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TECHNICAL EFFICIENCY OF PARTICIPATORY AND NON PARTICIPATORY CROP PRODUCERS: AN EVALUATION OF ICM PROJECT

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ABSTRACT

This study examines technical efficiency of participatory and non-participatory resource-poor farmers of integrated crops management (ICM) project in the north-west region of Bangladesh. Sixty farmers of which 30 from participatory and another 30 from non-participatory group were randomly selected from six purposively selected villages of Kurigram Sadar Upazila of Kurigram district. ICM project participatory farmers received higher net returns than the non-participatory farmers from selected crop production. Participatory farmers were technically more efficient than non-participatory farmers. Higher level of education and larger farm size were found to contribute in reducing technical inefficiency of T. aman and MV boro producing farmers. Getting membership status of non-participatory farmers' was suggested to be an important factor in removing technical inefficiency.

I. INTRODUCTION

The measurement of farming efficiency in agricultural production is an important issue from the standpoint of agricultural development exercises in developing countries, since it gives pertinent information useful for making sound management decision in resource allocations and formulating agricultural policies and institutional improvements. In the production efficiency area, we are usually familiar with two types of efficiency namely, technical and allocative efficiencies. Technical efficiency refers to the ability of a firm to obtain maximum output of a given set of inputs under certain production technology whereas allocative efficiency reflects the ability of a farm to use the inputs in optimal proportions, given their input prices; and a combination of these two measures provides a measure of economic efficiency. In Bangladesh, where resources are scarce and opportunities for new technologies are lacking, efficiency (or inefficiency) studies will be able to show that it is possible to increase productivity growth without new investment or developing new technology.

It is generally assumed that in Bangladesh farmers are inefficient at producing paddy crops and there are significant efficiency differences among region to region, farm groups and also crops. Sharif and Dar (1996) found higher technical efficiency in producing T. aman than

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Aus or MV boro. Rahman *et al.* (1999) investigated rice production in Bangladesh using Cobb-Douglas stochastic production function and found that technical inefficiency effects decrease significantly with the increase in the magnitudes of farmer's age, experience, extension contact and farm size. The study also reveals that there are significant technical inefficiency effects in the production of all rice crops and the random component of the inefficiency effects explains that a significant portion of the difference between the observed output and the maximum production frontier output is caused by differences in farmers' levels of technical efficiency. Miah (2001) noticed distinct yield gap in per hectare yield of MV boro rice among three categories of farmers. This yield gap certainly resulted from the inefficiency of farmers. Rashid and Chen (2002) examined technical efficiency of shrimp farmers of southeastern and south-western Bangladesh taking into account three farming methods viz extensive, improved extensive and semi-intensive. Sources of yield variations, i.e., production input, technical efficiency and other factors in all the three methods were investigated and factors affecting technical inefficiency were also analyzed simultaneously with the production frontiers using maximum likelihood method. The study showed that 85%, 61% and 87% variation, respectively in output among the farming methods in shrimp cultivation was due to differences in technical efficiency. Land, fry and feed have significant influence on the level of shrimp production.

After the measurement of efficiency differences, proper measures can be undertaken to reduce them. It is equally important to identify farm-specific factors, which influence inefficiency effects. In this study, farming efficiency for participatory and non-participatory resource-poor farmers of ICM project has been estimated. The findings of this study will be useful in a wide range of decision making situations affecting the development of agriculture in this country and also provide information to planners, government, extension workers, farmers and to those concerned with research on farm resource use for livelihood improvement of resource-poor farmers in Bangladesh.

II. METHODOLOGY

Sampling Procedure and the Data

The stratified random sampling technique was used in the study. Six villages namely: Khalisha Kalua, Prashad Kalua, Taluk Kalua, Jothabardan, Shibram and Sordarpara from Kathalbari union under Kurigram Sadar of Kurigram district were pu*rposively selected. Intotal 60 farmers of which 30 participatory and 30 non-participatory resource-poor farmers, were randomly selected for the study. It should be noted here that initially population lists of the selected two areas were collected from the concerned officials of ICM project.

Field Survey

A questionnaire was developed to obtain technical and economic details of different crops, resource availability and utilization, and farmers' perception. Information was gathered on socioeconomic characteristics of farmers, physical condition of soil, quantities of inputs and their costs, production and return from different crops and problems faced by the farmers and suggestions made by them.

