Foreign Aided Projects and Rural Livelihoods. Analysis of impact of project intervention in production efficiency: A case of livestock development project in the mid hill region, Nepal*

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Abstract

This study has examined some of the most important demographic and socio-economic factors influencing technical efficiency of farms in context of smallholder livestock farmers. Technical efficiency measures were estimated using stochastic frontier analysis. The results indicate that mean technical efficiency for goat meat, cow milk and egg production was found higher (64%, 48% and 82% respectively) with treatment group as compared with control group (56%, 43% and 70% respectively). Unlike the higher mean technical efficiencies of these three commodities for treatment group, the mean technical efficiency of buffalo milk production was found higher with control group.

The study recommends that focus of the future projects and programs should be concerted to provide the services on improving the factors "timely availability of credit, regular extension visits, technical training, level of education, and affiliation to farmers' group" causing inefficiency in order to raise the production efficiency and eventually their livelihoods.

1 Introduction

The agricultural sector is still the backbone of Nepalese economy and is a major source of livelihood for 81 percent rural inhabitants in Nepal. Its 39.2 percent contribution to the GDP is in declining trend although this sector has been receiving top priority in various periodic development plans. The agricultural growth rate has been recorded at 3.3 percent per annum as compared to 2.25 percent population growth rate (NPC, 2003). The livestock sector is an indispensable component to sustain agricultural system, which contributes 31.5 percent to agricultural and 18 percent to national GDP. Livestock provides more than 90 percent manure for crop production and concurrently more than 91 percent draft power required for agricultural operation. Unlike the declining trend of overall agricultural GDP, the upward though tardy trend of livestock contribution to the economy, has potentiality for the empowerment of women farmers and creation of enormous rural employment to help reduce the abject rural poverty since livestock activities are daily occupations, and products are produced, processed, and marketed throughout the year.

Government's plan to exploit the potentialities of livestock sector to upgrade the pastoralists' living standard has been expedited by multinational donors. The Hills Leasehold Forestry and Forage Development Project (HLFFDP) taken into this study is one of those. The Share of external donors to the government's development expenditure in livestock sub-sector ranged from 23 percent to 39 percent and even it reached up to 54.5% in the fiscal year 1997 (KARKI and KARKI, 1997). Despite such continuous endeavour of government and donor agencies to develop livestock sector, average per capita annual availability of milk, meat, and eggs is 48 litres, 8.4 kg, and 22 number respectively. Consequently, Nepalese have access to only 15 percent of the dietary animal protein, while people in developing and developed countries have access to 22 and 60 percent respectively (PATHAK and KARKI, 1998). The possibility of increasing consumption of animal protein by importation has become beyond the reach of Nepalese since their average per capita annual income is only US$ 240.

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The only alternative in such a circumstance would be increasing productivity of livestock with the optimal use of the available scanty resources and appropriate breeding techniques. One of the most important aspects for improving productivity of livestock in a friendly environment would be to enhance the efficiency of livestock farmers. Unless the efficiency of farmers is approached to frontier level, the technology introduced by any program or project would not be fruitful to accelerate the dawdling growth of this sub-sector in order to raise the socio-economic condition of farming communities. Keeping this frame condition in mind, this study was designed to assess the impact of project on production efficiency and to identify the factors causing inefficiency so future projects and planners would be able to embed in concrete interventions required to increase the level of efficiency.

2 Materials and methods

2.1 Methodological approaches for impact evaluation

According to BMZ "Federal Ministry for Economic Cooperation and Development" in Germany (2000), impact generally denotes aggregate changes observable after the completion of the whole project. According to CASLEY and LURY (1985), impact is to determine more broadly whether the program had desired effects on individuals, households and institutions. It can be accomplished comparing data from *with* and *without* the project population. According to FAO "Food and Agriculture Organization" (2000), impact refers to the broad, long-term economic, social and environmental effects resulting from intervention. Such effects generally involve changes in both cognition and behavior. There are two major approaches according to PITT and KHANDKER (1996), KERR and KOLAVALLI (1999), GTZ "Deutsche Gesellschaft für Technische Zusammenarbeit" (2000), and BAUER (2000, 2001) to evaluate the impact of a project intervention.

