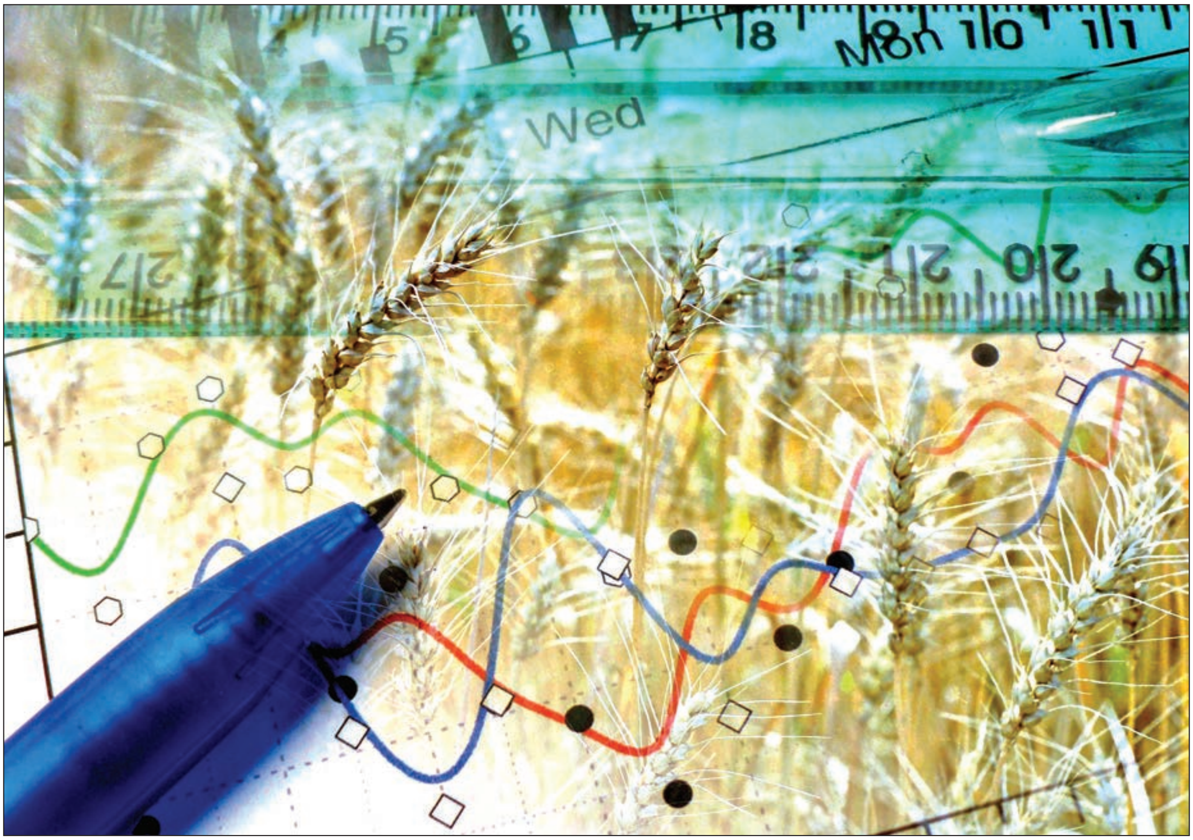

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Comparing the Technical Efficiency of Rice Farms in Urban and Rural Areas: A Case Study from Nepal

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ABSTRACT
This study focuses on comparing the technical efficiency of rice farms in two locations with different level of urbanization. A production function using maximum likelihood method is estimated and efficiency score of individual household is calculated using stochastic frontier analysis. The efficiency scores are regressed on variables including farm-household characteristics and degree of output market commercialization. The empirical evidence suggests that the elasticity of production to land size and biological inputs like chemical fertilizer, pesticide, fungicide and seed is positive and statistically significant. The average efficiency scores in two sample districts indicate that the production can be increased by 26-33% through improving efficiency in a given technological condition. The result suggests that the degree of commercialization has positive effect on technical efficiency. Furthermore, household characteristics like education, age, share of agriculture in total household income, sharecropping also have a significant effect on technical efficiency.

