**RESOURCE USE EFFICIENCY ANALYSIS FOR THE CUCUMBER PRODUCTION IN THE BISHNUPUR DISTRICT OF MANIPUR AND SEPAHIJALA DISTRICT OF TRIPURA,INDIA**

**Abstract**

Vegetable crops offer high yields, better profits, and job opportunities, making diversified agriculture successful in the northeastern region. Cucumbers are a popular and in-demand crop, especially among small and marginal farmers due to low cultivable land. The research study's conclusions regarding the cultivation and marketing of cucumbers in the Northeastern states of Tripura and Manipur are emphasized in this article. Data was collected from 80 respondents by adopting random sampling in 2022–2023. The study used a production function approach to analyse the efficiency of various input resources in cucumber production. The Cobb Douglas production function was used for Manipur and Tripura farms to fit the analysis. Factors affecting crop yield were identified, such as seeds, fertilizer, plant protection chemicals, human labor charges, and organic manure. The results showed that the unadjusted coefficient of multiple determinations (Ṝ2) was 0.62 and 0.58, respectively, which explained 62 and 58% of the variation in output. The remaining 38 and 42% variation in total output was explained by factors not included in the model. In Manipur, all coefficients of seed, plant protection chemical, and organic manure were positively significant at a 1% level of significance. In Tripura, all coefficients of fertilizer, human labor, and organic manure were positively significant at a 1% level of significance and also examined the relationship between the average value productivity of a resource with the factor's cost about resource use efficiency in cucumber production. The optimal resource use efficiency of a particular input occurs when the marginal value product (MVP) and marginal factor cost (MFC) are equal, or when MVP/MFC=1. The calculated values of the ratio of marginal value product to marginal factor cost were less than unity except for fertilizer in Tripura, indicating that seed, fertilizer, PPC, and organic manure in Manipur are overutilized, and fertilizers in Tripura are underutilized.

Keywords: Cobb Douglas, production function, Resource Use efficiency, Marginal value product, Marginal factor cost

**INTRODUCTION**

Horticulture is one of the most profitable industries; it may be found in agroecosystems such as coastal regions, hilly arid places, and dry plains with occasional rain. Horticultural crops are highly recognized for their superior yield, increased potential for export, enhanced returns, and employment-generating qualities. Most horticultural crops are not only much more environmentally benign than field crops, but they also have input-output ratios that are significantly greater (Nabi and Bagalkoti, 2017). The area increased to 28.44 million hectares, and the production rose to 355.48 million tonnes. This represents an increase in production by approximately 8.30 million tonnes, or 2.39%, compared to 2021-22. The area under horticultural crops also saw a growth of 0.40 million hectares, marking a 1.41% rise from the previous year (PIB,2024).

As important suppliers of protein, carbs, vitamins, and minerals, vegetables are an important part of a balanced diet. Due to their short growing seasons, most vegetables are ideal for intensive cropping systems, where they can provide growers with profitable yields (Singh and Devi, 2015). Production of vegetables has increased from 209.14 Million Tonnes in 2021-22 to 212.55 Million Tonnes in 2022-23 (Final Estimates) (PIB, 2024). Despite utilizing only 13.1% of the gross planted land, the horticulture industry generates approximately 30.4 per cent of agriculture's GDP (Tiwari *et al.,* 2021). Appropriate agroclimatic conditions, ranging from temperate to tropical and subtropical zones, offer plenty of opportunities for its cultivation in Manipur and Tripura. The horticultural business has just recently started to show signs of expansion, despite these obvious advantages. This is due to the large lag between the development and uptake of new technology. Lack of investment is another major factor contributing to the United States' horticultural development lag. Just 16% of the region's land is planted, and the overall area under cultivation—including that used for numerous crops—doesn't go above 22%. (Dikshit and Dikshit, 2014).

*Cucumis sativa L.,* a vegetable belonging to the Cucurbitaceae family, is highly valued for its vitamins, minerals, and antioxidants, and is a staple crop for fresh consumption across the globe. Because it is 90% water, cucumbers are low in calories and offer excellent hydration (Sallam *et al.,* 2021).  Cucumber is a very popular vegetable worldwide. In 2023, the area harvested for cucumbers and gherkins in India was 28,575 hectares, with an average yield of 6,407.8 kilograms per hectare, resulting in a total production of approximately 183,102.4 tonnes (FAOSTAT,2023). Due to its high productivity, demand, and high market price in NE Region of India, it is a potential crop for doubling the income of small and marginal farmers of the region. However, cucumbers need to be marketed quickly because they are perishable and their prices fluctuate in the market. Consumer prices are high and unstable, while farmers only receive a small share of these prices and with farmers, there is no trustworthy source of market information (Kalita, 2017).