(1) Before and After approach: This approach compares the conditions of the same households before the project was introduced and after the termination of the project. The major problems with this approach are: Often base line information are not available and isolation of influence of exogenous factors (government policy, market conditions) is rather difficult.

(2) The **With and Without approach** compares the conditions of the farmers involved in the project with the conditions of the farmers without the project activities. The with and without approach is considered more appropriate in a situation where obtaining baseline data is problematic. Moreover, isolation of influence of exogenous factors with this approach is relatively easier than the former one. Therefore, this approach was applied as the principal research methodology in this study.

2.2 Field study: Assessing the impact of a project intervention at household level is quite a delicate issue. Besides the impact of a project, there could be strong influence of various exogenous factors on the development of the farm household. Samples were chosen by randomization in order to assess the difference between with and without groups only due to project intervention. For this purpose, a household survey was conducted to collect primary data applying multi-stage random sampling procedure that consisted of 120 households with 60 beneficiaries from the project area and 60 households from non-project area. The beneficiaries were the primary stakeholders of the HLFFDP in Kavrepalanchowk district, Nepal. The major objectives of the project were: to raise the income of the farm families in the hills who were below the poverty line, and to contribute to improving the ecological conditions of the hills.

2.3 The empirical model: The most widely discussed, theoretically reasonable and empirically competent method of measuring efficiency of farms is the stochastic frontier model where the error term is divided into two elements: a symmetric random error that permits random variation of the frontier across firms and captures the effects of measurement error, statistical noise and random shocks outside the firm's control; and a non-negative random variable associated with technical inefficiencies of production (BAYARSAIHAN *et al*., 1998). Unlike the deterministic frontier approach, the stochastic frontier considers all the factors while estimating the model and accordingly it separates firm-specific efficiency and random error effects. Thus the efficiency measurements as well as the estimated parameters are unbiased. AIGNER *et al*. (1977); MEEUSEN and VAN DEN BROECK (1977) independently proposed the stochastic frontier production function, which extends the deterministic approach by allowing noise and inefficiency terms for the error measurement. The error terms accounts for two parts: (1) Inefficiency (under farmers' control) and (2) Random effects (beyond the farmers' control), that treat agricultural output as a stochastic variable due to random forces, such as disease and weather conditions, luck, fires and other exogenous random factors (JAFORULLAH *et al*., 1996). The approach by these authors allows for deviation from the production frontier due to both inefficiency and random events.

The Cobb-Douglas form has been used in many empirical studies, particularly those relating to agriculture in developing countries. It is one of the most widely used functions in the economic analysis of the problems relating to empirical estimation in agriculture and industry (SANKHAYAN, 1988: p.59). It is easy to estimate and manipulate mathematically but is restrictive in the properties it imposes upon the production structure such as a fixed returns to scale (RTS) value and an elasticity of substitution equal to unity (COELLI *et al*., 1998). Besides, the Cobb-Douglas is relatively easy to estimate because in logarithmic form it is linear in parameters (BEATTIE and TAYLOR, 1985). Consequently, the following type of Cobb-Douglas Stochastic frontier model has been estimated.

$$\ln Y_i = \beta_0 + \sum_{k=1}^{m} \beta_k \ln X_{Ki} + V_i - U_i \qquad (1)$$

Y_i = output (meat kg, milk litre, eggs number) for observation i, X_{ki}=different physical inputs (roughages (kg), concentrates (kg), labor (man-days), health services (rupees), breeding services (rupees), miscellaneous (rupees) used by observation i, β_k = vector of parameters to be estimated , V_i = random stochastic disturbance term U_i = technical inefficiency

In the second step**,** attempts have been made to include major socio-economic and demographic factors for explaining efficiency differentials in the study area in Equation 2.