Key words: Technical efficiency, production function, household characteristics, commercialization

INTRODUCTION
In the past, the role of agriculture in economic development has been recognized by many authors (Johnston and Mellor, 1961; Hayami and Ruttan, 1985). In this regard, the adoption of new technology has received more attention in developing countries. However, agricultural growth is not only determined by the level of technology but also by the level of efficiency that is associated with the utilization of given technology. The potential contribution of efficiency to the overall output growth has yielded a number of past studies on production efficiency (Bravo-Ureta and Pinheiro, 1993). Several hypotheses were tested to analyze the low production efficiency in developing countries. One of the celebrated hypotheses proposed by Schultz (1964) says that the poor farmers in developing countries are efficient under the circumstances they operate the farming business. This hypothesis had a strong influence in shaping the agricultural development policy in developing countries. Policy makers overlooked the inexpensive way of increasing agricultural production through increasing efficiency and focused only on the expensive option such as investment on new technology. The poor but efficient hypothesis assumes that the external conditions are steady and farmers are in a continuous equilibrium. In reality, farmers find themselves in disequilibrium because of continuously generated new technology and variation in input and output prices (Ali and Chaudhary, 1990). Farmers' cope-up strategy to these disequilibria differs with each other that may result into different levels of efficiency. Thus, against Schultz's

hypothesis, many past studies proposed that farmers in developing countries failed to exploit the existing technology no matter whether it's traditional or modern. For example, the study by Ali and Flinn (1989) concluded that the profit of rice farmers in Pakistan's Punjab could be increased by 28% through enhancing efficiency in the existing state of technology. Similarly, many other studies carried out in developing countries found similar results (Jamison and Moock, 1984; Squires and Tabor, 1991; Tadessea and Krishnamoorthy, 1997; Dhungana *et al.*, 2004; Idiong, 2007; Rahman *et al.*, 2008; Rahman, 2010). Thus, the technological advancement may not bring the expected impact if inefficiency is pervasive in farming business.

In general, past studies have explained the difference in technical efficiency mainly by socio-economic characteristics of farm households. For example, Rahman (2010) concluded that infrastructure, soil fertility, experience, extension service, tenancy and share of non-agricultural income were the main factors to affect the efficiency of rice farms in Bangladesh. Similarly, Brazdik (2006) found a rapid land fragmentation as the important factor affecting the technical efficiency of rice farms in West Java, Indonesia during the Green Revolution. The literature abounds on such studies. However, past studies have paid a little attention to the level of commercialization and its effect on technical efficiency. Under a given set of socio-economic characteristics, production decisions may vary if the level of commercialization varies. If farming is more commercially oriented, farm decisions tend to be affected by market phenomena. If it is for family consumption, farm decisions are mainly motivated to maintain household's food security. Due to difference in farm decisions under subsistence and commercial farming, the effect of farm characteristics on efficiency will be different. Market demand hypothesis advocates that commercialization leads higher level of productivity through its strong backward-linkage effect while alternatively, Boserup's hypothesis advocates that in a subsistence farming, the pressure due to population growth tends to make a farm more efficient as there is a need to produce more for growing population (Boserup, 1981). Thus, the incentive for being more productive differs according to the objective of farming. Our interest was to compare and analyze the technical efficiencies and investigate the behavior of farm characteristics under these two different scenarios. We assumed that the incentives for being more efficient would be higher as the level of commercialization increases and thus, the capitalization of existing technology would be relatively higher in a commercial farm.

The study was carried out in Nepal. Nepal, a small landlocked country in South Asia, has the most agriculturally dominant economy in the region. Agriculture accounts 37% of GDP and the sector absorbs more than 65% of labor force (The World Bank, 2010). Farming is mainly carried out in rural environment. However, most of the development efforts have been focused in urban areas. Generally, high-hill and mid-hill areas have less physical infrastructure and poor market access while, terai, plain areas of Nepal, is relatively more benefited with physical infrastructures and market access. This has provided different economic opportunities to the farmers residing in different geographic regions. Economic opportunity, defined by external market access, always interacts with the ability of farm household to harness the economic opportunity, defined by farm household characteristics. This affects various aspects of farming business like technology use, input intensification and technical efficiency. In this study focus is only given to the analysis of technical efficiency and factors affecting it considering the level of commercialization and household characteristics.