Cucumber production is aided by certain inputs or resources that increase productivity. The productivity of cucumbers is enhanced by using the resources efficiently. Resource use efficiency differs from farmer to farmer due to various reasons may be access to inputs, socio-economic condition of the farmers, non-availability of suitable high-yielding varieties of seed, low, unbalanced, and untimely use of chemical fertilizers, irrigation, plant protection measures, technical knowhow, etc*.* These variations, combined with an inefficient use of various resources and constraints faced by the farmers, resulted in low productivity, and lower returns, Most of the existing studies on resource use efficiency in horticulture are focused on agriculturally advanced states such as Punjab, Maharashtra, and Tamil Nadu (Singh and Sirohi, 2006). The Northeast is ecologically sensitive with varying agro-climatic conditions, but few studies analyze how local climate variability affects productivity and resource use in horticulture (Singh and Hussain, 2017). In contrast, there is a noticeable lack of empirical research from the northeastern states of India, particularly at the district level. This gap highlights the need for region-specific studies to understand the unique challenges and opportunities; hence, a study has been conducted to examine the resource use efficiency in the Bishnupur district of Manipur and the Sepahijala district of Tripura.

**METHODOLOGY**

Bishnupur district in Manipur and Sepahijala district in Tripura were selected purposively, as these districts had more prospects in cucumber cultivation with the highest area. Two blocks i.e., Charilam RD Block in the Sepahijala district of Tripura and Bishnupur RD Block in the Bishnupur district of Manipur were selected based on the concentration of cucumber farmers. A total of four villages were selected purposively from two blocks of which two villages were taken from Bishnupur block viz, the Kwasiphai village, the Nachou, and the other two villages viz, the Chesrimai, the Uttar Charilam were taken from Charilam block based on the number of cucumber growers. A sample of 80 respondents was selected using the Simple Random sampling technique.

**Production function of cucumber:**

Cobb-Douglas production function was used to analyse the relationship between output and input variables, estimate production elasticities, return to scale, marginal value product of inputs etc. This method has wide acceptability, theoretical fitness to agricultural data and simplicity in the calculation. The general form model specified for the present study is given below:

y = b0xibieu---------- (i)

Specified production function y=b0x1b1x2b2x3b3x4b4x5b5eu-------------(ii)

Production function transformed into log linear

lnY=ln b0+ b1ln x1+ b2ln x2+ b3ln x4+ b4ln x4+ b5ln x5+ eu---------(iii)

The following independent variables were selected for fitting and estimation of Cobb-Douglas production function for Cucumber cultivation in Tripura and Manipur:

where;

|  |  |  |
| --- | --- | --- |
| y  | = | yield (kg/ha)  |
| x1 | = | seed (Rs./ha) |
| x 2 | = | expenses on chemical fertilizer (Rs./ha) |
| x 3 | = | expenses on plant protection chemicals (Rs./ha) |
| x 4 | = | Human labour (Rs. /ha) |
| x 5 | = | Organic Manure (Rs. /ha) |
| b0 | = | constant term  |
| bi | = | elasticity coefficients (i = 1, 2, ......, 4)  |
| eu | = | error term |

**Multicollinearity:**

The seriousness of multicollinearity among the independent variables was tested using correlation analysis.

**Test for significance:**

**F-test:** Overall significance of regression coefficients was tested using F-test. This test aims at finding out whether the explanatory variables do actually have any significant influence on the dependent variable. The calculated F value was compared with the F table value at v1 = (k-1) and v2 = (n -k) degrees of freedom. The expression for F-test is as under-

F = $\frac{R^{2 }(n-k)}{\left(1-R̅^{2}\right)(k-1)}$ ---------(v)

where;

|  |  |  |
| --- | --- | --- |
| R2 | = | coefficient of unadjusted multiple determinations |
| R̅2 | = | coefficient of adjusted multiple determinations |
| n | = | number of observations in the sample |
| k | = | Number of parameters in the model |

**Coefficient of unadjusted multiple determination:**

In order to ascertain the goodness of fit, the coefficient of multiple determinations (R2) will be calculated using the formula;

R2 = $\frac{RSS}{TSS}$ ---------(vi)

where;

RSS = regression sum of squares

 TSS = total sum of squares

**Coefficient of adjusted multiple determinations (R̅2)**

The adjusted value of R2 is denoted as R̅2 and will be calculated as;

R̅2= 1-(1-R2)$\frac{n-1}{n-k}$ ---------(vii)

where;

R2 = Unadjusted multiple correlation coefficient

n = number of observations

 k = number of parameters estimated

**Resource use efficiency:**

Economic rationale of resource use of farms was examined by comparing the marginal value product of a given resource with the marginal factor cost (allocative efficiency).