Computerization

A data base was developed using the computer package Excel. Different data base files were designed to enter data on different aspects, each file with a common field for the farmer identification number. The survey data were analyzed to obtain summaries, averages, counts, minima, maxima and standard deviations of the important data pertaining to farm families. The data so entered in Excel, were then transferred to another computer package SPSS 11.5 for using in the FRONTIER 4.1 program.

Analytical Technique

To assess the profitability of the concerned crops of individual participatory and non-participatory sample farmers the following algebraic equation and/or π (i.e., profit) equation was followed:

$$\pi = TR - TC \quad (1)$$

$$\pi = P_r.Q_r + P_b.Q_b - \sum_{i=1}^{n} Px_i.X_i \text{ -TFC} \quad (2)$$

Where,

π = Per hectare net return or profit from the relevant crops/vegetables (Tk/ha);

P_r = Per unit price of the concerned crops/vegetables (Tk/kg);

Q_r = Per hectare yield of the concerned crops/vegetables (kg/ha);

P_b = Per unit price of by product (Tk/kg);

Q_b = Total quantity of the by-product (kg/ha);

Px_i = Per unit price of i_{th} inputs used for producing the concerned crops/vegetables (Tk /unit);

X_i = Total quantities of the concerned i_{th} inputs used for producing per hectare crops/vegetables;

TFC = Total fixed costs involved in producing per hectare crops/vegetables;

i = , 2, 3,..., n; and n = Number of inputs used.

Farrel (1957) suggested a method of measuring the technical efficiency of a firm in an industry by estimating the production function of firms which are "fully-efficient" (i.e., a frontier production function) and the technique has generally been preferred in the agricultural economics literature (Coelli and Battese, 1996). A Cobb-Douglas functional form is employed to examine rice production technology in this study. Kopp and Smith (1980) suggested that functional form has limited effects on empirical efficiency measurement. The Cobb-Douglas form has been used in many empirical studies, particularly those relating to developing country agriculture.

The Cobb-Douglas functional form also meets the requirement of being self-dual, allowing an examination of economic efficiency (Xiaosong and Scott, 1998). This is, in fact, an econometric technique was used to estimate frontier production function and thus, measurement of the efficiency which involves both (i) Allocative efficiency which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices; (ii) Technical efficiency that reflects the ability of a farmer to obtain maximum output from a given set of inputs. In the second stage, these predicted technical inefficiency effects (or technical efficiencies) are related to farm-specific factors using ordinary least-square regression (Coelli and Battese, 1996).

The stochastic frontier and inefficiency model specification were:

$$\ln (Y_i) = \ln\beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \beta_6 \ln X_{6i} + \beta_7 \ln X_{7i} + \beta_8 \ln X_{8i} + \beta_9 \ln X_{9i} + (V_i - U_i) \quad (3)$$

Where,

Y represents per hectare yield of crops (kg/ha);

β_0 indicates Constant or intercept;

X_1 represents quantity of human labour used (man days/ha);

X_2 represents quantity of bullock used (pair days/ha);

X_3 represents quantity of seed/seedlings used (Tk/ha);

X_4 represents quantity of manure used (kg/ha);

X_5 represents quantity of Urea used (kg/ha);

X_6 represents quantity of TSP used (kg/ha);

X_7 represents of amount of muriate of potash used (kg/ha);

X_8 represents cost of irrigation (Tk /ha);

X_9 represents cost of pesticides (Tk /ha);

β_i = Unknown parameters to be estimated;

ln = Natural logarithm;

V_i and U_i = V_i is an independently and identically distributed random error and U_i is a non-negative variable, associated with technical inefficiency in production; i = 1, 2, ..., 60;

Most farmers did not use power tiller and pesticides for T. aman in the study area. These variables were, therefore, not included in the model.

The model for the technical inefficiency effects in the stochastic frontier of equation (3) is defined by $U_i = \delta_0 + \delta_1 z_{1i} + \delta_2 z_{2i} + \delta_3 z_{3i} + \delta_4 z_{4i} + \delta_5 z_{5i} + \delta_6 z_{6i} + \delta_7 z_{7i}$ (4)

Where,

z_1 represents age of the selected farmers (years);

z_2 represents year of schooling of the selected farmers (years);

z_3 represents cultivated areas (ha);

z_4 represents experience of the selected farmers in farming (years);

z_5 represents transplanting space (inches);

z_6 represents period gap between uprooting of seedling and transplanting (days);

z_7 represents membership status (Dummy variable which receives '1' for participatory '0' for non-participatory farmers);

δ_0 = Constant;

δ_i = Unknown parameters to be estimated;

i = 1, 2, ..., 60.