THEORETICAL DISCUSSION

Technical efficiency: Technical efficiency refers to a firm's ability to achieve maximum output from a given bundle of inputs. Battese and Coelli (1995) defined the technical efficiency of a given firm (at a given time period) as the ratio of its mean production (conditional on its levels of factor inputs and firm effects) to the corresponding mean production if the firm utilized inputs most efficiently. In microeconomic theory of firm, production efficiency is decomposed into technical and allocative efficiencies. Farrell (1957) distinguished technical and allocative efficiencies through frontier production function. Production is technically efficient, if production occurs on the boundary of a production possibility curve and is allocatively efficient if production occur in a region of production possibilities set that satisfies the producer's behavioral objective. Thus, economic efficiency is the product of technical and allocative efficiency. An economically efficient input-output combination would be on the frontier function as well as on the expansion path. Efficiency analysis depends on certain assumptions to be made about the behavior of firm. The behavior of production entity can be described either by production function, cost function, profit function, or demand and supply functions. A producer always tries to either maximize profit or minimize cost. There are different alternative economic theories of peasant household behavior, which assume that peasant households maximize one or more household objectives (Mendola, 2007). In this study, we analyzed the behavior of producer in terms of production function.

Technical efficiency and the level of commercialization: In developing countries, agricultural farms are very heterogeneous. Some are commercialized but many are subsistence. Output market commercialization is related with various marketing decisions like where to sell, what to sell, how much to sell and the level of price of products. Commercialization of farms is mainly affected by the volume of production, family demand and market access. Market opportunity is the external factor to the farm household while family food demand and production volume are internal factors to the farm household. These internal and external factors interact to define the level of commercialization. Once farm households integrate into the mainstream of commercialization process, it affects various production decisions. Figure 1 presents the way farm household characteristics affect production decisions.

In a commercial farming, farm decisions are based on market signals while in a subsistence farming, decisions are based on the institutional arrangements that act as a surrogate for what market do not provide (Binswanger and McIntire, 1987; Rosenzweig, 1988). Due to imperfect

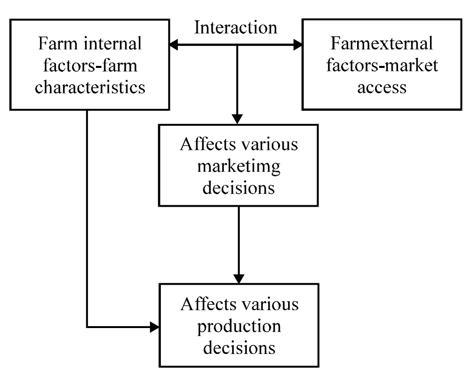

Fig. 1: Production and marketing decisions

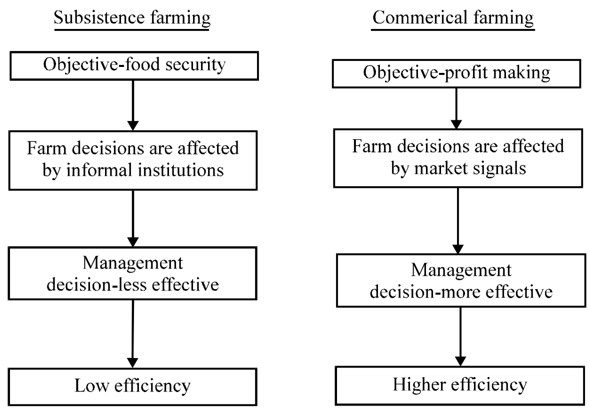

Fig. 2: Causal link between efficiency and the objective of farming

information in the subsistence farming, the informal institutional arrangements have high efficiency costs (De Janvry *et al.*, 1991). Figure 2 presents the reason for difference in efficiency in commercial and subsistence farming. In commercial farming, due to competition in the market, farmers' decisions tend to be more effective to utilize the given technology to its maximum extent. However, in subsistence farming, the objective of farm household is to maintain food security rather than profit making. Thus, production decisions tend to be based on the local informal institutions. Such a system lacks competitive environment and increases inefficiency in production. This means, same household characteristics in two different locations may have different kinds of impact on efficiency if the level of commercialization varies substantially.

MATERIALS AND METHODS

Study area, sampling and data collection: The study area comprises Dhading and Chitwan districts of Nepal. Both districts are bordered and located near to the capital city. Chitwan district is located at the center of Nepal and is one of the most potential districts in terms of agricultural production. Dhading district is located at the middle of Kathmandu (capital of Nepal) and Chitwan. Chitwan is more urbanized and has better infrastructure compare to Dhading. Production zones in Dhading district are farther from the main urban centers. Apart from this, many production zones at the northern part of the district have poor rural infrastructure. In contrast to this, all production zones of Chitwan are well connected with the motorable road and located near to the urban centers.

