boldsymbol{\mu}'\mathbf{q}_i] \\ &\text{st} && \mathbf{v}'\mathbf{x}_i = 1, \\ & && \boldsymbol{\mu}', \mathbf{q}_j - \mathbf{v}'\mathbf{x}_j \leq 0, \quad j = 1,2, \ldots \ldots, I, \\ & && \boldsymbol{\mu}, \mathbf{v} \geq \mathbf{0}, \end{aligned} \tag{2}$$

Where the change of notation from u and v to μ and V is used to stress that this is a different linear programming problem. The problem formulated in (2) is known as the multiplier form. Finally the derivation of an equivalent envelopment by introducing the duality in linear programming is:

$$\begin{aligned} & && \min_{\theta i \lambda}, \theta_i \\ &\text{st} && -\mathbf{q}_i + \mathbf{Q}\boldsymbol{\lambda} \geq \mathbf{0}, \\ & && \theta\mathbf{x}_i - \mathbf{X}\boldsymbol{\lambda} \geq \mathbf{0}, \\ & && \boldsymbol{\lambda} \geq \mathbf{0}, \end{aligned} \tag{3}$$

Where λ is a I*1 vector of constant, θ is a scalar and efficiency scores for the ith firm which satisfies: $\theta \leq 1$. Here θ is independent of input prices.

Charnes et al. (1994) and Färe et al. (1994) used this input oriented DEA model under CRS assumption to solve the overall technical efficiency. Farm specific factors responsible for technical inefficiency were measured through the second stage regression model. This sort of analysis was found in Dhungana (2010), Dhungana (2004), Wadud and

White (2000), Sharma et al. (1999), Wang et al. (1996) and, Hallam and Machado (1996). Early methodologies were based on deterministic models that attribute all deviations from the maximum production to efficiency; recent advances have made it possible to separately account for factors beyond and within the control of firms such that only the latter will cause inefficiency. The popular approach to measure the technical efficiency component is the use of frontier production function (Wadud and White, 2000 and Sharma et al., 1999). The present study employed the empirical model,

$$TE^* = \beta_0 + \beta_1 Z_{1j} + \beta_2 Z_{2j} + \beta_3 Z_{3j} + \beta_4 Z_{4j} + \beta_5 Z_{5j} + \beta_6 Z_{6j} + u_i \qquad (4)$$

$$\begin{cases} TE^* & \text{if } TE^* < 100 \\ 100 & \text{otherwise} \end{cases}$$

Where TE is efficiency index from DEA which was used as binary dependent variable. Z_1, Z_2, Z_3, Z_4, Z_5 and Z_6 were household size, education, sex, training/extension, age and farm experience respectively. β is a vector of unknown parameters, u_i is an independently and identically distributed normal random variables with zero means and common variances, σ^2 as; $u_i \sim$ iidN $(0, \sigma^2)$. It is noted that the dependent variable has a censored distribution (as TE lies between 0 and 100) and does not have normal distribution. Because OLS yields inconsistence estimates, we followed maximum likelihood approach to estimate the parameters of tobit regression model (equation 4) using SHAZAM 10.0 software.

IV. Results and Discussions

Inputs and outputs, and socio-demographic parameters were considered for empirical analysis. Summary descriptive statistics of socio-economic characteristics of the organic coffee production farms related to farm size and farm altitude are depicted in Table 2 and 3 respectively.

TABLE 2. Socio-economic characteristics of organic farms (Farm size category)

Variables	Small farm (n=186)		Medium farm (n=62)		Large farm (n=32)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Farm size (Rop.)	2.90	2.33	12.91	2.60	31.15	13.65
Production/Farm (kg)	39.88	55.05	38.67	85.34	37.09	56.94
Labor cost/Farm (Rs)	2049.19	1617.52	2251.61	2302.29	2406.25	1977.60
Fertilizer cost/Farm (Rs)	3614.89	4631.74	5401.93	10599.37	3460	4092.66
Marketing cost/Farm (Rs)	246.78	314.52	255.12	543.61	237.20	340.14
TVC/Farm (Rs)	6345.5	6435.31	8604.40	14076.08	6587.51	6580.94
GR/Farm (Rs)	9258.9	10014.57	9744.59	15469.66	11990.31	17971.55
GM/Farm (Rs)	2913.4*	6753.45	1140.19*	8986.75	5402.79*	12400.64
Age (yr)	45.32	9.77	47.64	11.07	45.62	10.35
Farm Experience (yr)	11.12***	2.96	9.08***	2.39	8.93***	2.15
Family size (No.)	4.65	1.29	4.58	1.36	4.68	1.30
Education (Lit. %)	94.08		95.16		93.75	
Training/Ext. (%)	77.96		56.45		40.62	

*and*** indicate means are significantly different in F-test at 10% and 1% respectively.
Source: Field survey 2011 and 2012, and author's calculation.