2.4 Description of the variables and specification of inefficiency model

Of the variables selected, the larger the farm size the less the technical efficiency is hypothesized because farmers may not be able to maintain the productivity of farm as its size increases. Availability of credit in time would facilitate farmers to procure inputs timely thereby increasing productivity and decreasing inefficiency. Regular visits of an extension agent would spur farmers to increase the efficiency. Access to technical trainings was hypothesized to reduce the inefficiency. The higher the farmers' experience, the greater the technical efficiency was assumed. Family size was hypothesized to have positive effect to the technical efficiency. It was assumed that the farmer with off-farm income does not concentrate much on his on-farm activities, rather tends to search for lucrative off-farm jobs, which lead to higher inefficiency. Education was considered as the number of years of schooling and was supposed to have positive relationship with level of efficiency. Group members were considered more efficient than the non-members. The following multiple regression model was fitted for explaining technical inefficiency for Cobb-Douglas Stochastic frontier production function:

$$\cup_i = \beta_0 + \sum \alpha_i X_i + \varepsilon_j \qquad (2)$$

Where, U_i is technical inefficiency, X_i represents explanatory variables include: farm size (ha), availability of credit (binary), access to extension services (categorical), availability of training opportunities (binary), farmers' experiences in farming (years), family size (no.), off-farm income (binary), farmers' level of education (years of schooling), affiliation to farmers' group (binary), β_0 = intercept, α_i = unknown parameters to be estimated, ε_j = unobservable random disturbance term.

3 Results and discussion

This study adopted the FRONTIER version 4.1c package, which automates the Maximum Likelihood Estimation (MLE) method for the estimation of the parameters of the models in two step procedure to explain the farmers' differences in technical efficiencies. The impact on technical efficiency is calculated for all four livestock commodities (output). The estimation is done separately for the project and non-project farmers in order to differentiate the impact of project interventions on production efficiency. Goat is found the most commonly raised commodity in the study area. Therefore, the estimated results for goat meat production are presented in the table below.

Table 1: Maximum Likelihood Estimates of the Cobb-Douglas Stochastic frontier production function for goat (meat) production

	Project farmers		**Non-project farmers**	
	coefficient	standard-error	coefficient	standard-error
Stochastic frontier				
Constant	0.58480	0.34321	0.81262	0.18757
Roughage	0.32641***	0.94236	0.25115**	0.47485
Concentrate	0.26765***	0.81696	0.61256***	0.55841
Labor	0.13766	0.95903	0.23910**	0.32466
Health	0.46196***	0.10555	0.20718***	0.11661
Breeding	0.26047***	0.91249	0.72571***	0.28010
Miscellaneous	-0.41084***	0.95045	-0.59690***	0.12429
Inefficiency model				
Constant	0.27072*	0.14785	-0.69874*	0.36171
Farm size	-0.68243***	0.66939	-0.39810***	0.88985
Credit availability	-0.41347*	0.22385	- 0.13752**	0.11706
Extension service	-0.28531***	0.86420	-0.15723*	0.94751
Training	-0.40862***	0.11259	-0.86437***	0.87563
Experience	-0.15355***	0.46593	-0.12084***	0.52443
Family size	0.46261	0.163702	-0.12084***	0.52443
Off-farm income	0.73074	0.11226	0.33368	0.18083
Education level	-0.72473***	0.15198	-0.57199***	0.10521
Group member	-0.27072*	0.14785	-0.64442***	0.15449
Variance parameters				
σ^2	0.80873	0.12545	0.15878	0.12121
γ	0.99879	0.15013	0.89178	0.24670
Log likelihood function		-43.96		-67.62
LR test (one-sided error)		135.15***		110.57***

***, ** and * indicate significance at 1%, 5% and 10% levels respectively

In the model, coefficients of roughage are found to be positively significant to the dependent variable goat meat output. Accordingly, a one percent increase in roughage input leads to 0.33 percent and

0.25 percent increase in goat meat output with the project and non-project farmers respectively in the ceteris paribus condition. The coefficients of concentrate, health and breeding are found positively significant to both groups. Similarly, the coefficient of labor is found to be significantly positive in case of non-project farmers. The negatively significant coefficients of miscellaneous input in both groups imply the converse result to the output.

