# Resource Use Efficiency in Brinjal Production: an Empirical Study of Mau District of Uttar Pradesh

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## Abstract

The main purpose of this empirical study is analysed level of resource use of brinjal produced by growers. The growth rate of population is very high, to fulfil requirement of food of human only few solutions. The resources are very scared so it would not proceed to increase the production but it would be done by optimization of resources. To get perform this work it must to analyse resource use efficiency to aware that up to what level the resources had used which has been carried out in this research. In Mau district, it has found that the value of $R^2$ 0.93, 0.93 and 0.82 of marginal, small and medium farmers which shown that 93 per cent, 93 per cent and 82 per cent of variation in farm yield have explained by explanatory variables which reflect higher magnitude of resource use efficiency. Sum of elasticities have indicated decreasing returns to scale.

## Introduction:

Brinjal (Solanum melongena L.) belongs to the family Solanaceae and is one of the popular vegetable crops grown in India, as well as, other parts of the world. It is known as Brinjal in India and Aubergine in Europe. It is grown throughout the year under tropical and subtropical conditions except higher altitudes and usually cocked in common men's kitchen of India. It is undoubtedly of Indian origin and has been cultivated since long time (Thompson and Kelly, 1967).

Overall, this favourite vegetable is counted in the top ten vegetables of the world. Around one quarter of the world production is occupied by India. In the world area, production and productivity of brinjal in year 2016 was 1.79 million ha, 51.29 million tons and 28.59 tons per ha, respectively (source – www.faostat3.fao.org). It is widely grown in India, China, Egypt, Turkey, Iran, Indonesia, Iraq, Japan, Italy, Philippines and several African countries.

Asia content is main producer of brinjal as China covers 53% of the brinjal production. India contributes 28% production and Turkey 4% (Daunay et al., 2001). China is leading having first rank in production with 32.03 million metric ton (MT), area with and 0.78 million ha and productivity with 40.96 MT/ha, respectively in the whole world during the year 2016-17. India is the second largest producer of brinjal being cultivated over an area of 730.4 (000, ha), production 12800.8 (000, MT) with an average annual production of 17.5 million tons per ha in the year 2017-18 (source – www.faostat3.fao.org).

It is the fourth most important vegetable after potato, onion and tomato in India. Brinjal is primarily grown by marginal, small and medium farmers for home consumption as well as serve as source of income in India.

Even though, the experience with cultivation of Bt. cotton (*Bacillus thuringiensis*) in India has provided a strong evidence to convince various stakeholders about the benefits of GM or biotech crops, concerns have been expressed about the ability of small farmers to adopt the biotech crops cultivation, which involves issues like large capital, new skills, affordability, etc.

Brinjal crop is cultivated in Uttar Pradesh over an area of 8.01(000, ha) with an annual production of 275.40 (000, million tons) and productivity of 34.40 (MT/ha) in the year 2017-18 (www.faostate3.fao.org) while the West Bengal ranks 1st having the area and production of 163.15 (000, ha) and 3027.00(000, million tons), respectively in the year 2017-18. However, U.P. is on apex in the productivity over India.

Now-a-days, the demand for brinjal as a fruit vegetable is increasing rapidly among the vegetable consumers viewing its better fruit colour, size and taste. Average productivity of brinjal crop is quite low and there exists a good scope to improve its average productivity in India in general and the State of Karnataka, in particular to fulfil the both domestic and national needs.

Brinjal is almost cultivated in all parts of India except higher altitudes. It is susceptible to severe frost. Nick named Eggplant is a perennial vegetable crop but cultivated on commercial level as an annual crop. Along and warm growing season with a mean temperature of 20-30 $^0$C is most favourable for its successful production. In northern India, it is adversely affected during December to February due to low night temperature. The main crop of brinjal is raised during autumn-winter season however, some population cultivates during spring-summer season also. But during spring-summer season, high temperature (above 35 $^0$C) causes drastic reduction in brinjal production due to poor fruit set.