TABLE 3–Socio-economic characteristics of organic farms (Farm altitude category)

Variables	Low (n=76)		Medium (n=132)		High (n=72)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Farm size (Rop.)	9.94***	9.56	7.90***	10.44	7.41***	11.40
Production/Farm (kg)	23.47***	25.21	36.27***	65.35	61.62***	78.91
Labor cost/Farm (Rs)	1821.05***	1253.08	2013.63***	1849.52	2684.72***	2178.68
Fertilizer cost/Farm (Rs)	2979.34***	3846.19	3426.66***	7454.69	6106.38***	6127.83
Marketing cost/Farm (Rs)	152.18***	154.30	235.21***	403.92	371.25***	458.63
TVC/Farm (Rs)	5335.86***	5102.41	6177.64***	9924	9771.81***	8903.07
GR/Farm (Rs)	6569.21	4481.737	9385.83	13946.04	13507.29	14325.67
GM/Farm (Rs)	1233.34	4935.90	3208.18	8795.64	3735.47	9407.26
Age (yr)	47.36	10.32	45.27	10	45.63	10.24
Farm experience (yr)	9.36***	2.19	10.12***	2.60	12.08***	3.47
Family size (No.)	4.47	1.47	4.7	1.20	4.69	1.31
Education (Lit. %)	96.05		93.93		93.05	
Training/Ext. (%)	65.78		65.9		77.77	

*, ** and*** indicate means are significantly different in F-test at 10%, 5% and 1% respectively.
Source: Field survey 2011 and 2012, and author's calculation.

The first section of both tables describes farm economic characteristics and lower section socio-demographic information. Observations showed that variations in economic characteristics were more significant in altitude category than farm size category. Most means are significantly different in farm altitude categories at 1% in ANOVA. From Table 2, we observed that average production of organic coffee beans is higher in small farms consuming lower inputs than medium and large size farms in the study areas. The non-discounted benefit cost ratio (B/C ratio) was highest in large farms (1.84), followed by small farms (1.68) and medium farms (1.66) respectively. About 78% of the small growers were receiving training and extension facilities where as 56.45 and 40.62% of farmers received the same in medium and large size farm category.

From Table 3, we observed that average production of coffee is higher in high altitude farms along with higher levels of labor and organic fertilizer consumption than other altitude categories. Gross margin (GM) obtained from high altitude (9407.26) is higher than others and three times greater than low altitude farms.

A. TECHNICAL EFFICIENCY

Technical efficiency ranged from 0.185 to 1.00, 0.400 to 1.00 and 0.467 to 1.00 in low, medium and high altitude respectively (Table 4). Similarly, TE ranged from 0.406 to 1.00, 0.179 to 1.00 and 0.652 to 1.00 in small, medium and large farm size respectively (Table 5). When TE gets closer to one, the farm is considered more technically efficient. Mean technical efficiency in low, medium and high altitude were 84.7%, 90.7% and 90.6% respectively. From the TE distribution series, it would be possible to draw the inference; organic coffee can be increased by about 16%, 10% and 10% in low, medium and high altitude respectively.

About 10, 14 and 9% output could be augmented in small, medium and large farm size respectively if each producer was working on the production frontier. Around 46%, 43% and 39% of the coffee farms in low, medium and high altitude were found technically efficient (Table 4). Likewise, about 43%, 50% and 56% coffee farms were technically efficient in small, medium and large farm size respectively (Table 5).

TABLE 4–Distribution of technical efficiency in different farm size altitude categories in deciles range

Efficiency Level	Low altitude		Medium altitude		High altitude	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
≤0.50	4	5.27	2	1.51	1	1.39
0.51-0.60	4	5.27	1	0.76	1	1.39
0.61-0.70	7	9.21	4	3.03	2	2.78
0.71-0.80	15	19.73	17	12.88	9	12.5
0.81-0.90	8	10.52	33	25	18	25
0.91-1	38	50	75	56.82	41	56.94
Total	76	10	132	100	72	100
Mean	0.847		0.907		0.906	
Std. Dev.	0.183		0.118		0.111	
Minimum	0.185		0.400		0.467	

Source: Field survey 2011 and 2012, and author's calculation.