The β- and δ- are coefficients of unknown parameters to be estimated, together with the variance parameters which are expressed in terms of

$$\sigma^2 = \sigma^2_u + \sigma^2_v \quad (5)$$

and $$\gamma = \sigma^2_u / \sigma^2 \quad (6)$$

The technical efficiency of a farmer at a given single period of time is defined as the ratio of the observed output to the frontier output which could be produced by a fully-efficient firm, in which the inefficiency effect is zero. The technical efficiency of the ith farmer in the single period of observation can be shown to be equal to

$$TE_i = \exp(-U_i) \quad (7)$$

The γ parameter has value between zero and one. The parameters of the stochastic frontier production function model are estimated by the method of maximum likelihood, using the computer program, FRONTIER Version 4.1 (see Coelli, 1992 and 1994).

It is worth mentioning here that the above model for the inefficiency effects (equation 4) can only be estimated if the inefficiency effects are stochastic and have a particular distribution specification. Hence, it is important to test the null hypothesis that the inefficiency effects are not present, H_0: $\gamma = \delta_0 = --- = \delta_7 = 0$ and the coefficients of the variables in the model for the inefficiency effects are zero, H_0: $\delta_1 = --- = \delta_7 = 0$. These null hypotheses can be tested using the generalized likelihood ratio statistic LR, defined by

$$LR = -2\{\ln[L(H_0)/L(H_1)]\} = -2\{\ln[L(H_0)] - \ln[L(H_1)]\} \quad (8)$$

where, $L(H_0)$ and $L(H_1)$ are the values of the likelihood function under the null and alternative hypothesis, H_0 and H_1, respectively.

III. RESULTS AND DISCUSSION

Returns from Crop Cultivation

The ICM project participatory farmers earned higher net return from all the selected T. aman, MV boro, potato and wheat crops than those of non-participatory farmers. ICM participatory farmers obtained the highest per ha net return (Tk 96,786.00) from potato cultivation followed by T. aman (Tk 23,025.00 per ha) and MV boro. The wheat farmers earned the lowest per ha net returns of Tk 6,342.00. Potato growers in the non-participatory group also earned the highest per ha net return (Tk 74,296.00) followed by T. aman (Tk 20,766.00) and MV boro (Tk 14,980.00).

Like the participatory wheat growers, the non-participatory wheat growers also earned the lowest per ha net returns (Tk 5,742.00) (Table 1).

Table 1. Per hectare net return and BCR of different crops in Kurigram district

Crops	Participatory		Non-participatory	
	Net return (Tk/ha)	BCR (undiscounted)	Net return (Tk/ha)	BCR (undiscounted)
T. aman	23,025.00	2.72	20,766.00	2.64
MV boro	16,033.00	1.59	14,980.00	1.58
Potato	96,786.00	2.77	74,296.00	2.39
Wheat	6,342.00	1.51	5,742.00	1.49

Source: Adapted from Sumy (2003, pp. 85,87).

It is evident that the undiscounted BCR of participatory potato farmers was the highest (2.77) followed by T. aman (2.72), MV boro (1.59) and wheat (1.51). Unlike participatory farmers, T. aman farmers of the non-participatory group got the highest BCR (2.64). Although the BCR of non-participatory potato growers was quite high (2.39), it was relatively lower than the participatory potato growers'. The selected study area was one of the most fertile and suitable for potato cultivation. Moreover, the ICM project gave the farmers all kinds of logistic and material support for better crop cultivation.

Model Analysis

OLS Estimates of Cobb-Douglas Production Function

Ordinary least square estimates of the parameters show the average performance of the sample farmers. Farmers of Kurigram area widely used human labour, Urea and TSP for the cultivation of T. aman.