Plant nutrition plays a vital role for increasing yield and quality of brinjal. Eggplant can be successfully cultivated in any good agricultural soil by using suitable management practices. However, a deep fertile and well-drained sandy loam or silt loam soils with a pH of 5.5 - 6.8 and rich with organic content are advantageous for its cultivation (Kiran, 2006).

Brinjal being the most important to the growers and consumers, there is pressing need to study the profitability of brinjal crop; considering the available resources at farmers' field. Hence, present paper is an effort to assess the resource use efficiency in brinjal production of Mau district of Uttar Pradesh.

## Methodology:

## Data collection:

Particularly primary data has implemented in this empirical study of resource use efficiency. The pre-structured and pre-tested schedules have used to collect the of famers from village. The multi-stage stratified random sampling has implemented for taking the sample from the population. The sampling procedure has started by purposively selection of Uttar Pradesh state and Mau district. In Mau district, total number of block nine and their area of brinjal production have listed. The Fatehpur Mandav block has maximum area of brinjal crop selected for study. In this block, we have randomly selected five village namely Katghara Shankar, Kakaradih, Hasanpur Nemdar, Dharawal Ptrawn and Gothari and their area of brinjal 146, 153, 134, 141 and 126 respectively out of 700 population. Total number of hundred samples have taken from total population on random sampling basis and categories into marginal, small and medium farmers. Under marginal farmers category 75, small famers 14 and medium farmers 11 have occurred out of hundred samples.

## Econometric Model:

In the procedure of data analysis both tabular and functional analysis have been implemented. The cobb-Douglas production function has applied to analysis of data. The mathematical form of cobb-Douglas production function is,

$$Y = aX_1^{b1}\ X_2^{b2}\ X_3^{b3}\ X_3^{b4}\ X_4^{b4}\ X_5^{b5}\ X_6^{b6}e^u$$

Where, 'Y' denotes per ha output (Rs.), 'a' is an intercept, $X_1$ is Seed cost (Rs.), $X_2$ is total human labour (Rs/ha), $X_3$ is Machinery charges (Rs.), $X_4$ is irrigation charges (Rs./ha), $X_5$ is Manure and fertilizers (Rs. ha), $X_6$ is Plant protection charges (Rs.) and $e^u$ Error terms $b_1$, $b_2$, $b_3$, $b_4$, $b_5$ and $b_6$ production elasticity of the respective input variables.

## Techniques of estimation of parameters:

The formula has used for estimating parameters of the function based on sample data. The marginal value product of resources was analyzed by following formula:

$$MVPxj = \frac{bj\bar{y}}{\bar{x}j} \qquad (J = 1, 2, \ldots\ldots k.)$$

Where, MVPxj is the marginal value product of $j^{th}$ input bj production elasticity of with respect to xj, $\bar{y}$ Geometric mean of Y, and $\bar{x}$j geometric mean of the independent variable X.

## Hypothesis testing:

Having, the estimated elasticity of coefficients and desirable to ascertain the relativity of these estimates. The t-test was implemented to test, whether bj is statistically significant or not at some specified probability level.

$$t - cal.value = \frac{bj}{SE\ of\ bj}$$

If the calculated value of 't' is greater than the table value of 't' at specified probability level and n-k-1 degree of freedom, bj is said to be statistically significantly different from the zero (k is the number of independent factor and n is sample size).

F-test has applied to test the significance of the regression as a whole.

$$F = \frac{regression\ mean\ square}{error\ mean\ square} = \frac{SRR/k}{\sum e2/n-k-1}$$

