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MEASUREMENT OF TECHNICAL, ALLOCATIVE AND ECONOMIC EFFICIENCY OF DIFFERENT AQUACULTURE POND SYSTEMS IN MAHARAJGANJ DISTRICT OF EASTERN UTTAR PRADESH

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Abstract: *The fisheries sector is an important player in the overall socio-economic development of India. Fish production was purely traditional activity in the early fifties, but now fisheries and aquaculture have now transformed into a significant commercial enterprise. The sector's contribution to employment generation, food and nutritional security and foreign exchange earnings is now well recognized. Sustainable agricultural development necessitates sustainable aquaculture or sustained production at a level which creates minimal impact on the environment. This is possible only when one carefully applies the economic and ecological principles to aquaculture. Presently most of the world's fishery resources are near the point of over exploitation it is because of the fact that harvesters prefer to avoid under exploitation. At global level, there has been observed a declining trend in fisheries due to pollution of water bodies, over exploitation and other anthropogenic disturbances etc. Therefore, there is urgent need to check or control these factors for sustainable development of fisheries.*

In both the systems fishers were operating at less allocative efficiency than the technical efficiency. In other words, allocative inefficiency was higher than the technical inefficiency in both the systems of aquaculture production. The average technical efficiency for MGD production systems of aquaculture and BHU aquaculture fishers was 0.84 and 0.67, respectively. The average economic efficiency for MGD aquaculture fisher's andBHU aquaculture fishers was 56.99 and 24.58, respectively.

Keywords: *Fisheries, allocative efficiency, technical efficiency and socio-economic development.*

Introduction: The inland fisheries resources provide full time vocation to 1.24 million inland fishers, and 3.4 MMT of annual fish production. India is the third largest producer of inland fish in the world (after China and Bangladesh) and the sector plays a great role in nutritional security and employment potential. The sector is also an important source of ancillary jobs for the rural population, especially in marketing, retailing, transportation, etc. However, the sector remains largely unorganized even today mainly due to scattered and diffused nature of activities. Though fisheries have been recognized as a thrust area in the successive Five-Year Plans, there has been little attention to the development of inland fisheries resources.

The country also occupies second position in the world after china. Aquaculture accounts for about half of the total fish production and provides food and nutritional security to millions of people at affordable price as well as contributes to the livelihood support to a large number of rural populations in the country. Its growth rate (over 6 percent a year) is the fastest among all other food production systems. It is also considered as the most efficient form of animal production system. The contribution of this sector to the gross domestic product is about 1.4 percent in 2010-11. Similarly, the share of fisheries to agricultural GDP (Gross Domestic Product) has increased from 2.17 percent in 1980-81 to 5.4percent in 2010-11 and thus boosting the agricultural growth since last several years.

Modified the procedure in a number of ways and evolved an output based measure of technical efficiency [1]. The Cobb-Douglas (CD) function was transformed into a deterministic frontier function by imposing a constraint on error terms to be positive. Defined technical efficiency as the production of maximum output from a set of given resources [2]. Using Kopp measure of technical efficiency the frontier usage of input was worked out and compared with the actual usage of inputs to know the savings in input use had the pond operated at higher efficiency level. Defined allocative efficiency as the ability of a farm to maximize profit by equating the marginal revenue product of inputs to their respective marginal costs [3].

Research Methodology

Data and Sampling Design: There are 15 districts which come under the Eastern U.P.Maharajganj district being the highest fish producing district was selected purposively. A list of all 12 blocks was prepared on the basis of fish production. Two blocks having highest fish production viz. Partawal, Mithaura and two blocks with lowest fish production viz. Bridzemanganj, Pharenda, were selected purposively. List of villages along with fish production were selected purposively. List of fishers as per three categories viz. Private fish ponds, community fish ponds and leased fish ponds were prepare randomly. Thus, a total of 200, fishers of four blocks were selected for the study. After the preparation of the schedules, actual field work as started and data were collected. Under primary sources, the desired data were collected by personal interview which pertained to the year 2008-2009, the information regarding the fish grower on the sample ponds, family size, income, education, attainment, occupation, number of the family member available for farm work, types of machinery and implements, irrigation structure along with their values were procured data were also obtained for various kinds and level of inputs used and output of main and by products of fish. The input and output prices used were that at which the fishermen had actually sold their output or procured the input.