The information for this study was obtained through a household survey conducted in the selected Village Development Committee (VDC) from December, 2009 to January, 2010. A Village Development Committee (VDC) represents the lowest administrative unit of the government. Five VDCs from each district are selected for the study. Each VDC is divided into nine small wards. Due to resource and time constraints, only two wards from each VDC were selected purposively. Households within the wards were selected on the basis of random sampling. However, the sample size from each selected ward was drawn so as to make sample size proportional to the population size of the wards. The total household covered in this study was 120, 60 from Dhading and 60 from Chitwan. A structured questionnaire was administered at farmers' level after pre-testing and the detailed information on farm socio-economics, cropping pattern, cost of cultivation, marketed volume, consumption volume, gross income, market distance and linkage to input and output service providers was collected.

Table 1: Descriptive statistics of the input and output for the sample farms

District	Description	Unit	Mean	Standard deviation	Min.	Max.
Chitwan	Land	Katha	16.18	9.10	2	45
	Seed	Rs/farm	1550.40	1254.13	180	7750
	Labor	Rs/farm	17017.55	111741.01	1900	61000
	Fertilizer	Rs/farm	2505.05	1574.84	303	7800
	Pesticide and fungicide	Rs/farm	479.91	484.71	0	2100
	Livestock	no/farm	3.26	2.45	0.1	16.8
	Productivity	kg ha^{-1}	139.66	38.03	65	214.28
Dhading	Land	Katha	10.06	6.44	1.5	37.56
	Seed	Rs/farm	667.91	460.61	100	2500
	Labor	Rs/farm	14111.33	13111.31	600	81250
	Fertilizer	Rs/farm	1425.98	1111.76	0	4500
	Pesticide and fungicide	Rs/farm	156.75	259.11	0	1300
	Livestock	no/farm	4.3	2.03	1.67	12.51
	Productivity	kg ha^{-1}	108.39	44.89	31.94	228.13

Table 1 presents the descriptive statistics of inputs and output of the sample farms studied. The quantity of variable inputs use is converted into its value terms. The average land size of farms in Chitwan was 16.18 katha while it was 10.06 katha in Dhading. Thus, the farm size in Chitwan district was almost 1.6 times of the farm size in Dhading district. The investment on seed, fertilizer and pesticide/fungicide was 2.32, 1.75 and 3.06 times higher respectively in Chitwan compare to the rice farms in Dhading. This shows that the intensity of modern input use is higher in Chitwan. The use of livestock and labor in Chitwan was 0.75 and 1.2 times higher than that of Dhading district, respectively which is lower than the proportion by which the farm size in Chitwan is higher than that of Dhading. This indicates that conventional input use is higher in Dhading. Input prices were similar in both districts. As Dhading and Chitwan districts are bordered districts and are not far away from the capital, the local input suppliers working at production pockets have same channels for purchasing and selling inputs and farm products. Apart from this, government funded input-corporation and farmers' cooperatives play a substantial role to stabilize the input price.

Measurement of efficiency and degree of commercialization: In this study, Stochastic Frontier Analysis (SFA) method was used to calculate the production efficiency. Aigner *et al.* (1977) and Meeusen and van den Broeck (1977) independently proposed the stochastic frontier production function of the form:

$$\ln q_i = x_i\boldsymbol{\beta} + v_i - u_i \tag{1}$$

where, q_i represents the output of the I-th firm; x_i is a K×1 vector containing the logarithms of inputs; $\boldsymbol{\beta}$ is a vector of unknown parameters; v_i represents a symmetric random error (noise effect) and u_i is an asymmetric non-negative random variable associated with technical inefficiency.

$$q_i = \exp\,(\boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 \ln x_i + v_i - u_i) \tag{2}$$

$$q_i = \underbrace{\exp(\beta_0 + \beta_1 \ln x_i)}_{\text{Dertermin stic component}} \times \underbrace{\exp(v_i)}_{\text{Noise}} \times \underbrace{\exp(-u_i)}_{\text{Inefficiency}} \tag{3}$$

