International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating: 5.29
IJABR 2025; 9(7): 1100-1103
www.biochemjournal.com
Received: 22-04-2025
Accepted: 26-05-2025

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Yield gap and resource use efficiency of okra cultivation in Tapi district of Gujarat

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DOI: https://www.doi.org/10.33545/26174693.2025.v9.i7n.4898

Abstract
This study delves into the resource use efficiency and yield gap in okra cultivation within Tapi district, Gujarat, employing a multistage random sampling method. Cobb-Douglas production functions were utilized to analyze resource use efficiency, revealing significant findings on fertilizer application and labor utilization. The study highlights under-application of Nitrogen and Potash, suggesting potential for enhanced fertilizer usage. Additionally, the yield gap analysis underscores substantial disparities between best and average farmers, emphasizing the importance of adopting best practices for maximizing yields. The findings suggest avenues for optimizing input usage and improving economic efficiency in okra cultivation.

Keywords: Yield gap, resource use efficiency, cultivation and okra

Introduction
The cultivation of okra (*Abelmoschus esculentus* L.) in Tapi district, Gujarat, stands as a cornerstone of agricultural activity, with its presence extending across various locales within the region. As a high-value crop, okra holds considerable promise for augmenting farmers' incomes and bolstering the economic landscape of the area. However, the efficient utilization of resources in okra cultivation remains a crucial aspect deserving thorough investigation to ensure sustainable productivity and profitability.

Against this backdrop, this research endeavors to comprehensively examine the resource use efficiency and yield gap prevalent in okra cultivation within Tapi district, Gujarat. The primary objective is to quantitatively evaluate the effectiveness of resource allocation in okra farming, discerning the inputs contributing significantly to productivity. By meticulously measuring resource use efficiency, the study aims to pinpoint areas for enhancement and formulate strategies to optimize resource allocation in okra cultivation.

Additionally, the research seeks to assess the yield gap existing in okra production within the Tapi district. Through a comparative analysis of actual yields against potential yields achievable under optimal conditions, the study endeavors to quantify the extent of productivity shortfall. Such an assessment not only illuminates the prevailing inefficiencies within okra cultivation but also serves as a foundation for devising interventions aimed at narrowing the yield gap and enhancing overall agricultural performance.

By addressing these critical aspects, this research aspires to contribute significantly to the understanding of okra cultivation dynamics in the Tapi district. Through actionable insights derived from the pursuit of its objectives, the study aims to support sustainable agricultural development and foster economic prosperity in the region.

Methodology
For the present investigation, primary data were collected using multistage random sampling method from Tapi district of South Gujarat. Out of the 7 talukas of Tapi District, 3 talukas were selected. Then 3 villages per taluka were selected. Thus total 9 villages were selected. Then 20 farmers were randomly selected per village. Total 180 okra growers were selected for the present study.

Resource use efficiency
The use of different inputs in production of Okra crops on sample farms was studied.

To analyse the resource use efficiency in Okra, Cobb-Douglas production functions was used. The production function used as under:

$Y = a.X_1^{b1}.X_2^{b2}.X_3^{b3}\ldots\ldots\ldots\ldots\ldots X_n^{bn}.Ui$

Different variables were used in the production function as under:

Where,
Y = Output in quintals per hectare
X_1 = Quantity of seed (kgs) per hectare
X_2 = Quantity of F.Y.M. (in quintals) per hectare.
X_3 = Quantity of Nitrogen (in kgs) per hectare
X_4 =Quantity of Phosphorus (in kgs) per hectare
X_5 = Quantity of Potash (in kgs) per hectare
X_6 = Human labour (man-days) used per hectare
X_7 = Number of irrigations per hectare
X_8 = Number of sprays (PP chemicals) per hectare
a = Constant
b1, b2……b8 = Regression coefficients/elasticities of production
Ui = Error term.

Yield Gap
To estimate farm level yield gaps of the study area, sample farmers were classified into two categories, *viz*., best and average farmers according to their yield levels of the okra. The top five farmers on the basis of the yield obtained by them were considered as best farmers and the remaining farmers were categorized as average farmers. The difference between the mean yield of the best farmers and the average farmers was studied.

Results and Discussion
To full fill the objectives of the study, three talukas from Tapi district *viz*. Vyara, Valod and Dolvan were selected. A list of villages was prepared from the selected talukas from the revenue records of the office of TDO. Three villages from every selected talukas were selected. Thus total nine villages were selected randomly from each selected taluka. The lists of villages are presented in Table-1.

