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Resource use efficiency analysis for watermelon production in Haryana and Karnataka

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Abstract

The *Citrullus lanatus* (Watermelon) is one of the most important fruit crop grown in tropical regions and eaten around the world. Generally, the smallholders' farmers, especially those located in remote villages are inadequately informed about technical knowledge, inputs and efficient use of resources causing poor production and low productivity. Thus, the present study aimed to examine the efficiency of resources used in watermelon production in Haryana and Karnataka. The total of 120 watermelon growing respondent farmers were selected using multi stage sampling technique from the two watermelon growing states in 2022. In Haryana, the results showed that, the estimated MVP/MFC ratio (Resource use efficiency) of different inputs used in production was revealed as positive and indicating their underutilization, except for the machine labour where it found to be negative and indicating its over-utilization. Whereas, in Karnataka the estimated MVP/MFC ratio (Resource use efficiency) of seed cost found to be negative and indicating its over-utilization. We concluded that inadequate training, exposure, knowledge gap and extension service to farmers in study sites were the reasons that farmers were using their resources inefficiently. It is recommended that the farmers involved in watermelon farming in the surveyed sites should be provided with additional proper technical knowledge for optimizing the use of resources which would help to increase the production and return from watermelon production.

Keywords: Resource use efficiency, utilization, watermelon, Haryana and Karnataka

Introduction

The *Citrullus lanatus* (Watermelon) is one of the most important fruit crop grown in tropical regions and eaten around the world. In many regions of India, the word "watermelon" is also known as "Tarbuj," "Tarmuj," "Kalingad," and "Kalindi." (Sarker *et al*., 2018) [13]. The fruit is consumed more widely than any other cucurbit in the world. According to FAO (2019) statistics, China, Turkey, India, and Brazil are the world's largest producers of watermelon. Watermelon was grown on 110 thousand acres of land in India in 2021–2022, with a production of 2,787 thousand tonnes. In terms of watermelon production, Uttar Pradesh is in the lead with 16.86 thousand ha, followed by Andhra Pradesh (15.18 thousand ha) (FAO, 2021) [15].

Watermelon production in the state of Haryana was 147.76 thousand tonnes, with 6.23 thousand ha area under cultivation. Sonipat district was the highest producer, with 2.55 thousand ha under cultivation, followed by Jhajjar (0.95 thousand ha) and Karnal (0.4 thousand ha) (Anonymous, 2022) [5].

Watermelon production in the state of Karnataka was 298.39 thousand tonnes, with 7.13 thousand ha under cultivation. The top producer is Koppal district, with 1.10 thousand ha of watermelon planted there, followed by Chitradurga (0.63 thousand ha.) (Kumar and Kulkarni, 2018) [7] (Anonymous, 2022) [4].

West Africa is where the watermelon was first cultivated. It is a fruit that is very beneficial to the health system and is extremely medicinal. Watermelon has 46 percent calories yet offers 20 percent vitamin C and 17 percent vitamin A (Maoto *et al*., 2019) [10]. It has significantly more lycopene than tomatoes to combat free radicals. It soothes tight muscles and is healthy for body hydration. The minerals included in watermelon seeds prevent cancer and lower levels of harmful cholesterol in the body (Ahmed *et al*., 2017) [3].

Many people around the world like fresh watermelon as a fruit. The watermelon is the cucurbitaceous plant with the highest concentration of iron. Lycopene can be found in high amounts in watermelons with red flesh. The flat, brown seeds are more nutritious than the flesh and have a pleasant, nutty flavour. They are a good source of minerals, lipids, and vitamin C (Nath and Barik, 2015) [11]. They can be used in flour mixtures and consumed raw or roasted. A study has demonstrated that the seeds pulp is utilised to thicken soups. The fermented seeds are used to make a sweetener known as "Ogiri" in the area, or they can be boiled with leaves to make "Igblo", another type of sweetener (Lakdan and Stanzen, 2017) [9]. *Citrullus lanatus* seeds are increasingly employed in the cosmetic and pharmaceutical industries in addition to being used for their oil (Abdu *et al*., 2015). Seeds are utilised to promote baby feeding because of their high protein and fat content. Watermelon is well recognised for having little calories and for containing vitamins C and A that aid with dry skin, dermatitis, and psoriasis as well as night blindness (Balogun *et al*., 2019) [6].

Comparative studies conducted in two separate areas can be very beneficial in providing alternate solutions that farmers, marketers, and policymakers may choose to implement. As a result, both consumers and producers will gain. This is another approach to connect more farmers, to lessen spatial variations in the plan of production and selling, and to reduce spatial pricing inequalities.

Materials and Methods

Sampling procedure

For the study, Haryana and Karnataka states are selected purposively. In Haryana state, the study is carried out in Sonipat and Jhajjar districts. These districts are purposively selected because both the districts are having highest area under watermelon production as per statistical abstract of Haryana (2020-21). From the Sonipat district, two blocks i.e., Rai and Murthal were selected randomly and one village from each block namely, Khedwa and Asadpur were selected randomly to collect the data on watermelon cultivation. From Jhajjar district, two blocks i.e., Jhajjar and Machhrauli were selected randomly and one village from each block namely, Kheri hoshdarpur and Neola were selected randomly. Further, fifteen (15) farmers were chosen from each selected village. Thus, a sample of 60 farmers were interviewed in Haryana for an investigation on watermelon production and marketing aspects.