Where, SRR = Sum of square due to regression, $\sum e^2$ is the sum of square of error term MVP of $j^{th}$ input factor has tested by using formula:

$$t = MVPj / S.E.\ of\ MVPj$$

$$SE\ of\ MVPj = (\bar{y}/\bar{x})\ standard\ error\ of\ bj$$

## Results and Discussion:

## Cost of Cultivation:

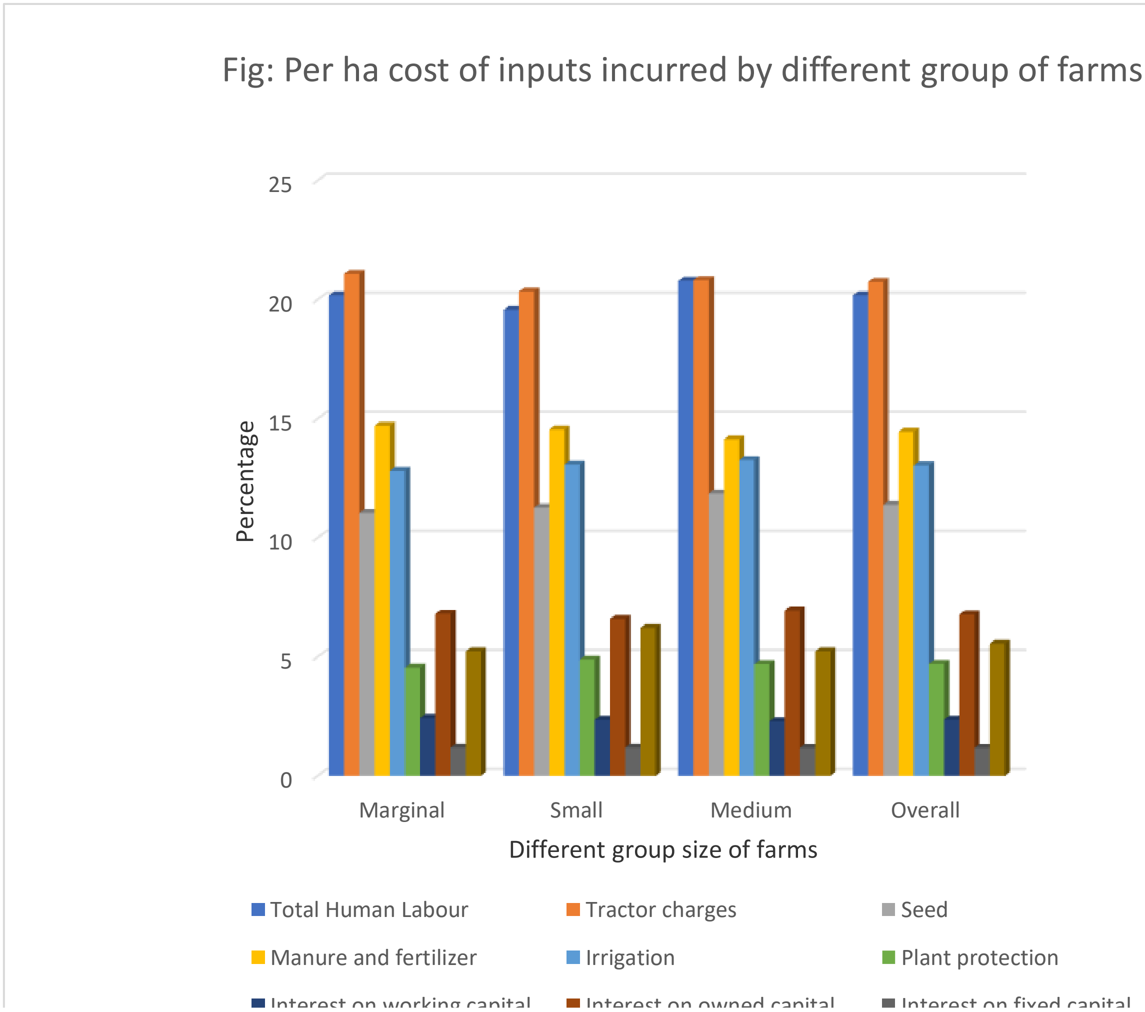
The per ha cost of the cultivation of different factors have mentioned in table no. 1. which indicates that the average cost of cultivation (per ha) of brinjal was ₹ 94355.67. In case of marginal farm cost of cultivation was very high about ₹ 98091.00 followed by small farm ₹ 93549.55 and medium farm ₹ 91426.46, respectively.