Method of Data Analysis: The Cobb-Douglas production function is the most widely used form of production functions for fitting agricultural production data, because of its mathematical properties like ease of interpretation and computational simplicity. In the present study the Cobb-Douglas production function in the log form was defined as follows.

$$\text{Ln } Y = \text{In } b0 + b1 \text{ In } X1 + b2 \text{ In } X2 + b3 \text{ In } X3 + b4 \text{ In } X4 + b5 \text{ In } X5 + b6 \ln X6 + \ln u \text{---------} (1)$$

Where,

Y = Output in Rs/ ha

X1= Seeds in Rs/ ha

X2= feed in Rs/ ha

X3= Fertilizer in Rs/ ha

X4= Manure in Rs/ ha

X5= lime in Rs/ ha

X6= Irrigation charges Rs/ha

ln = natural logarithms

u = Error term

The CD function was estimated by using OLS method assuming the error term (u) to be randomly and normally distributed. In this case about half of the observations will lie above and about half below the OLS estimated function. Thus average production function estimated through OLS does not distinguish between technically efficient and technically inefficient farms. It ignores the problem of technical efficiency by assuming that all the techniques of production are identical across farms and as such it assumes that each farmer is technically efficient, which is untrue. Modified the procedure in a number of ways and evolved an output based measure of technical efficiency [1]. The Cobb-Douglas (CD) function was transformed into a deterministic frontier function by imposing a constraint on error terms to be positive. The deterministic frontier was defined as

$$Y = \pi_{i=0}^{n} Xi \; bi \; e \; ui; \; u < 0 \text{ ---------------} (2)$$

Where,

Y = Output

Xi = Inputs

ui = Error term

The production function was estimated using corrected ordinary least square for transforming it to deterministic frontier production function. As a first step, ordinary least square was applied to the CD function to yield best, linear and unbiased estimates of bi coefficients. The intercept estimate (b_0) was then corrected by shifting the function until no residual is positive and one becomes zero. This has been done by adding the largest positive error term to the intercept.

The new production function with the shift in the intercept is the deterministic frontier production function and it gives the maximum output obtainable from given level of input and it would be of the form.

$$\text{In } Y^* = A + \sum_{i=1} bi \; 1nXi + u \;\; u < 0 \text{ …………..} (3)$$

Hazarika and Subramanian (1999) defined technical efficiency as the production of maximum output from a set of given resources**.**

The Timmer measure of technical efficiency (TE) is the ratio of actual output to the potential output on the deterministic frontier production function.

$TE_i = \frac{Yi}{Yi*}$ or $lnTE_i = lnY_i - lnY_i*$ …….(4)

TE_i =Technical efficiency of $_i$th fishers

Y_i= Actual gross return in Rs. Per hectare of $_i$th fishers

Y_i*=potential output (maximum output of $_i$th fishers at present input use

ln = natural logarithms

Yi* is estimated by substituting ith fishers level resources into the estimated deterministic frontier production function. Suggested an alternative approach within the Farrell framework [4]. Here the measure of technical efficiency compared the actual level (Xi) of input used to the level (Xi*) at which it should be used, by pond 'i', to obtain the same output Y, but at the efficient level. This level of input (Xi*) to realize the same output Y is calculated as follows.

If, 1n Y = b0* + b1 lnX1 + b2 lnX2 + …..+ e

Let $R1 = \frac{X1}{X2}$, $R2 = \frac{X2}{X2}$ …… $Rn\text{-}1 = \frac{Xn}{X2}$

Then,

$$lnX2 = \frac{lny - b0 - b1lnRn - 1}{\sum_{i=1}^{n} bi} \quad \text{…………..(5)}$$

1nX1*, 1nX3*………. 1nXn* is calculated in a similar fashion.

X1*, X2*, X3*, X4* …Xn* indicate the frontier values of the corresponding input use. Then, the technical efficiency of the ith pond would be.