Table 1: Farmers selected from different talukas of Tapi district.

Name of Taluka	Name of village	No's of farmers
Vyara	Balpur	20
	Karanjvel	20
	Unchamala	20
	Sub-total	60
Valod	Andhatri	20
	Dadariya	20
	Degama	20
	Sub-total	60
Dolvan	Pati	20
	Ghani	20
	Gadat	20
	Sub-total	60
Grand total		180

The lists of respondents were prepared from each village at the third stage. From this list, 20 farmers were selected from each village and finally 180 respondents were selected by random sampling technique. Data were collected using pre-tested and well-structured interview schedule.

Input utilization
Per hectare quantities of different input /resources are given in table 2.

Table 2: Per hectare Resource use pattern for okra cultivation

Sr. No.	Input	Small	Medium	large	All
1	Seeds (kg)	11.35	11.43	11.92	11.48
2	FYM (quintals)	31.65	50.4	72.6	45.45
3	Fertilizers				
	(a) Nitrogen (kg)	55.32	65.09	68.51	61.24
	(b) Phosphorus (kg)	40.54	53.4	59.74	48.62
	(c) Potash (kg)	39.55	43.85	40.95	41.45
4	No. of irrigation	13.15	13.00	12.05	12.91
5	No. of spray (PP chemicals)	10.63	11.14	12.15	11.07
6	Human labour (man-days)				
	(a) Family	335.70	291.13	13.21	267.183
	(b) Hired	43.20	110.57	431.42	131.058

It was observed from the table 2 that at overall level, seed and FYM used 11.48kg/ha and 45.45 qts/ha respectively. They were highest used by big farmers followed by medium and small farmers. Regarding the fertilizers it was observed that overall NPK fertilizers used were 61.21kg/ha, 48.62 kg/ha and 41.45 kg/ha respectively. It was highest used by big farmers, except Potash, it was highest used by medium farmers (43.85kg/ha) followed by large and small farmers. Overall irrigation given was 12.91 and it was highest by small farmers followed by medium and large farmers. In case of plant protection chemicals spray, at overall level it was 11.07 spray. The highest spray was done by big farmers followed by medium and small farmers.

Resource use efficiency
The resource productivity of input used in the cultivation of okra in the study area is given in Table 3. This table indicated that the application of fertilizer viz., Nitrogen, Potash and human labour were statistically significant. The application of Nitrogen had an elasticity of 0.061, indicating that one percent increase in the application of Nitrogen would bring 0.061 percent increase in the production. The application Potash and human labour in the cultivation had significant positive elasticity coefficients of 0.056 and 0.222, indicating that at current level these resources were under-applied. The seed had a depressing influence on the yield as indicated by the negative coefficient (-0.090), though it was statistically non-significant. The elasticity

coefficients for used of Phosphorus, pesticides spary and bullock labour for the okra cultivation were found negative, but it was statistically non-significant, indicating that a marginal increase in the amount of these input would not raise the total value of output realized. The elasticity coefficients of other inputs like FYM and irrigation were statistically non-significant, indicating that at the current level they were applied at the physically optimum level.

Table 3: Regression coefficient of different production variables and their significance in cultivation of okra

Variable	Coefficients	Standard Error
Intercept	28.28976	0.653
Seed	-0.090	0.053
Farm Yard Manure	0.004	0.012
Nitrogen	0.061**	0.024
Phosphorus	-0.002	0.017
Potash	0.056**	0.016
Human labour	0.222*	0.109
Irrigations	0.027	0.050
Pesticides Spray	-0.057	0.050
Bullock Labour	-0.012	0.017
* and ** Indicates significance at 5 percent and 1 percent level		

In order to study the resource use efficiency, the marginal value product (MVP) of each input was computed and compared to the marginal factor cost (MFC) and allocative efficiency is estimated as a ratio of MVP/MFC. The allocative efficiency in okra cultivation is reported in Table 4. The allocative efficiency indicated the price response of the farmers. The allocative efficiency of 1 indicated that the farmers were price efficient in allocating that particular resource in okra cultivation. The allocative efficiency of more than 1 indicated the under-utilization of that particular resource and scope in increase in its application till the ratio reached 1. The results indicated that the MVP/MFC ratio was highest in the case of application of Potash (15.476) followed by Nitrogen application (10.117), irrigation (2.976) and human labour (1.736). This indicated that application of more fertilizers composing of Nitrogen and Potash would enhance the return of 10 to 15 percent. This showed that the fertilizer application could be enhanced in the okra cultivation in the area to reach higher benefits. The irrigation application had an MVP/MFC ratio of 2.97, indicating that farmer would gain Rs1.97 if they applied an additional irrigation worthing Rs 1.