Frontier outputs tend to be evenly distributed above and below the deterministic part of the frontier. However, observed outputs tend to lie below the deterministic part of the frontier. They can only lie above the deterministic part of the frontier when the noise effect is positive and larger than the inefficiency effect ($q_i > \exp(\beta_0+\beta_1 \ln x_i)$ iff $\epsilon i \equiv v_i - u_i > 0$). The most common output-oriented measure of technical efficiency is the ratio of observed output to the corresponding stochastic frontier output:

$$TE_i = \frac{q_i}{\exp(x_i\beta + v_i)} = \frac{\exp(x_i\beta + v_i - u_i)}{\exp(x_i\beta + v_i)} = \exp(-u_i) \tag{4}$$

This measure of technical efficiency takes a value between zero and one. It measures the output of the ith firm relative to the output that could be produced by a fully-efficiency farm using the same input vector. Thus, to estimate the technical efficiency, first, we estimated stochastic production function. v_i is assumed to be distributed independently of each u_i and both errors are supposed to be uncorrelated with the explanatory variables in x_i. The noise component v_i is assumed to have zero mean and constant variance as assumed in the classical linear regression model while the inefficiency component (u_i) is assumed to have similar properties except it has a non zero mean. Under these assumptions, OLS estimator of the intercept coefficient is biased downwards. Thus, assumptions are made about the distribution of error terms. Aigner *et al.* (1977) obtained ML estimates under the assumptions:

$$v_i \sim iidN(0, \sigma_v^2) \tag{5}$$

$$u_i \sim iidN^+(0, \sigma_u^2) \tag{6}$$

The v_is are independently and identically distributed normal random variables with zero means and variance σ_v^2. The u_is are independently and identically distributed half-normal random variables with scale parameter σ_u^2. That is, the probability density function (pdf) of each u_i is a truncated version of a normal random variable having zero mean and variance σ_u^2. This study followed the same distributional assumptions as proposed by Aigner *et al.* (1977). The log-likelihood function for the half-normal model in terms of $\sigma^{2♣}$ and $\lambda^{2♦}$ and is given by Eq. 7. If $\lambda = 0$ there are no technical inefficiency effects and all deviations from the frontier are due to noise.

$$\ln L(y|\beta,\alpha,\lambda) = -\frac{1}{2}\ln\left(\frac{\pi\sigma^2}{2}\right) + \sum_{i=1}^{I}\ln\Phi\left(-\frac{\varepsilon i\lambda}{\sigma}\right) - \frac{1}{2\sigma^2}\sum_{i=1}^{I}\varepsilon_i^2 \tag{7}$$

where, y is a vector of log-outputs; $\varepsilon_i = v_i - u_i = \ln q_i - x_i\beta$ is a composite error term and Φ (x) is the cumulative distribution function (cdf) of the standard normal random variable evaluated at x.

Another important variable considered in this study was the household commercialization index. It was measured by following indexing method.

$$HCI = (Y_s/Y_p)*100 \tag{8}$$

♣$\sigma^2 = \sigma^2_v + \sigma^2_u$, ♦$\lambda^2 = \sigma^2_u/\sigma^2_v \geq 0$

where, HCI = Household commercialization index, Y_s = Total sales of a crop per year and Y_p = Total production of the crop per year.

This index measures the extent to which the crop production is commercialized. A value of zero would indicate a totally subsistence-oriented household; the closer the index is to 100, the higher the degree of commercialization.

Empirical model: Many studies used a second stage regression method to determine the farm specific attributes in explaining inefficiency (Kalirajan, 1991; Sharma *et al.*, 1999; Shafiq and Rehman, 2000). However, Battese *et al.* (1996) and Battese and Coelli (1995) incorporated farm specific attributes in the efficiency model directly. This study followed the first approach. Many past studies used Data Envelopment Analysis method (DEA) to calculate the efficiency score and used the Tobit regression to analyze the factor affecting efficiency due to score bounded at lower and upper level. In this study, almost all technical efficiency scores calculated were above zero and below 100, so we avoided the use of Tobit regression and just stuck to the ordinary least square technique. Following was the model used in the study. Seven types of explanatory variables were considered in the study. Farm household characteristics like education, share of agricultural income, cropping intensity, age of household head, land tenancy system and degree of commercialization were considered. Age of household head represents a proxy variable to the farming experience of household head. Education is measured by the years of schooling; share of agricultural income to the total household income is measured by the percentage share of agricultural income to the total household income, cropping intensity is measured by the ratio of total area of cropped land in a year to the total land area; land tenancy is measured by the total land area under share cropping; degree of commercialization is measured as mentioned in Eq. 8. Variables like degree of commercialization, education, age, cropping intensity, agricultural income were expected to have a positive impact on technical efficiency while share cropping was expected to have negative impact on efficiency.