Table 2. Ordinary least square (OLS) estimates of a Cobb-Douglas (C-D) production function for Kurigram Sadar

Variable	Parameters	T. aman paddy		MV boro paddy	
		Co-efficient	Standard error	Co-efficient	Standard error
Intercept	β_0	8.145***	0.392	9.311***	1.627
Human labour	β_1	0.296**	0.147	-0.763**	0.323
Bullock	β_2	-0.051*	0.031	0.105	0.132
Seedlings	β_3	-0.029	0.074	-0.137	0.202
Manure	β_4	0.065	0.071	0.015	0.064
Urea	β_5	0.068*	0.041	0.403*	0.238
TSP	β_6	0.079**	0.039	0.052*	0.029
MP	β_7	0.008	0.022	0.494*	0.301
Irrigation	β_8	0.324*	0.203	0.462*	0.289
Pesticides	β_9	-	-	0.0103**	0.005

***Significant at 1%, **Significant at 5%, *Significant at 10%.

Source: Adapted from Sumy (2003, p. 90)

The estimated value of the coefficient of human labour, Urea and TSP were positive and statistically significant at 5, 10 and 5 percent level of significance, respectively. The estimated values of the coefficients of bullock and seedling used for T. aman were negative but significant. This indicated that these two inputs were important for T. aman cultivation but the farmers would have used these inputs excessively. The coefficient of irrigation has positive and significant impact on T. aman production. In MV boro paddy production, the coefficients of human labour and seedlings were negative but significant, indicating excessive use of these inputs. The coefficients of Urea, MP and irrigation have positive and significant impact on MV boro production.

Maximum Likelihood Estimates

The estimates of the stochastic frontier shows the best practice i.e., efficient use of available technology. The estimated values of the coefficients of human labour, manure and TSP were positive and significant for T. aman production. Therefore, human labour, manure and TSP were productive inputs for successive production of T. aman. The estimated value of the coefficient of bullock was negative but statistically significant. This indicated that, although both bullock power and power tiller were used to plough the land, bullock power was not essential after plough by power tiller for better yield of T. aman. The coefficient of seedlings has got a negligible negative impact on per hectare yield of T. aman paddy due to overuse of this input since farmers think that more use of seedling would give higher yield which was a wrong idea. The coefficient of irrigation was positive and significant at 10% indicating 0.064 percent increase in T. aman production with 1% increase in irrigation water. '

The estimated value of the coefficient of human labour and seedlings were negative but significant indicating overuse of these factors in producing MV boro paddy. Statistically significant and positive value of the estimated coefficient of bullock power, urea and MP indicate that farmers can increase per hectare yield easily by employing more units of these inputs. Although insignificant, but use of pesticides has a positive impact on MV boro production.

The estimated value of the coefficient of education in the case of both T. aman and MV boro producing farmers was negative but significant at 1% and 10% level indicating that inefficiency of the farmer decreases with the increase of farmers' education.

The sign on the 6-parameter in the inefficiency model were expected to be negative. The estimated results indicated that technical inefficiency decreases as the age of farmers increases in case of MV boro paddy. Similarly, technical inefficiency decreases as the education level of farmers' increases in case of both T. aman and MV boro production. The positive sign on age of farmers of T. aman paddy indicated technical inefficiency of older farmers. The coefficient of farm size in the inefficiency model was negative, which indicated that technical inefficiency of both the T. aman and MV boro producing farmers decreases as the farm size increases.

Table 3. Maximum likelihood estimates of parameters of C-D stochastic frontier production function and technical inefficiency effect model for T. aman and MV boro for Kurigram Sadar farmers

Variable	Parameters	T. aman paddy		MV boro paddy	
		Co-efficient	Standard error	Co-efficient	Standard error
Intercept	β_0	8.156***	0.240	9.557***	1.012
Human labour	β_1	0.115***	0.016	-0.514*	0.262
Bullock	β_2	-0.052*	0.031	0.029**	0.013
Seed/seedling	β_3	-0.019	0.021	-0.312*	0.191
Manure	β_4	0.059*	0.036	-0.003	0.054
Urea	β_5	0.015	0.044	0.301*	0.180
TSP	β_6	0.063*	0.038	0.435	0.311
MP	β_7	0.012	0.015	0.532***	0.293
Irrigation	β_8	0.064*	0.034	0.258	0.215
Pesticides	β_9	-	-	0.0096	0.012
Inefficiency model					
Intercept	δ_0	-0.045	0.061	-0.212	0.269
Age	δ_1	0.0008*	0.0005	-0.012*	0.007
Education	δ_2	-0.0006***	0.0001	-0.007*	0.004
Farm size	δ_3	-0.004**	0.002	-0.061	0.056
Experience	δ_4	-0.0004	0.001	-0.011	0.008
Transplanting space	δ_5	0.002	0.004	0.053**	0.021
Transplanting gap	δ_6	0.005**	0.002	0.0046	0.094
Membership status (Dummy)	δ_7	-1.012*	0.522	-1.052***	0.245
Variance Parameters	σ^2 γ	0.0014*** 0.009*	0.0002 0.005	0.0103*** 0.143***	0.002 0.044
Log likelihood function		-114.63		-53.38	