Similarly, in Karnataka state, Koppal and Chitradurga districts are selected purposively for the study based on highest area under watermelon cultivation as per the secondary data published by the Department of Horticulture (2020-21), Govt. of Karnataka. From the Koppal district, two blocks i.e., Koppal and Yalaburga are selected randomly and two villages from each block namely, Hanumanahatti and Vadparvi were selected randomly. From Chitradurga district, two blocks i.e., Chitradurga and Challakere were selected randomly and two villages from each block namely, G R halli and Neralagunte were selected randomly to study watermelon cultivation. Further, fifteen farmers were chosen from each selected village. Thus, total 60 farmers were interviewed on watermelon production and marketing aspects in Karnataka.

Estimation of Resource-use Efficiency

Cobb-Douglas production function was used to assess resource-use efficiency by following the methods mentioned in (Sapkota *et al*., 2020) [12]. Both dependent and explanatory variables were considered in monetary values.

$$Y = a x_1^{b1} x_2^{b2} x_3^{b3} x_4^{b4} x_5^{b5} x_6^{b6} e^{u} \qquad (1)$$

Where,
Y= Gross return
X_1= Human labour
X_2= Machine labour
X_3= Seeds
X_4= Irrigation
X_5= Fertilizer
X_6= Plant protection
a = Intercept
e^{u} = error term
b = b_1, b_2, b_6 are the regression coefficients to be estimated.

To estimate the parameters, method of least square was used and goodness of fit was assessed by computing coefficient of determination (Subedi *et al*., 2020) [14]. Both dependent and explanatory variables were transformed by using natural logarithm. The above equation (3.8) was transformed to linear form for ease in computation.

The efficiency of resource use in production of watermelon was determined by the ratio of Marginal Value Product (MVP) to Marginal Factor Cost (MFC) of variable inputs based on the estimated regression coefficients. The coefficients from Cobb-Douglas production are used in the resource use efficiency measurement (Kumari and Nahatkar, 2021) [8]. The efficiency of the resource was calculated by using following formula:

$$r = \frac{\text{MVP}}{MFC}$$

Where,
r = Efficiency ratio
MVP = Marginal value product of a variable input, which is the value of incremental unit of output resulting from the additional unit of inputs.
MFC = Marginal factor cost (Price per unit input) which is equal to one since both dependent and explanatory variables are converted to monitory value; and is defined as the increase in the cost of inputs due to purchase of additional unit of inputs.
The value of MVP was estimated using the regression coefficient of each input and the price of the output.

$$MVP_i = \frac{b_i \bar{Y}}{\bar{X}_i}$$

Where,
bi= Estimated regression coefficient of input X
$\bar{Y}$= Geometric mean value of output
$\bar{X}i$= Geometric mean value of input being considered
The decision rule for the efficiency analysis was as:
r =1 (Efficient use of a resource)
r >1 (Underutilization of a resource)
r < 1(Overutilization of a resource)
Finally, the relative percentage change in MVP can be calculated using following formula:

$$D = 1 - \frac{1}{r} \times 100$$

Where, D= absolute value of percentage change in MVP of each resource (Abdulai, 2006) [2].

Hypothesis development and its testing

Null hypothesis: It states that there is no relationship between the variables being studied i.e., dependent and independent variables.

Alternative hypothesis: It states that independent variables did affect the dependent variable and results are in terms of supporting the theory being investigated.

Hypothesis was tested by considering F-value, as interpreted below;

If, F-calculated value > F-critical value = Reject null hypothesis

F-calculated value < F-critical value = Fail to reject null hypothesis

Where, F-calculated value was taken out from ANOVA table and F-critical value was obtained by using F-distribution table.

Results and Discussion

Resource use efficiency on watermelon production in Haryana: Cobb-Douglas production function was used for the purpose of finding out elasticities of different inputs used on the farms. Table.1 shows the estimated value of coefficients and associated statistics of the Cobb-Douglas production function. Human labour, seed cost and plant protection cost were found to be significant and rest of the variables were found to be non-significant. The coefficient of determination (R square) was 0.68, which depicts that the model as fitted explained 68 percent of the variability in gross return from watermelon production was due to independent variables considered in the model. The returns to scale from watermelon production in Haryana was found to be 0.96 which signifies that the production function exhibited nearly constant return to scale indicating that if all the inputs specified in the function are increased by 100 percent, income will increase by about 96 percent.

The estimated MVP/MFC ratio (Resource use efficiency) of different inputs used in production was revealed as positive and greater than one indicating their underutilization, except for the machine labour where it found to be negative and less than one indicating its over-utilization (Table. 2).