$$E = \beta_0+\beta_1 E_d+\beta_2 E_m+\beta_3 I_n+\beta_4 R_{mf}+\beta_5 C_i+\beta_6 A_{hh}+\beta_7 S_c+\beta_8 \text{HCI}+e \quad (9)$$

where, E = observed efficiency, E_d = Education of household head, E_m = maximum education of household members, I_n = share of agricultural income in total household income, C_i = cropping intensity, A_{hh} = Age of household head, S_c = area under sharecropping and HCI = commercialization index.

In Eq. 9, the level of efficiency and the level of commercialization could be simultaneously determined variables (endogenous variables). In such condition, the least-squares estimators would not only be biased but also be inconsistent. In such case the estimators do not converge to their true (population) values as sample size increases indefinitely (Gujarati, 2004). Hausman specification test was carried out to see whether efficiency and degree commercialization are endogenous to the model. At 10% level of significance, these two variables appeared to be endogenous to the model. Thus, instrumental variables were used to represent the degree commercialization to avoid the endogeneity bias. Market distance and per capita rice production were used as instrumental variables. As two instrumental variables were used, equation 9 was over identified. Thus, we used the two-stage regression instead of indirect least square regression.

RESULTS AND DISCUSSION

Production function: Cobb Douglas production function was estimated using the maximum likelihood method (MLE). Table 2 presents the result of MLE estimates for Chitwan, Dhading and combination of both. The result showed that rice production was comparatively more responsive to land size in all three cases. Land is a scarce resource in Nepal. Around 18% of land is arable. Due to population pressure on limited land, land fragmentation has been a common trend in Nepal that has caused a smaller per capita cultivable land. Thus, the marginal productivity of land is quite higher in Nepal. The production response to the investment on the modern inputs (chemical fertilizer, pesticide, fungicide) was also positive and statistically significant in all three cases. The response was found higher in Chitwan compare to Dhading. The elasticity of production to improved seed was also positive and statistically significant in all cases. The impact of labor and livestock was statistically not significant in case of cross-district and Dhading while, the impact of livestock was positive and statistically significant in case of Chitwan. Nepal is a labor surplus country. More than 70% labor force is engaged in agriculture. Thus, the disguised unemployment is quite higher in Nepal. This could be the reason for insignificant to negative response of labor on production. Similarly, Nepal has got very high livestock density per unit land compare to other south and Southeast Asian countries, thus, its impact was also very low on production. So, in conclusion, the investment on the fixed capital like land and variable capital like fertilizer, pesticide, fungicide and improved seed have a greater impact on increasing the production.

Land productivity and technical efficiency: A comparison of average rice productivity in two districts is presented in Fig. 3. Average rice productivity in Chitwan was 140 kg ha^{-1} while it was 108 kg ha^{-1} in Dhading. The difference in land productivity in two districts could be due to various factors like technology, production efficiency, input intensification and other external factors. As this study was focused on analyzing the difference in technical efficiency in two districts, we estimated the technical efficiency with respect to respective district frontier and cross-district frontier. Cross-district frontier technology represents the frontier that is either similar to or superior to district frontier. The result is presented in Fig. 4. The average efficiency score of Dhading with respect to district frontier was slightly higher (just 3 percent) than that of the efficiency with respect to cross-district frontier while there was no difference in two efficiency scores with respect to district and cross-district frontiers in case of Chitwan. This indicates that Chitwan district is slightly superior in terms of rice technology use. Rice is considered as a major staple crop in Nepal and grown every parts of the country except mountain area. The government role in promoting technology is substantial. Thus, the level of technology to a particular location is highly influenced

Table 2: Maximum likelihood estimates

Variables	Cross districts	Chitwan	Dhading
Land	0.61***	0.68***	0.53***
Chemicals (fertilizer, pesticide and fungicide)	0.22***	0.34***	0.16***
Seed	0.18***	0.07***	0.19***
Livestock	-0.008	0.02***	0.04
Labor	-0.11	-0.11***	-0.13
Const.	4.27	3.88	4.81
$Sigma^2$	0.28	0.16	0.36
Lambda	5.02	1.26e+08	4.32