AExi= $\frac{MVP\_{xi}}{MFC\_{xi}}$ ---------(viii)

where;

AExi = allocative efficiency of ith input

MVPxi = marginal value product of ith input

MFCxi = marginal factor cost of ith input

If the marginal value product of ith factor is greater or less than the marginal factor cost of ith factor, it is said that the resource is not used optimally. For optimal use of an ith resource, the marginal value product of the ith factor/resource should equal to marginal factor cost of the ith factor/resource.

**Estimation of marginal value productivity:**

 The marginal value product (MVP) of a particular resource represents the expected addition to the gross returns caused by an additional unit of that resource, while other inputs are held constant. The marginal value productivities (MVPs) of different resources were calculated by multiplying the marginal physical product of the ith input by the unit price of the output.

MVPxi = MPPxix Py

MVPxi = bi $\frac{y̅}{x̅\_{i}}$(Py) (∵MPPxi= bi $\frac{y̅}{x̅\_{i}}$ ) --------(ix)

where;

MPPxi = marginal physical product of ith input

Py = price of output per unit (Rs.)

y̅ = geometric mean of the output

$x̅\_{i}$ = geometric mean of ith input

bi = regression coefficients (i = 1,2, ......, 6)

**Estimation of marginal factor cost:**

The marginal factor cost indicates the cost of an additional factor used in the production of an output. The factor cost of different resources will be worked out by taking per unit charges of the respective resource.

MFCxi = Pxi---------(x)

where;

MFCxi= marginal factor cost of ith input

Pxi = unit price of ith input

**Marginal value product and factor cost ratio:**

To evaluate the economic rationale of resource use of farms, the marginal value productivities of an ith input (MVPxi) will be equated with its marginal factor cost (MFCxi). If the ratio of marginal value productivities and marginal factor cost is greater than one, then more input has to be added in the production and if it is less than one, less input should be used and if it is equal to one then existing input use level should be continued.

$\frac{MVP\_{xi}}{MFC\_{xi}}$ ----------- (xi)

1. MVP/MFC=1, implies that resources are used efficiently in the study area.
2. MVP/MFC>1, implies resources are underutilised and increasing the rate of use of that resource will help increase productivity.
3. MVP/MFC<1, implies resources are over utilised and reducing the rate of use of that resource will help improve productivity.

To test the significance of the difference between the ratio of Marginal value productivity of inputs to their respective prices and unity will be tested by employing the following formula:

tcal=$\frac{MVP\_{xi}-P\_{xi}}{SE (MVP\_{xi})}$ ----------- (xii)

where;

 SE(MVPxi) = $\sqrt{AVP\_{xi }V(b\_{i}}$)

AVPxi= Average value product of ithinput

 V(bi) = SE$(b\_{i})^{2}$ = Variance of ith elasticity coefficient

The tcal value was compared with ttab value at the chosen level of probability. If tcal > ttab shows statistically significance, which would indicate the condition of deviation from optimality in resource use and hence the existence of resource use efficiency.

**RESULT AND DISCUSSION**

A production function approach was used to analyze the efficiency of the various input resources. As a result of the functional analysis, the ratio of marginal value productivity to factor cost has been calculated in order to analyze the resource use efficiency for two states of cucumber growers. Details of the analysis were presented.

 To fulfil the analytical requirements of the study’s second objective, farms were fitted using the estimated Cobb Douglas production function for Manipur and Tripura farms. The below-mentioned variables were used to determine the factors affecting the yield of the crop.

y=b0x1b1x2b2x3b3x4b4x5b5eu

X1= seeds

X2= Expenses on fertilizer

X3= expenses of plant protection chemicals

X4= human labour charges

X5= expenses on organic manure

The effects of different independent variables on output variable, resource use efficiency, and response to scale were studied using the estimated coefficients of the production function. Below are provided and discussed the estimated regression coefficients, and the adjusted coefficient of multiple determinations (R) value.