TABLE 5–Distribution of technical efficiency in different farm size categories in deciles range

Efficiency Level	Small Farm Size		Medium Farm Size		Large Farm Size	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
≤0.50	3	1.61	5	8.06	0	0
0.51-0.60	7	3.76	3	4.84	0	0
0.61-0.70	13	6.99	3	4.84	3	9.38
0.71-0.80	18	9.68	6	9.68	3	9.38
0.81-0.90	39	20.97	10	16.13	58	15.62
0.91-1	106	56.99	35	56.45	21	65.62
Total	186	100	62	100	32	100
Mean	0.896		0.861		0.919	
Std. Dev.	0.135		0.196		0.112	
Minimum	0.406		0.179		0.652	

Source: Field survey 2011 and 2012, and author's calculation.

The estimated mean technical efficiencies in small, medium and large farm sizes were 89.6%, 86.1% and 91.9% respectively. Large farms reached relatively higher technical efficiency even though there can be room for increasing total output by 8.1%. Organic coffee farms operating with more than 80% technical efficiency in low, medium and high altitude were 62.52%, 81.82% and 81.94% respectively (Table 4). While in small, medium and large farm size, the farms reaching the same level of technical efficiency were 77.96%, 72.58% and 81.24% respectively (Table 5). Regardless of category, the farms operating under CRS, DRS and IRS were 46.07%, 10.72% and 43.21% respectively (Table 6).

The average coffee output in the farms operating under CRS was higher than DRS and IRS. The matrix of farm size and altitude categories revealed that mean TE was higher for large farm size in high altitude, followed by large farm size in low altitude than other cross categories. Lower TE was recorded for medium farm size in low altitude.

TABLE 6–Summary of returns to scale results (n=280) in organic cultivation of coffee.

Characteristics	No. farms	Coffee output (kg/farm)		
		Mean	Min	Max
CRS	129 (46.07)	19.35	0.2	140
DRS	30 (10.72)	15.55	0.83	49.33
IRS	121 (43.21)	10.521	0.1	80

Source: Field survey 2011 and 2012, and author's calculation

B. FARM SPECIFIC FACTORS RELATED TO FARM INEFFICIENCY

The maximum likelihood estimation of determinants of technical efficiency of organic farmers for farm size and farm altitude categories are presented in Tables 7 and 8 respectively. Most of the factors were not significant in small farm size category except gender in farm managerial decision. The coefficients of education, training and age were positive. The factor education is significant in medium size farm while other factors such as training/extension, age and farm experience were significant at 0.1 and 0.05 respectively in large size coffee farms.

Education, training and farming experiences in agricultural enterprises were significant and followed the findings of Dhungana (2010), Inoni (2006) and Dhungana (2004). Farm experience was not significant in small farm size, and low and medium altitude, but had negative sign. This indicates that farmers with more years of experiences do not necessarily place value on producing more output. Insignificant and negative coefficient of age variable in small and medium farm size and in low and high altitude indicated that younger farmers tend to be more productive than aged one. This is consistent with the findings of Llewelyn and Williams (1996), Ajibefun et al. (1996), Seyoum et al. (1998) and Coelli and Battese (1996). Education was significant in medium farm size and high altitude at 1% level of significance. The coefficient of education was positive in all categories except in the medium altitude. This suggests that educated people are more likely to be efficient in applying technical knowhow on crop management and post-harvest management. These sorts of results were discovered in Idiong (2007), Dhungana (2004) and Binam et al. (2004). Similar results were also reported by Moock (1976), Stefanou and Saxena (1988), Ali and Flinn (1989), Parikh et al. (1995), Battese et al. (1996), Wang et al. (1996) and Llewelyn and Williams (1996). In the long run, increasing private and public investment in education might lead to better performance in the agricultural sector (Dhungana, 2004).

Educated farm manager are more efficient than their counterparts, perhaps as a result of their keen interest coupled with better skill to access information and thereby production planning. Similar results were also reported by Minh (2009) and Wang et al. (1996). But Umoh (2006) reported that education does not contribute to farm efficiency in studying urban farming in Nigeria. The estimated coefficient of training/extension facilities was not significant except for large farm size. Coefficient of farm experience were of mixed result such that significant at 1% in medium and large farm size but unexpected sign (negative) in small farm size and low altitude. However, the farm experience in medium and high altitude was positive. These mixed results infer that being an experienced farmer is not enough to reach a farm to attain higher level of efficiency unless a farm manager rearranges the basket of inputs with a given technology.