$TEi = \frac{X2*}{X2}, = \frac{X1*}{X1}, \ldots = \frac{Xn*}{Xn}$ ------------------(6)

Using Kopp measure of technical efficiency the frontier usage of input was worked out and compared with the actual usage of inputs to know the savings in input use had the pond operated at higher efficiency level. Defined allocative efficiency as the ability of a farm to maximize profit by equating the marginal revenue product of inputs to their respective marginal costs [3]. The concept of allocative efficiency refers to the adjustment of inputs and output to reflect relative prices, the technology of production already having been chosen. These adjustments consider the marginal conditions in such a way that Marginal Value Products (MVPs) should equal Marginal Factor Cost (MFC)for any single variable input, and that marginal value product per unit of input should be equal across different outputs (the principle of equimarginal returns). The notion of allocative efficiency is clearly goal-oriented, in the sense that different goals have different allocative efficiency requirements, unlike technical efficiency in which a producer is technically efficient or inefficient, regardless of the producers' behavioral goals. Allocative efficiency measures the degree of correctness in the adoption of factor proportions to current input prices. A producer is allocatively efficient if production occurs in a sub set of the economic boundary of the production possibilities set that satisfies the producer's behavioral objective. The Allocative Efficiency (AE) in the use of variable inputs is worked as the ratio of,

AEij=MGRj/ OGRij

Where,

MGRj= Maximum possible gross revenue of the jth farm

OGRij= Gross revenue at the optimum level of the ith input with all input remaining at the same level of the activity by jth farmer

Farm specific optimum input level (Xij) Equated by marginal value product of an input with its price.

Xij*=[Pi/bo*]-1/[1-bi]

Pi= per unit price of input (i)

$b_o = \quad bi = \sum_{i=0}^{n-1} bi$

In order to determine optimal use of a resource, keeping the use of other resources constant, MVP and opportunity cost (factor cost) of that resources were compared. The marginal product (MP) was estimated from the parameters of Cobb-Douglas production function and the geometric mean levels of the output and input. The MVP of each resource was calculated. The formulae used to compute MVP is,

$MVP (Xi) = bi . \frac{\bar{Y}}{\bar{X}i} . P_y$……………4)

Where,

bi = Elasticity of production of ith input

$\bar{Y}$ = Geometric mean of output

$\bar{X}$i = Geometric mean of ith input

Py = Price of the product

The criterion for determining optimality of resource use was,

MVP/MFC > 1 underutilization of resource

MVP/MFC = 1 optimal use of resource

MVP/MFC < 1 excess use of resources

Economic efficiency is a combination of technical and allocative efficiencies. Technical and allocative efficiencies are mutually exclusive and exhaustive, so that a producer can be efficient in any one way, or in both ways. Thus a producer is economically efficient in a private sense if, and only if, the producer is technically and allocatively efficient. The simultaneous achievement of both efficiencies provided sufficient condition to ensure economic efficiency.

Farm specific economic efficiency (EEj) can be estimated using the following equation

EEj = TEj X AEj

Where,

TEj == Farm specific technical efficiency of jth farmer

AEj = Allocative efficiency of all inputs on the jth farm

Results and Discussion

The classical production function assumes that all the fishers are technically efficient. Efficiency would be relevant when it is studied in the context of the situation in which the fishers operates. Frontier production function is an approach where the efficiency is studied on a relative basis. The fishers in a particular ponds area evaluated for their efficiency by comparing with the best in their peer group. This is done by shifting the intercept of the average Cobb-Douglas production function upwards top coincide with the most efficient fishers and the rest are compared with this, both in terms of output and input.

The objective of the study was to analyze technical, allocative and economic efficiency in MGD and BHU production systems of aquaculture in the study area. For this purpose, the popularly used Cobb-Douglas production function was fitted. The production parameters of the estimated Cobb-Douglas production function are presented in Table 1.

The coefficient of multiple determinations (R2) was 0.79 for estimated production function of MGD production systems and it was 0.66 for BHU production systems. The high and significant F values indicated that the Cobb-Douglas production function was adequate in explaining 79 per cent of the variation in output MGD production systems and 66 per cent of the variation in BHU production systems due to variations in the resources included in the model. The constant returns to scale were noticed in both the methods since sum of elasticity coefficients was nearly five. An examination of production parameters of Cobb-Douglas function for MGD production systems indicated that aquaculture output was positively and significantly conditioned by all variable inputs except pond for which the positive relation was no doubt observed but was statistically not established.