***Indicate significant at 1% level of significance

Table 3: Frequency distribution of farm-specific technical efficiency in two districts

Technical efficiency (%)	Chitwan (n = 60)	Dhading (n = 60)
<30	0	4
30-40	0	4
40-50	3	5
50-60	6	10
60-70	15	12
70-80	12	11
80-90	14	10
90-100	10	4
Average	74	67

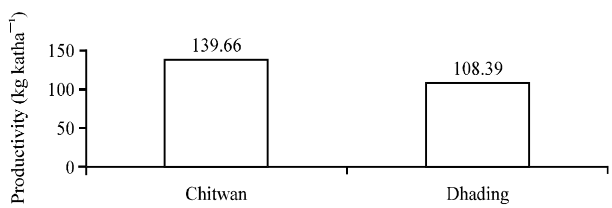

Fig. 3: Average rice productivity in chitwan and dhading

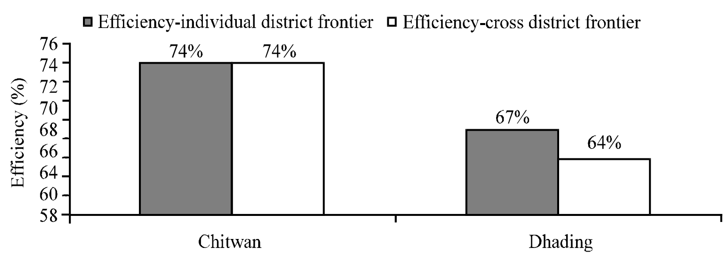

Fig. 4: Average efficiency in chitwan and dhading

by exogenous factors like government policy and program. This could be the reason for small differences in technological frontiers in two districts. Apart from this, both districts are bordered with each other, thus, a mutual transfer of technology could have made the gap in frontier technology smaller in two districts.

Table 3 presents the comparative frequency distribution of technical efficiencies with respect to individual district frontiers. The result showed that the average technical efficiency in Chitwan district was 74%. This indicates that rice farmers in Chitwan district can improve production by 26% under the existing technology. The case of Dhading was worse than Chitwan. The average technical efficiency was just 67 indicating that farmer could increase rice production by 33% in the existing technological state. The frequency distribution showed that more than 50% farmers in Chitwan district had attained the efficiency level of 70-100% while in case of Dhading, around 35% of farmers had attained that level.

Technical efficiency and degree of commercialization: Figure 5 presents a comparison of degree of commercialization and technical efficiency in Chitwan and Dhading districts. The result showed that the technical efficiency and the degree of commercialization are higher in Chitwan

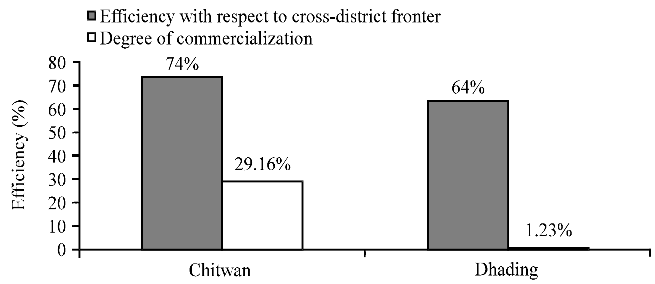

Fig. 5: Comparative chart of efficiency and degree of commercialization

Table 4: Factors affecting technical efficiency

	Chitwan (Semi-Commercial area)		Dhading (Subsistence area)		Cross-districts	
Variables	Coefficient	SE	Coefficient	SE	Coefficient	SE
Degree of commercialization	0.13***	0.08	-	-	0.17**	0.073
Education of HH head	-0.41	0.68	0.23	0.72	0.08	0.51
Highest education in family	-0.54	0.61	1.99**	0.92	0.40	0.54
Age of HH head	0.43**	0.17	0.25***	0.20	0.33*	0.13
Share of agricultural income in total income	0.39***	0.09	0.67***	0.12	0.52***	0.078
Cropping intensity	-0.001	0.02	0.015	0.03	0.01	0.01
Sharecropping	-0.30*	0.16	-0.021*	0.34	-0.33**	0.16
Constant	29.31	24.74	-21.93	18.03	4.16	11.64
F	5.13**		6.90***		11.60***	
R^2	0.40		0.45		0.41	
Adj R^2	0.35		0.40		0.38	

*, **, *** Indicate 0.01, 0.05 and 1% of level of significant

compare to Dhading district. This indicates that there is a positive association between commercialization and technical efficiency. On an average 30% of total rice production was found to be sold in the market in Chitwan while in case of Dhading it was neghigible. This shows that rice farming in Dhading district is mainly subsistence in nature. The higher level of commercialization in Chitwan is mainly due to rice farms located at the adjoining areas of big urban centers and higher marketable surplus.