 The results were presented in Table 1 of the production function analysis for cucumber. In the analysis as pointed out earlier five independent variables were taken based on their importance.

**Table1 Estimated production function for different states of sample farms of cucumber**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Farm Category  | No.of obs. | Intercept | Regression coefficient (bi) |  |  |  |
|  |  |  | X1 (Seeds) | X2(Fertilizer) | X3(PPC) | X4(HL) | X5(OM) | ∑bi | F | AdjṜ2 |
| Manipur | 40 | 2.61 | 0.19\*\*\* | 0.11\* | 0.26\*\*\* | 0.03 | 0.43\*\*\* | 0.98 | 13.79 | 0.62 |
| Tripura | 40 | 0.89 | 0.04 | 0.63\*\*\* | 0.02\* | 1.18\*\*\* | 0.44\*\*\* | 2.46 | 9.71 | 0.58 |

 \*\*\* Significant at 1 percent probability level and \*Significant at 10 percent probability level

A careful look at the estimated production function for cucumber in the case of Manipur and Tripura presented in Table 1 shows that the values unadjusted coefficient of multiple determinations (Ṝ2) was 0.62 and 0.58, respectively, and was found to be statistically significant. This shows that the explanatory variables taken in the regression model explained 62 and 58 percent of the variation in output. The remaining 38 and 42 percent variation in total output is explained by the factors not included into the model. In Manipur, All the coefficients of seed, plant protection chemical and organic manure were positively significant at 1% level of significance. The regression coefficient of fertilizer was positively significant at 10% level of significance. The study revealed that an increase in 1% cost of fertilizer, seed, plant protection chemical, organic manure increases and, remaining the other factors constant would increase the gross returns of cucumber by 0.11, 0.19, 0.26, and 0.43 percent respectively. In Tripura, All the coefficients of fertilizer, human labour, and organic manure were positively significant at a 1% level of significance. The regression coefficient of plant protection chemicals was positively significant at 10% level of significance. The study revealed that an increase in 1% cost of plant protection chemical, organic manure fertilizer, and human labour, increases remaining the other factors constant would increase the gross returns of cucumber by 0.02, 0.44, 0.63, and 1.18 percent respectively. The sum total of all the production co-efficient of the equation for cucumber production in Manipur was 0.98. This indicates that the production function exhibits decreasing returns to scale. The sum total of all the production co-efficient of the equation for cucumber production in Tripura was 2.46. This indicates that the production function exhibits increasing returns to scale.

**Resource use efficiency of sample farms of cucumber**

The average value productivity of a resource with the factor’s cost was studied in relation to resource use efficiency in the production of cucumbers. Only variables with a statistically significant and having positive effect on the dependent variable were used to study resource use efficiency. The optimal resource use efficiency of a particular input is occurred when the marginal value product (MVP) and marginal factor cost (MFC) are equal, or when MVP/MFC=1. The degree of inefficiency in resource use is indicated by the disparity between marginal value product and marginal factor cost. If the ratio is less than one, indicates that more profit can be obtained by using less amount of inputs. The relationship between the marginal value product and marginal factor cost of various variables for both states is presented in Table 2.

**Table 2. Allocative efficiency of cucumber of sample farms of Manipur and Tripura states**

|  |  |  |
| --- | --- | --- |
| Sl.no | State | Allocative efficiency (MVP/MFC) for different inputs |
| Seed | Fertilizer | PPC | Human Labour | Organic Manure |
| 1 | Manipur | 0.83 | 0.6 | 0.15 |  | 0.03 |
| 2 | Tripura | - | **2.61** | 0.22 | 0.02 | 0.14 |

Conclusion

Resource use efficiency analysis using Cobb Douglas production function, it was found that in the case of Manipur and Tripura farms, the values unadjusted coefficient of multiple determinations (Ṝ) was 0.62 and 0.58 respectively, and found statistically significant. The regression coefficients for Manipur farms showed that seed, fertilizers, PPC, and Organic matter had a significant impact on the output whereas in Tripura, fertilizers, PPC, human labour, and Organic matter were found to have a significant impact on output. The calculated values of the ratio of marginal value product to marginal factor cost less than unity except for fertilizer in Tripura on an overall farm basis indicating that seed, fertilizer, PPC, and organic manure in Manipur are overutilized. In Tripura, fertilizers were found to be underutilized.

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