***Significant at 1%, **Significant at 5%, *Significant at 10%
Source: Adapted from Sumy (2003, p. 93).

'Experience' of the farmer has a negative effect upon the inefficiency effects for T. aman and MV boro production. This means that the inefficiency effects decrease with the increase of the experiences of farm operators of aman and boro rice. That is, technical efficiency increases with the increase of experiences of the farmers. The experienced farmers are more efficient than less experienced ones in managing and allocating productive resources.

'Transplanting space' and 'transplanting gap' have positive effect upon the inefficiency effects for T.aman and MV boro rice. This means that farmers using wider plant-to-plant distance (wider than suggested by the ICM personnel) and maintaining longer gap between uprooting and transplanting of seedling increases the inefficiency of the T.aman and MV boro farmers.

The coefficients of membership status for T. aman and MV boro growing farmers were negative but statistically significant at 10% and 1% level of significance, respectively. It means that participatory farmers were technically more efficient than non-participatory farmers i.e., the participatory farmers were more productive than non-participatory farmers.

The γ parameter associated with the variances in the stochastic frontier is significant for both the rice crops. It indicates that there are inefficiency effects in the rice crop production and the random component of the inefficiency effects makes a significant contribution in the analysis of agricultural production. These scenarios clearly show that farmers gained knowledge about crop production from ICM project and harvested better crops (Table 3).

The estimates of σ^2 (the ratio of the variance of farm specific technical efficiency to the total variance of output) was 0.0014 for T. aman and 0.0103 for MV boro and both were significant at 1% level. These suggest that the technical inefficiency effects were a momentous component to the total variability of the yield of paddy crops. Log likelihood functions of T. aman (114.63) and MV boro (53.38) were large and significantly different from zero, indicated a good fit and the correctness of the specific distribution assumption. Therefore, excluding inefficiency factors or traditional production function was not an adequate representations and/or explanations of the research data.

Efficiency Scores of the Kurigram Farmers for T. aman and MV Boro Paddy

In case of the participatory farmers, technical efficiencies varied from 0.88 to 0.99 and 0.83 to 0.97 for T. aman and MV boro respectively and mean technical efficiencies were 0.95 for T. aman and 0.91 for MV boro paddy. On the other hand, in case of non-participatory farmers, mean technical efficiencies were 0.84 for T. aman and 0.81 for MV boro paddy. This indicated that both T. aman and MV boro producing participatory farmers were about 11 percent technically more efficient than non-participatory farmers.

It is evident that technical efficiency of non-participatory T. aman farmers' was distributed over a range from 71.0 to 99.0 percent and only 26.67 percent farmers belonged to a high technical efficiency range of 91.0 to 100.0 percent. The non-participatory MV boro producers were also distributed in a similar technical efficiency range and only 23.34 percent farmers belonged to high technical efficiency range. On the other hand, 93.33 percent T. aman producing and about 67.0 percent MV boro producing participatory farmers had a technical efficiency score of 0.91 to 1.00. The wider range of distribution of technical efficiency in non-participatory farmers indicated that they produced these crops in a very traditional method and they did not consult the production techniques with anybody.