The total cost on marginal farms has observed maximum due to heavy expenditure on the machinery charges about 21.08 percent followed by charge of human labour about 20.18 percent and fertilizers and manures charges about 14.70 percent of the total cost, respectively. The study further reveals that in case of small farms, cost incurred on tractor charges about 20.34 per cent followed by total human labour 19.57 per cent and manure and fertilizers 14.54 per cent of the total cost, respectively and on medium farms, cost incurred on total machinery charges about 20.82 per cent followed by human labour charges about 20.79 per cent and charges of manure and fertilizers 14.13 per cent of the total cost, respectively.

The further distribution of costs on aver all average, reveals maximum expenditure charges of tractor 26.74 per cent followed by charges of total human labour 20.18 per cent and manure and fertilizers 14.45 per cent of the total cost, respectively. It has been realized that per ha cost of cultivation and holding size inversely related in the study area.

Table No. 1. The Per hectare cost (₹) of various input factors applied by different size group of farms in the study area:

| Sl. No. | Inputs | Categories of sample farms | | | Total |
|---|---|---|---|---|---|
| | | Marginal | Small | Medium | |
| 1. | Human Labour (i + ii) | 19794.76 (20.18) | 18307.64 (19.57) | 19007.56 (20.79) | 19040.97 (20.18) |
| i. | Family labour | 2530.74 (2.58) | 1421.95 (1.52) | 1700.53 (1.86) | 1868.24 (1.98) |
| ii. | Hired labour | 17264.01 (17.60) | 16885.69 (18.05) | 17307.02 (18.93) | 17163.29 (18.19) |
| 2. | Machinary charges | 20677.58 (21.08) | 19027.97 (20.34) | 19034.98 (20.82) | 19569.36 (20.74) |
| 3. | Seed cost | 10829.24 (11.04) | 10533.67 (11.26) | 10834.03 (11.85) | 10737.67 (11.38) |
| 4. | Manure and fertilizers | 14419.37 (14.70) | 13602.10 (14.54) | 12918.55 (14.13) | 13634.39 (14.45) |
| 5. | Irrigation charges | 12565.45 (12.81) | 12226.92 (13.07) | 12123.14 (13.26) | 12303.97 (13.04) |
| 6. | Plant protection | 4453.33 (4.54) | 4565.21 (4.88) | 4287.90 (4.69) | 4434.71 (4.70) |
| 7. | Interest on working capital | 2383.61 (2.43) | 2207.76 (2.36) | 2093.66 (2.29) | 2226.79 (2.36) |
| 8. | Interest on owned capital | 6679.99 (6.81) | 6164.91 (6.59) | 6344.99 (6.94) | 6397.31 (6.78) |
| 9. | Interest on fixed capital | 1557.47 (1.18) | 1103.88 (1.18) | 1069.68 (1.17) | 1103.96 (1.17) |
| 10. | Rental value of land | 5130.15 (5.23) | 5809.42 (6.21) | 4781.60 (5.23) | 5236.73 (5.55) |
| | Grand total | 98091.00 (100) | 93549.55 (100) | 91426.46 (100) | 94355.67 (100) |




## Resource use efficiency:

The Cobb-Douglas production function has applied to find out the efficiency of various resources used in the production of brinjal crop. The value of elasticity of production, standard error, coefficient of multiple determination and return to scale for brinjal cultivation on different group size of farms are presented in Table-1.2. The high value of $R^2$ of the fitted function indicates that sufficient and large proportion of total variation in the dependent variable is explained by the inputs included in function. The Table further indicates that six variables *viz.* seed cost, human labour, machinery charges, irrigation charges, manure and fertilizers and as well as plant protection charges jointly explained 93.88, 93.14 and 82.93 per cent variation on dependent variable of marginal, small and medium farms, respectively.

Value of sum of elasticities or returns to scale on all size group of farms have observed less than unity which indicates that the functional analysis is of diminishing nature in the study area.