TABLE 7–Tobit regression analysis

Independent variables (Z_{ij})	Small farm size		Medium farm size		Large farm size	
	β coeff.	t-ratio	β coeff.	t-ratio	β coeff.	t-ratio
Constant	-1.144	-1.948	-0.552	-0.626	-2.964	-2.747
HH size (Z_{1j})	-0.039	-0.572	-0.120	-1.200	0.012	0.088
Education (Z_{2j})	0.147	0.550	0.793	1.402*	0.620	1.054
Sex (Z_{3j})	0.706	2.867*	0.41	0.266	-0.326	-0.554
Training/Extension (Z_{4j})	0.179	0.933	0.115	0.495	0.535	1.792*
Age (Z_{5j})	0.008	0.927	-0.009	-0.760	0.034	2.049**
Farm Experience (Z_{6j})	-0.002	-0.072	0.079	1.404*	0.123	1.524*
Variance of the estimate $(\hat{\sigma}^2)$	1.095		0.810		0.610	
Standard error of the estimate $(\hat{\sigma})$	1.046		0.900		0.781	
Log likelihood function	-184.799		-61.404		-29.847	

***Significant at 1%, ** Significant at 5% and * Significant at 10% level of significance.
Source: Field survey 2011 and 2012, and author's calculation.

TABLE 8–Tobit regression analysis

Independent variables (Z_{ij})	Low altitude		Medium altitude		High altitude	
	β coeff.	t-ratio	β coeff.	t-ratio	β coeff.	t-ratio
Constant	0.237	0.260	-2.424	-3.354	-0.078	-0.061
HH size (Z_{1j})	0.476	0.540	0.121	1.317	0.012	-0.937
Education (Z_{2j})	0.311	0.657	-0.092	-0.300	1.391	1.668*
Sex (Z_{3j})	0.613	1.454*	0.745	2.722***	-0.402	-0.585
Training/Extension (Z_{4j})	0.080	0.331	0.194	0.973	0.129	0.321
Age (Z_{5j})	-0.009	-0.719	0.022	2.054**	-0.014	-0.745
Farm Experience (Z_{6j})	-0.044	-0.617	0.009	0.217	0.023	0.407
Variance of the estimate $(\hat{\sigma}^2)$	0.918		1.110		1.040	
Standard error of the estimate $(\hat{\sigma})$	0.958		1.054		1.019	
Log likelihood function	-74.758		-131.706		-47.707	

***Significant at 1%, ** Significant at 5% and * Significant at 10% level of significance.
Source: Field survey 2011 and 2012, and author's calculation.

V. Conclusion

This study estimates the technical efficiency using DEA approach of organic coffee farms of Gulmi district. It also compares the technical efficiency among different altitudes and different landholding sizes. Results indicated lower technical efficiency on lower altitude and medium farm size. Higher technical efficiency was on higher altitude and large farm size. Overall, 46.07 % of sampled farms were operating under constant return to scale (technically efficient) with mean coffee output of 19.35kg/farm. Tobit regression model produced mixed results in different categories. Most of the factors were not significant in small farm size category except sex. Farmer's sex is significant at 1% in small farm size, low altitude and medium altitude. Education was significant in medium farm size and high altitude at 1% level of significance. The coefficient of education was positive in all categories except in the medium altitude. It could be concluded that educated people are more likely to adopt technical knowhow on farming system management. These results are consistent with other studies such as Mesike et al. (2009) and Dhungana et al. (2010). Since this study specifically identified efficient and inefficient coffee farms, inefficient farms can learn from efficient farms to improve their efficiency in coffee production. Even efficient farms can learn further from their current combination of farms inputs to improve efficiency in the future.

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Endnotes

1. The National Association for Sustainable Agriculture, Australia (NASAA), founded in 1986, supports industry and consumers on organic, biodynamic and sustainable agricultural practices. It works to develop and maintain organic standards; assist operators in gaining organic certification; and conducting ongoing compliance supervision (NASAA 2015).
2. Internal controls systems (ICS) represent standardized rules for operating organic smallholder farms. International Federation of Organic Agriculture Movements (IFOAM) has developed this short summary of the requirements. The rationale for an ICS is to bring down the cost of organic certification to small holders by establishing a group that can do much of the monitoring itself. Certifiers monitor whether the group processes and data collection are working well, and to check a small number (sample) of the farms. After carefully setting up the group and its rules, the regulations can be simplified to such an extent that even illiterate farmers are clear on the rules they must follow, and the data that must be kept, and by whom (IFOAM 2015).
3. VDC is the smallest geopolitical boundary in Nepal