Factors affecting technical efficiency: There is a distinct gap in technical efficiencies between two districts. In general, farm household characteristics between two districts do not differ much. However, two districts are distinct in terms of urbanization and market access. Farmers in Dhading district is producing rice in a rural environment while farmers in Chitwan districts in more urban environment. To explain the difference in technical efficiency among farmers within individual district and across districts, three models-Chitwan only, Dhading only and cross-district are estimated. The result is presented in Table 4. Both commercialization index and household characteristics were used as explanatory variables. As almost all farms in Dhading district was subsistence in nature, the commercialization variable was not included in Dhading model.

The result showed that the level of commercialization had significant impact on technical efficiency. The result showed that 1% increase in the degree of rice commercialization increases the technical efficiency by 0.13% in Chitwan district and by 0.18 in cross-district case. To assess the impact of education on the level of efficiency, two types of variables, namely the education level of household head and the highest educational level of farm household members were accounted for. The impact of the level of education of household head did not come significant while the impact of highest level of education of household members had significantly positive only in case of Dhading. Age of household head had a positive impact on efficiency in all three cases. Similarly, share of agricultural income to the total income had a positive impact on efficiency in all three cases. Sharecropping had negative impact on efficiency in all three cases. However, its magnitude was relatively higher in case of Chitwan compare to Dhading. Cropping intensity did not show any significant impact in all three cases. The overall explanatory power of the models is below 50%. This indicates that there must be other variables that might affect the level of technical efficiency which were not accounted in the study. The main purpose of the study is to compare the efficiency in two different production locations having different market access and see whether the higher level of commercialization lead significant impact on efficiency. Due to time and resource constraints all other potential variables like land quality could not be included in the study. This is the limitation of the study.

CONCLUSION

The result showed that there is a remarkable gap in land productivity between two districts. The difference in input intensification, technical efficiency and technology are the main reason for difference in productivity. In individual district case, the technical inefficiency of rice production is very high. The result showed that farmers in Chitwan district can increase production by 26% while farmers in Dhading district can increase production by 33% in the existing technological condition. The result concurs with the result of many past studies in developing countries. It seems that farmers residing near to urban areas have higher technological level and technical efficiency relative to farmers residing far away from urban centers. The farmers residing in and near to urban areas have better economic opportunities in the form of market access compare to that residing in rural areas. This could be the plausible reason for higher technical efficiency in Chitwan. Apart from this farmers residing in urban areas are benefitted by easy access to various production and marketing information.

Technical efficiency depends on various factors. The analysis in this study considered only some of the variables. This has limited the scope of the study. However, it succeeded to conclude some of the important facts relating to technical efficiency. Higher level of commercialization increases technical efficiency. This means, a new technology would be capitalized more efficiently in the location where rice farming is relatively more commercialized. Thus, agricultural development policy should focus not only to the technological enhancement but also give equal importance to transform the subsistence agriculture to commercial one. The result indicated that four household characteristics are important namely age, share of agriculture income to total household income, education of household members and land tenancy system. Sharecropping has a significant negative impact on efficiency in all cases but its magnitude is higher in Chitwan compare to Dhading. The issue of land distribution is always linked with the agricultural productivity. In Nepal, land distribution is not equitable. Many real farmers are working as sharecropper. Thus, to increase the efficiency in rice farming, the government should revisit the tenancy policy. The impact of age of household head and share of agricultural income to the total household income are positive in all cases. This indicates that farming experience and farmers' dependency on agricultural income has positive impact in all types of farms. However, the magnitude of impact of these variables on efficiency differs in two districts. This study also found a positive impact of education but only in case of Dhading. Chitwan showed a negative impact of education on efficiency but is statistically not significant. In summary, agricultural development program and policy should able to conceptualize the dynamics of farming at micro-level. Basically, market strengthening, tenancy right and education in rural areas should be given a due concern.

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