Table-1.2: Resource use efficiency of brinjal crop on different size group of farms in the study area:

| Size group of sample farms (ha) | Production elasticity | | | | | | Sum of elasticity | $R^2$ |
|---|---|---|---|---|---|---|---|---|
| | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | | |
| Marginal | ** 0.1710 (0.0524) | ** 0.3020 (0.0224) | 0.0261 (0.0484) | 0.0175 (0.0143) | ** 0.1632 (0.0207) | ** 0.1103 (0.0348) | 0.9689 | 0.9388 |
| Small | 0.2246 (0.1589) | * * 0.2761 (0.0667) | 0.0438 (0.1543) | 0.0165 (0.0410) | 0.1281 (0.0426) | ** 0.0305 (0.1204) | 0.9651 | 0.9314 |
| Medium | 0.1905 (0.1425) | ** 0.2695 (0.0915) | ** 0.1324 (0.0368) | 0.0197 (0.0415) | 0.0531 (0.0217) | 0.1230 (0.1234) | 0.9107 | 0.8293 |

(Note: figure in parenthesis indicates standard error of respective variable)

*Significant at 1 percent level

**Significant at 5 percent level

Where, $X_1$, $X_2$, $X_3$, $X_4$, $X_5$ and $X_6$ denote seed cost, total human labour, machinery charges, irrigation charges, manure and fertilizers and plant protection charges.

## Marginal value of productivity:

From Table 1.3, it is observed that the MVP of seed cost, total human labour, machinery charges, manure and fertilizers and plant protection was greater than unity, which indicates further scope to increase the quantity of these resources to realize more return from brinjal crop in the study area. The MVP of Irrigation charges was less than unity, which also indicates that the excessive utilization of irrigation was made in the study area which need further adjustment on utilization of fertilizer in the study area to realise optimum return.

In case marginal farms $X_1$, $X_2$, $X_5$, and $X_6$ variables were found statistically significant at 5 per cent and 1 per cent level while $X_3$ and $X_4$ variables were found statistically non-significant. In case small farms $X_2$ and $X_5$ variables were found statistically significant at 5 per cent level of significance. In case small farms $X_2$ and $X_3$ variables were found statistically significant at 5 per cent level of significance.

Table-1.3: Marginal Value of Productivity (MVP) of included factors in production process of the brinjal crop in the study area:

| Size group of farms | MVP | | | | | |
|---|---|---|---|---|---|---|
| | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ |
| Marginal | 9.1200 | 42.9500 | 1.4525 | 0.9015 | 11.7357 | 42.7800 |
| Small | 119.20 | 3.9592 | 16.5754 | 0.8412 | 9.2096 | 11.7813 |
| Medium | 83.7600 | 3.7747 | 7.3210 | 49.1185 | 3.7478 | 45.1700 |

## Conclusion:

Overall, after the empirical measurement of this study it has concluded that brinjal production by the farmers of Mau district are profitable. They are using various resources of brinjal production efficiently. But in case of some resources i.e., irrigation and fertilizer are overutilizing due to lack of sufficient knowledge so there are need to getting scientific information about this aspect to applied optimum level of resources.

Under the marginal farms, the elasticity of production with respect to seed cost, total human labour, manure and fertilizers and plant protection charges were statistically significant. Under small farms, the elasticity of production of total human labour as well as manure and fertilizers were found statistically significant and under medium farms, total human labour and irrigation charges were found statistically significant.

In case of brinjal, returns to scale on marginal, small and medium size of sample farms characterized by decreasing returns to scale. Out of total variation in dependent variable explained by independent variables *i.e.*, seed cost, total human labour, machinery charges, irrigation charges, manure and fertilizers and plant protection which were found significant at 5 per cent and level of significance. $R^2$ was found to be 0.93, 0.93 and 0.82 which means that 93 per cent, 93 per cent and 82 per cent marginal, small and medium farms of the variation in yield was explained by independent variables which reflect higher magnitude of resource use efficiency. Sum of elasticities indicates decreasing returns to scale. Marginal Value Productivity of different inputs except irrigation charges used in brinjal crop grown were found more than units which indicates that there was further scope of investment on these factors but irrigation need to decrease to obtain optimum return from the brinjal crop in study area.

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