3.1 Factors determining technical efficiency

The technical inefficiency model as specified in Equation 2 was run for all four livestock commodities (Figure 1). All the selected variables in the model produced negatively significant coefficients to the inefficiency model in one or the other enterprises. In other words, the level of technical inefficiency decreases as each unity increase in those factors where project intervention can mitigate the inefficiency effect of the factors in case of goat production such as credit facility, extension service, training, education, and organization in a group activity if accorded priority in planning and execution.

In particular to goat model, the coefficients of farm size are found to be negatively significant to both groups. It indicates that every unity increase in land leads to decrease in technical inefficiency effect by 0.68 percent and 0.39 percent with project and non-project farmers respectively. However, converse result was expected in this regard. COELLI and BATTESE (1996) observed the same phenomena while studying the technical efficiency of Indian farmers. This result is in contradiction to the hypothesis that peasants are poor but efficient as stated by SCHULTZ (1964), and the findings by LAU and YOTOPOULOS (1971), that small farms perform with greater economic efficiency than large farms but that the farm types are equally efficient allocatively. The advantage of small farms is thus attributed to their greater technical efficiency. According to ADMASSIE (1999), factors other than farm size are more important in explaining the variation in technical efficiency.

The coefficients of credit are found to be negatively significant as assumed. This implies that farmers having access to credit when required are found to more efficient than the non-receivers in case of project and non-project farmers respectively. Nepalese farmers are overwhelmingly resource constrained. Therefore, access to credit assures timely availability of inputs that increases production efficiency. The results are found consistent with those of PARIKHA and SHAH (1994). The coefficients of extension service and technical training are found to be negatively significant to both groups as expected. A greater influence of training is observed in case of non-project farmers while their access to training was rather meager as compared to project farmers. A similar result was obtained by RAHMAN (2002) while analyzing rice farming in Bangladesh. The negatively significant coefficients of experience with both groups indicate that farmers with more experience are found technically more efficient. In other words, the older the farmers, the more the experience and the less the technical inefficiency. RAHMAN (2002), found similar results in rice farming in Bangladesh. The negatively significant coefficients of family size to non-project farmers imply that consistent availability of labor helps decrease inefficiency by mitigating the shortage of labor. This result is similar to the findings of PARIKHA and SHAH (1994), that family size has positive and significant relationship with efficiency. The coefficients of education are found to be negatively significant to both groups meaning that the technical inefficiency effect decreases by 0.72 percent and 0.57 percent with every year increase in schooling with project and non-project farmers respectively. Positive impact of education on technical efficiency was also observed by ADAMASSIE (1999). The negatively significant coefficients of affiliation to farmers' groups in both instances mean that members of farmers' groups are technically more efficient than the non-members as expected**.** The influence is, however, found remarkably higher to non-project farmers as compared to project farmers since only a few of the former are organized into groups.

3.2 Impact of project on production efficiency

Commodity and farm specific technical efficiency of project and non-project farmers are estimated using the Cobb-Douglas type Stochastic production function as presented in Equation 2. According to KARKI (2004), impact of project intervention is attributed to the upgraded capacity of the primary stakeholders (beneficiaries). During the project period, beneficiaries were supported by various activities (institutional development, technology transfer, natural resource management and animal breed improvement). The impact of those activities on production efficiency (technical) of the treatment group is estimated and compared with control group (Figure 1). Mean technical efficiency is found higher with project farmers in three of the four commodities, though the difference between the groups is small. However, converse result is found in buffalo milk production.