Table 4. Average technical efficiency estimated from Cobb-Douglas stochastic frontiers for participatory and non-participatory farmers of Kurigram Sadar

Efficiency level (%)	T. aman paddy		MV boro paddy	
	Participatory	Non-participatory	Participatory	Non-participatory
	Technical efficiency	Technical efficiency	Technical efficiency	Technical efficiency
66-70	0 (0.00)	0 (0.00)	0 (0.00)	1 (3.33)
71-75	0 (0.00)	8 (26.67)	0 (0.00)	8 (26.67)
76-80	0 (0.00)	4 (13.33)	0 (0.00)	8 (26.67)
81-85	0 (0.00)	2 (6.67)	3 (10.00)	3 (10.00)
86-90	2 (6.67)	8 (26.67)	7 (23.33)	3 (10.00)
91-95	16 (53.33)	5 (16.67)	11 (36.67)	5 (16.67)
96-100	12 (40.00)	3 (10.00)	9 (30.00)	2 (6.67)
Total number of farmers	30 (100)	30 (100)	30 (100)	30 (100)
Mean efficiency	0.95	0.84	0.91	0.81
Maximum Efficiency	0.99	0.99	0.97	0.97
Minimum Efficiency	0.88	0.72	0.83	0.70

Source: Adapted from Sumy (2003, p. 95). Values within parentheses indicate percentage

Test of Hypotheses

Now we are in a position to test the hypotheses for the study. The null hypothesis that the inefficiency effects are not present, H_0: $\gamma = \delta_0 = --- = \delta_7 = 0$ and the coefficients of the variables in the model for the inefficiency effects are zero, H_0: $\delta_1 = --- = \delta_7 = 0$ were tested using the generalized likelihood ratio statistic LR, defined by Equation 8. It is imperative, according to Coelli (1995), to perform one sided generalized likelihood ratio test when ML estimation is involved because this test has the correct size (i.e., probability of Type I error).

Table 5. Tests of hypotheses for coefficients of the explanatory variable for the technical inefficiency effects in the Cobb-Douglas stochastic frontier production functions

Null Hypothesis	Log-likelihood value	Test statistic LR	Critical value	Decision
$H_0: \gamma = \delta_0 = --- = \delta_7 = 0$				
T. aman	- 114.63	28.36	15.51	Reject H_o
MV boro	- 53.38	19.45	15.51	Reject H_o
$H_0: \delta_1 = --- = \delta_7 = 0$				
T.aman	- 108.22	24.57	14.07	Reject H_o
MV boro	- 48.79	16.43	14.07	Reject H_o

Source : Calculation by using frontier 4.1

The result of the hypothesis tests reveals that there are significant technical inefficiency effects in T. aman and MV boro production since the null hypothesis is rejected for both the rice crops. This indicates that the average response function is not an adequate representation for rice production in the study area.

Another null hypothesis, $H_0: \delta_1 = --- = \delta_7 = 0$ considered in Table 5 is also rejected for the two rice crops production. Hence, it could be concluded that the inefficiency effects are significantly influenced by the variables included in the inefficiency model.

IV. CONCLUSION AND RECOMMENDATIONS

The present study confirms that the ICM project participatory farmers earned higher returns from crop production than the non-participatory farmers. One of the important causes behind it was that the participatory farmers were assisted by the project. In fact, they got material as well as logistic support from the project. As a result, per ha yield and crop production efficiency (technical efficiency) were higher than non-participatory farmers. The mean technical efficiency of project farmers in producing T. aman and MV boro were 0.95 and 0.91, respectively. Results of the technical inefficiency model indicated that more education and larger farm size can increase the efficiency level both of T. aman and MV boro farmers'. 'Transplanting space' and 'transplanting gap' had positive effect upon the inefficiency effects for T.aman and MV boro rice. Membership status was also an important factor in removing technical inefficiency. It indicated that non-participatory farmers can increase their crop production as well as can improve technical efficiency by getting the project membership.

It was observed that a good number of participatory farmers did not strictly follow the training and advice provided by ICM project personnel. Some farmers, of course, followed the ICM project direction. The concerned officials of ICM project should pay more attention to supervise field level farm activities of participatory farmers and encourage all farmers to adopt new techniques of production for their own interest. Field experiences suggested that there is a tremendous shortage of financial capital among the farmers in these study areas. The financial institutions and/or NGOs should provide more financial support in the form of corruption-free supervised credit to genuine farmers for crops and vegetables production. Thus, food security as well as sustainable yield of crops and vegetables of resource-poor farmers could be ensured. It could be concluded that the reasons for less efficiency of non-participatory farmers were lack of capital, lack of awareness, lack of training, lack of storage and marketing facilities of products, etc. The findings of this study, therefore, suggested that in order to increase efficiency of both participatory and non-participatory farmers the above mentioned problem should be solved as early as possible.

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