Table 1: Estimated production function for MGD and BHU aquaculture production systems

S. N.	Particulars	MGD			BHU		
		Regression coefficient	Standard error	t-value	Regression coefficient	Standard error	t-value
1.	Intercept	4.291**	0.373	11.503	5.236**	1.677	3.122
2.	Seed (fingerlings)	0.513**	0.069	7.414	-0.205	0.109	-1.874
3.	Feed	0.075**	0.022	3.411	0.146	0.073	1.995
4.	Manure	0.010	0.025	0.400	-0.065	0.065	-0.997
5.	Lime	0.004	0.025	0.140	0.001	0.132	0.008
6.	Fertilizers	0.093**	0.025	3.744	0.598*	0.261	2.287
7.	Disease control(chemical)	0.064	0.027	2.356	0.061	0.108	0.559
8.	Human labour	0.230**	0.067	3.433	0.217	0.113	1.908
	∑bi	0.989			0.753		
10.	Coefficient of multiple determination (R2)	0.790			0.669		
11.	Adjusted Coefficient of multiple determination (R2)	0.783			0.477		
12.	F value	103.40			3.471		

*Note: Figures in parentheses are standard errors; **Significant at 1% level * Significant at 5% level, respectively.*

Table 2: MVP to MFC ratios of resources in MGD and BHU aquaculture production systems

S.N.	Particulars	MGD			BHU		
		MVP	MFC	Ratio	MVP	MFC	Ratio
1.	Seed (fingerlings)(Kg.)	30.73	117.72	0.26	-32.86	100	-0.32
2.	Feed (Qt.)	7.12	6.00	1.18	7.38	6.00	1.23
3.	Manure (Tonnes)	0.95	112.37	0.008	-3.89	120	-0.03
4.	Lime (Kg)	1.31	8.50	0.15	0.15	6.50	0.023
5.	Fertilizers (Kg)	32.02	12.00	2.66	39.88	12.00	3.32
6.	Disease control (chemical) (Rs)	41.71	295.17	0.14	17.18	80	0.21
7.	Human labour (man days)	4.60	100.00	0.046	3.2	158.65	0.02

S. N.	Per cent Technical efficiency rating	MGD	BHU
1.	≤70%	45 (22.50)	20(100.00)
2.	71% – 75%	21(10.50)	0
3.	76% – 80%	38(19.00)	0
4.	81% – 85%	18(9.00)	0
5.	86%-90%	25(12.50)	0
6.	Above 90%	53(26.50)	0
	Average technical efficiency	84.12	67.76

Table 3: Distribution of fishers according to technical efficiency ratings
Note: Figures in parentheses indicate percent to total

To analyse the scope for intensification of resources in both systems, the marginal value products (MVP) of resources are compared with the respective marginal factor cost (MFC). The MVP and MFC ratios for different resources for both the systems are furnished in Table 2. The MVP-MFC ratios for MGD production systems indicated that there was also true for variable resources like feed and fertilizers as MVP-MFC ratio for these resources was more than one. Nevertheless, MVP-MFC ratio for seed, Manure, lime, disease control and labour items use were less than one and positive indicating that profit could be optimized by using less quantity of labour and bringing down the area under aquaculture. The BHU production systems fishers indicated that there was of labour, lime, disease as the MVP-MFC ratio for all these resources less than one and positive indicating that profit could be optimized by using less quantity of labour and bringing down the area under aquaculture and variable resources like feed and fertilizers as MVP-MFC ratio for these resources was more than one. However, MVP-MFC ratio for seed and manure was negative indicating that BHU production systems fishers could increase their profit by reducing the seed and manure under aquaculture.

The technical efficiency in MGD and BHU systems was worked out by using Timmer method. The distribution of sample fishers according to different technical efficiency ratings along with average technical efficiency for both the systems are presented in Table 3.The average technical efficiency for MGD production systems of aquaculture and BHU aquaculture fishers was 0.84 and 0.67, respectively. About 22.50 per cent of MGD aquaculture fishers and 100.00 per cent of BHU aquaculture fishers were found to operate at technical efficiency rating less than 0.70. Highest 26.50 per cent of MGD aquaculture fishers were operating at technical efficiency rating above 0.90. The amounts of various resources that would have been required for the farmers to produce existing level of output at the highest level of technical efficiency were worked out and these levels of inputs are called as frontier level of input use.