The mean technical efficiency of goat production is found to be higher (64%) with project farmers as compared to non-project farmers (56%). This means that the difference between the observed values of output and the frontier that could have been produced from the inputs for farms in both groups are mainly due to technical inefficiencies. Under perfect technically efficient production plan the project and non-project farmers will be able to increase their output by about 36 percent and 44 percent respectively. The highest TE is found in case of egg production i.e., 82 percent with project farmers, whereas 70 percent with non-project farmers. As in goat, under perfect technically efficient production condition the project and non-project farmers would be able to increase their output (the difference between the observed and frontier) by about 18 percent and 30 percent respectively. Similarly, the level of technical efficiency in cow milk production is found to be higher with project farmers (48%) than the non-project farmers (43%). However, the level of TE for cow milk production with both groups of farmers is found to be very low than for the other two commodities. The same principle applies here as well i.e., the difference between the observed output and the frontier can be produced from the available inputs for both project and non-project groups under perfect technically efficient production plan by 52 percent and 57 percent respectively.

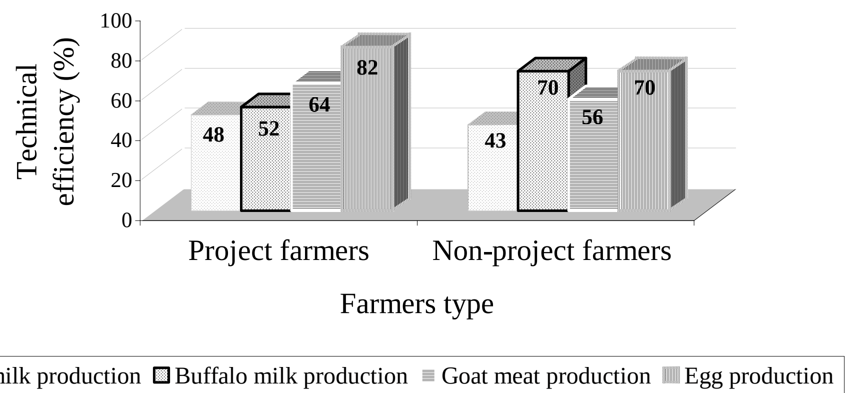

Figure 1: Commodity-specific technical efficiency (%) of project and non-project farmers

Conversely, the mean TE in buffalo milk production was found higher with non-project farmers (70%) than that with project farmers (52%). In other words, the difference in production (observed and frontier) is due to technical inefficiency. Both non-project and the project farmers will be able to increase their output from the available inputs by about 30 percent and 48 percent respectively under perfect technically efficient production condition. The range of inefficiency effect is found minimum

(18%) with project farmers in egg production and maximum (57%) with non-project farmers in cow milk production.

The variation of inefficiency effect in case of goat is found 80 percent and 15 percent from the efficient to the inefficient producer with project and non-project farmers respectively. Of the total inefficiency effect, 99 percent with project and 89 percent with non-project farmers is found within the farmers' control that can be minimized from the available resources if allocation is made optimally, whereas the rest i.e., 1 percent with project and 11 percent with non-project farmers is due to random effects.

4 Concluding remarks

The higher technical efficiency in three of the four commodities of project farmers, compared with non-project farmers, urge future projects to recapitulate the determinants of technical inefficiency as revealed by econometric results. It is found that availability of credit, having regular extension visits, access to regular training, off-farm income, level of education, and farmers affiliation to groups can raise their efficiency significantly. Therefore, it is suggested that enough resources be allocated and necessary provision be made for improving the factors determining the technical efficiency of the farmers. More importantly, promotion of income generating activities in the package is mandatory in order to make resource poor producers able to afford to essential factors of production that eventually helps farmer increase efficiency.

Increasing production efficiency is of paramount importance to combat food insecurity in a country like Nepal where majority of the inhabitants have to depend on subsistence farming to obtain their livelihood. This can be translated into the practice only when the future projects and programs focus primarily on building capacity at various levels (beneficiary, institution and organization) whereby farmers will be able to apply their acquired knowledge and skills in order to make themselves competent to perform effectively, efficiently and sustainably over the time even after the termination of the project.

Retrospection on resources allocation and explicit participatory ex-post evaluation of the impact would navigate the future projects more sustainably.

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