Table 4: Resource use efficiency in Okra production

Variable	Coefficients	MPP	MVP	MFC	MVP/MFC
Seed	-0.09	-99.79	-3074.25	3581.48	-0.86
Farm Yard Manure	0.00	0.01	0.33	1.20	0.27
Nitrogen	0.06	12.67	390.46	38.60	10.12
Phosphorus	0.00	-0.52	-15.99	52.17	-0.31
Potash	0.06	16.33	502.96	32.50	15.48
Human labour	0.22	7.09	218.50	125.87	1.74
Irrigations	0.03	26.60	819.34	275.29	2.98
Pesticides Spray	-0.06	-65.58	-2020.38	998.67	-2.02

MPP = Marginal physical product, MVP = Marginal value product, MFC = Marginal factor cost

The production function analysis gave statistically non-significant value to the amount of seed applied, but the allocative efficiency ratio indicated that an additional expenditure of one rupee on this account would reduce the revenue by Rs.0.86. Hence, to be economically efficient, the farmers had to reduce the amount of seed used. Similarly, the Pesticide spray also gave a negative ratio (-2.023), indicating that an increase of one-rupee in the PP chemicals applied at the current price level would reduce the return by Re 2.023. The negative return for the Phosphorus was contrary to the expectation. This could be explained taking into account the management of the fertility status.

Yield gap

As described in methodology, the present analysis has been attempted to estimate only farm level yield gap for Okra in the study area. For this the sample growers were classified into two categories *viz*., best and average farmer accordingly to the level of their Okra productivity. The highest yield of crop obtained by the best five sample farmers was considered as the potential yield of the Okra in the area. This was treated as a farm level potential yield which can be realized through proper input use and management. This farm level potential yield was then compared with the average yield obtained by remaining farmers (average farmers). Therefore, the yield gap in the present study was calculated between the best and the average sample farmer. The result pertaining to yield levels and yield gap is presented in Table 5.

Table 5: Yield levels and yield gap in Okra

Sr. No.	Particular	Yield (Qt/ha)
1	On farm average yield level	
	(a) Best farmers	147.56
	(b) Average farmers	126.86
2	a. Yield gap in absolute term	20.70
	b. Yield gap in percentage term	16.32

It can be observed from the Table 5 that the average yield of best farmers for Okra were considerably high (147.56 Qt/ha) than the average yield levels (126.86 Qt/ha) of the average farmers. The results revealed that there was significant difference between the yield of the best farmer and average farmers, which was about 20.70 quintals per hectare absolute terms.

Table 6: Resources used by best and average farmers

Resources used	Average farmers	Best farmers
Seeds (kg/ha)	11.57	9.10
FYM (quintals/ha)	44.4	72
Fertilizers		
(a) Nitrogen (kg/ha)	59.62	98.06
(b) Phosphorus (kg/ha)	48.38	54.1
(c) Potash (kg/ha)	41.03	51.3
No. of irrigation	12.91	13
No. of spray (PP chemicals)	11.22	11.80
Human labour (man-days)		
(a) Family	265.46	306.8
(b) Hired	132.92	88.2

It was observed from the table-6 that best farmers used less seed rate (9.10 kg/ha) than average farmers (11.57 kg/ha). So we can say that best farmers maintain proper sowing distance. It was also revealed that use of organics and

chemical fertilizers were used higher by the best farmers as compared to average farmers, which may be responsible for getting higher yield. Particularly Nitrogen was used in very less amount (59.62 kg/ha) by average farmers as compared to best farmers (98.06 kg/ha).

Conclusion

The per hectare input use for okra cultivation showed tendency to increase with increase in size of holding. The analysis indicated that, the fertilizer application specially, Nitrogen and Potash could be enhanced for the okra cultivation in the area to getting more benefits. To be economically efficient, the farmers had to reduce the amount of seed use.

Acknowledgement

The authors extend their gratitude to Navsari Agricultural University for providing the platform to conduct this research.

Conflict of Interest

The authors affirm that they do not have any conflicts of interest. It is noteworthy to mention that the authors are employed by the funding agency, a governmental organization.

Authors Contribution

All authors have made significant contributions to the inception, design, execution, analysis, and/or writing of the manuscript. Additionally, they have thoroughly reviewed and approved the manuscript before its submission.

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