Table 1: Estimated value of the coefficients on watermelon production in Haryana

Factors	Coefficient	t stat
Constant	**2.977**	
Human labour (X1)	0.431** (0.307)	1.400
Machine labour (X2)	0.023 (0.092)	0.252
Seed cost (X3)	0.280** (0.188)	1.482
Irrigation cost (X4)	0.071 (0.130)	0.544
Fertilizer cost (X5)	0.039 (0.071)	0.554
Plant protection cost (X6)	0.125** (0.082)	1.521
R^2	0.689	
Returns to scale	0.969 (Constant)	

Note: ** represents 10% level of significance respectively.
Figure in paranthesis indicates standard errors of respective co-efficient.

Table 2: Measures of allocative efficiency of resources used in watermelon production in Haryana

Factors	Coefficient	MVP	MFC	R (MVP/MFC)	Status of resource use
Human labour (X1)	0.431	3.87	1	3.873	Under utilized
Machine labour (X2)	0.023	0.84	1	0.845	Over utilized
Seed cost (X3)	0.280	4.20	1	4.205	Under utilized
Irrigation cost (X4)	0.071	1.72	1	1.724	Under utilized
Fertilizer cost (X5)	0.039	1.41	1	1.411	Under utilized
Plant protection cost (X6)	0.125	4.62	1	4.620	Under utilized

Note: If efficiency ratio(r), less than one; indicates over utilization of resources, equal to one; indicates optimal utilization of resources, and greater than one; indicates under-utilization of resources.

Resource use efficiency on watermelon production in Karnataka

Cobb-Douglas production function was used for the purpose of finding out elasticities of different inputs used on the farms. Table.3 shows the estimated value of coefficients and associated statistics of the Cobb-Douglas production function. Human labour, irrigation cost, fertilizer cost and plant protection cost were found to be significant and rest of the variables were found to be non -significant. The coefficient of determination (R square) was 0.60, which depicts that the model as fitted explained 60 percent of the variability in gross return from watermelon production was due to independent variables considered in the model. The returns to scale from watermelon production in Karnataka was found to be 0.96 which signifies that the production function exhibited nearly constant returns to scale indicating that if all the inputs specified in the function are increased by 100 percent, income will increase by about 96 percent.

Table 3: Estimated value of the coefficients on watermelon production in Karnataka

Factors	Coefficient	t stat
Constant	3.163	
Human labour (X1)	0.296** (0.170)	1.735
Machine labour (X2)	0.052 (0.084)	0.620
Seed cost (X3)	0.079 (0.089)	0.877
Irrigation cost (X4)	0.193** (0.154)	1.246
Fertilizer cost (X5)	0.192* (0.046)	4.162
Plant protection cost (X6)	0.155* (0.058)	2.634
R^2	0.605	
Returns to scale	0.966 (Constant)	

Note: *and **represents 5% and 10% level of significance respectively.
Figure in paranthesis indicates standard errors of respective co-efficient

Table 4: Measures of allocative efficiency of resources used in watermelon production in Karnataka

Factors	Coefficient	MVP	MFC	r (MVP/MFC)	Status of resource use
Human labour (X1)	0.296	3.06	1	3.069	Under utilized
Machine labour (X2)	0.052	1.68	1	1.682	Under utilized
Seed cost (X3)	0.079	0.96	1	0.967	Over utilized
Irrigation cost (X4)	0.193	3.15	1	3.151	Under utilized
Fertilizer cost (X5)	0.192	5.60	1	5.609	Under utilized
Plant protection cost (X6)	0.155	3.84	1	3.843	Under utilized

Note: If efficiency ratio(r), less than one; indicates over utilization of resources, equal to one; indicates optimal utilization of resources, and greater than one; indicates under-utilization of resources.

The estimated MVP/MFC ratio (Resource use efficiency) of different inputs used in production was revealed as positive and greater than one indicating their underutilization, except for seed cost and where it found to be negative and less than one indicating its over-utilization (Table.4).

Estimation of resource use efficiency on watermelon production in selected regions of both Haryana and Karnataka shows that, the returns to scale from watermelon production in Haryana was found to be 0.96 which signifies that the production function exhibited nearly constant return to scale indicating that if all the inputs specified in the function are increased by 100 percent, income will increase by about 96 percent. In case of Haryana, the estimated MVP/MFC ratio (RUE) of different inputs used in production was revealed as positive and greater than one indicating their underutilization, except for the machine labour where it found to be negative and less than one indicating its over-utilization.

Whereas, in Karnataka the estimated MVP/MFC ratio (Resource use efficiency) of different inputs used in production was revealed as positive and greater than one indicating their underutilization, except for seed cost and where it found to be negative and less than one indicating its over-utilization.

Conclusion

Watermelon was one of the major crop grown in the study area. The resources such as, machine labour and seed cost were underused whose cost need to be increased for its optimum allocation of resources. There is a need of proper technical knowledge to the farmers to use the resources efficiently. Government and other supporting agencies should give efficient technical knowledge about agricultural practise.

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