The average allocative efficiency and economic efficiency of MGD aquaculture fishers and BHU aquaculture fishers are presented in Table 4 and Fig. It could be seen from the table that allocative efficiency (0.557) of MGD aquaculture fishers was more than the allocative efficiency of BHU aquaculture fishers (0.440). In both the systems fishers were operating at less allocative efficiency than the technical efficiency. In other words, allocative inefficiency was higher than the technical inefficiency in both the systems of aquaculture production. The average economic efficiency for MGD aquaculture fisher's and BHU aquaculture fishers was 56.99 and 24.58, respectively.

Table 4: Technical, allocative and economic efficiency in aquaculture (%)

Sl. No.	Particulars	MGD ponds systems	BHU ponds systems
1.	Technical efficiency	84.12	67.76
2.	Allocative efficiency	55.75	44.09
3.	Economic efficiency	56.99	24.58

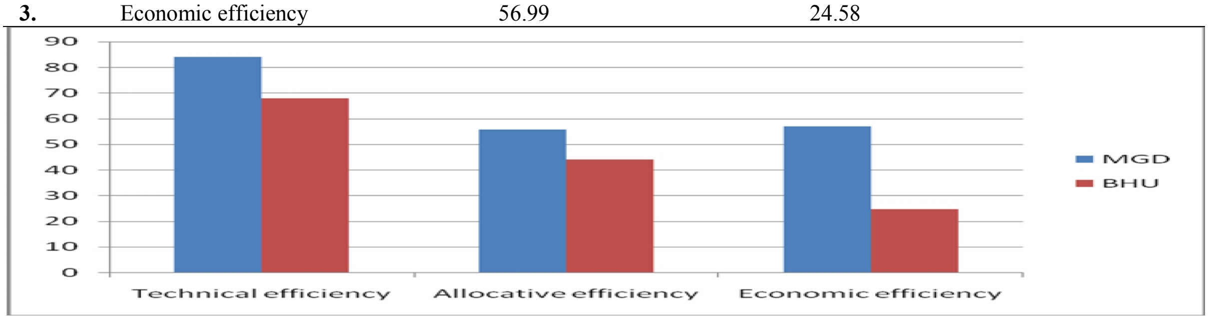

Fig : Technical, allocative and economic efficiency in MGD and BHU Aquaculture production systems.

Conclusion: The average technical efficiency for MGD production systems of aquaculture and BHU aquaculture fishers was 0.84 and 0.67, respectively. About 22.50 per cent of MGD aquaculture fishers and 100.00 per cent of BHU aquaculture fishers were found to operate at technical efficiency rating less than 0.70. Highest 26.50 per cent of MGD aquaculture fishers were operating at technical efficiency rating above 0.90.The average allocative efficiency and economic efficiency of MGD aquaculture fishers and BHU aquaculture fishers are presented in Table 4 and Fig. It could be seen from the table that allocative efficiency (0.557) of MGD aquaculture fishers was more than the allocative efficiency of BHU aquaculture fishers (0.440). In both the systems fishers were operating at less allocative efficiency than the technical efficiency. In other words, allocative inefficiency was higher than the technical inefficiency in both the systems of aquaculture production. The average economic efficiency for MGD aquaculture fisher's and BHU aquaculture fishers was 56.99 and 24.58, respectively**.**

References

1. R. Timmer, R. ter Heide, H. J. Wobben, P. J. de Valois. (1971). Phenolic Compounds in Rum. *Journal of Food Science*, 1365-2621.
2. Hazarika, C., Subramanian, S.R., (1999). Estimation of technical efficiency in the stochastic frontier production function model: An application to the tea industry in ASAM. *Indian Journal of Agricultural Economics*, V54(2): 201-211.
3. Farrell, M.J. (1957). The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society*, 120, 253-290.
4. Kopp, R.J. *(1981)*. "The Measurement of Productive Efficiency: A Reconsideration." *Quarterly J Economics*, 96(3): 477-503.