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AGRICULTURAL ECONOMICS

An Economic Analysis of Garlic Cultivation in Ratlam District of Madhya Pradesh

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ABSTRACT

The study focuses on economic analysis of garlic production in the Ratlam District of Madhya Pradesh. The study is carried out to determine resource use efficiency and constraints of garlic production in the study area. Production data were collected from 60 farmers randomly from three village areas of Ratlam block of Ratlam district of Madhya Pradesh State. The data were analyzed using OLS regression method to estimate the production function and the ratio of marginal value product to marginal factor cost as the measure of resource use efficiency. In this study, the overall average productivity and gross return of garlic was recorded 136.04 q/ha and ₹ 306550 respectively. The farm size group wise productivity of garlic was 140.81q/ha obtained in small size group followed by 142.47q/ha and 124.85q/ha in medium and large size farm, respectively. Gross income obtained in small size group was ₹ 315414 followed by ₹ 321950 in medium and ₹ 282285 minimum in large size group. The lead functional form was the double log function which produced overall R^2 of 0.98 followed by 0.96, 0.66 and 0.92 in small, medium and large farm group with an overall average of 0.98. On average, overall sum of elasticity was found to be 0.72 which is less than one whereas it was followed by followed by 0.91 in small, 0.93 and 1.00 in medium and large size group, respectively. Regression coefficients of human labour, fertilizer and irrigation were positive and highly significant in all farm size groups as well as in overall.

Highlights

- This study focuses on economic analysis of garlic production in Madhya Pradesh. It also carried out to determine resource use efficiency and constraints of garlic production in the study area.
- On an average productivity and gross return of garlic was recorded 136.04 q/ha and ₹ 306550 respectively. The lead functional form was the double log function which produced overall R^2 was 0.98 and sum of elasticity was found to be 0.72 which is less than one.
- Regression coefficients of human labour, fertilizer and irrigation were positive and highly significant in all farm size groups as well as in overall.
- In this study most serious constraints as perceived by the farmers in garlic production were lack of irrigation when needed, costly and irregular supply of electricity, lack of labours in peak time and costly labour etc.

Keywords: Garlic, production, resource use efficiency, benefit-cost ratio, constraints

Garlic (*Allium sativum*) is one of most important bulbous spices. It is medicinal and widely consumed bulbous spice crops both in India and world. Garlic originated from Central Asia about 3000 years and later spread to the Mediterranean regions. Garlic cultivation in India is under horticulture, which is an important sector of Indian agriculture. India is the second largest producer of garlic in the world. Garlic holds fifth position in the area under cultivation among vegetable crops in India. The area and production of garlic in the country showed substantial increases. The productivity of garlic stood at 2975 kg /ha during 1974-75, has increased to 5760 kg/ha during 2015-16. In India

Garlic is cultivated under 280.95 thousand hectare with total production of 1617.34 thousand MT and productivity of 5.76 tonnes per hectare. Which is 26.25% share of Madhya Pradesh in total production of the country (NHRDF, Nashik 2015-16). The main garlic producing states in India are Madhya Pradesh, Rajasthan, Gujarat, Uttar Pradesh, Assam, Punjab, West Bangal, Haryana, Maharashtra, Orissa, Karnataka, Tamil Nadu, Bihar etc. Madhya Pradesh is the first garlic producing State in India. In the Madhya Pradesh total production was estimated as 424.50 thousand MT which is 26.25% share of total production of the country with an area under 81.17 thousand hectares and productivity of 5.23 tonnes per hectare (NHRDF, Nashik 2015-16). India's share in the world garlic production stands at a meagre 5.27 per cent in 2015-16. Total export of garlic from India in 2015-16 has been estimated at 4804.47 MT (₹ 1654.81 Lakhs in value).

Garlic belonging to Allianceae family, genus Allium and species sativum. Garlic produces a much divided bulb consisting several cloves, covered by a thin white skin. The bulb can be consumed as a spice or condiment in the form of different processed products such as garlic paste and pickles. It is also used as an ingredient in several food preparations like chutneys, vegetables, curries, curry powders and in meat preparations etc. (Tindal 1986). The crop when fully grown is between 40 and 60 cm in height. It consists of an underground bulb and above ground vegetative part, which also consist of a flat as well as slender leaves. Rooting system is fibrous, while the bulb comprises small bulblets called cloves (Amans 1989; Wadjito *et al.* 1988). Garlic is a high valued crop and used as medicine, food, preservative and curative agent. For instance, Miko (1999) reported the use of green parts and the bulbs as spices in salad and seasoning of vegetables; the extract is used as curative agents against ear ache and eye sore, antidote against some poison and antibacterial agent (Debkitanya *et al.* (1981); while Purseglove (1972) reported its extract use to reduce cholesterol level in human blood and the volatile sulphurs and oil extracts for treating several skin diseases. Garlic cultivation requires a high level of working capital and human labour that profit margins were good and that price levels were generally stable and concluded that timely and adequate irrigation facilities are essential in raising the profitability of the Garlic crops (Kucchadiya 1992).

MATERIALS AND METHODS

Multi-stage sampling technique was adopted for selection of the block, villages and the respondents in Ratlam district. The three villages namely Delanpur, Dhamnod and Bilpank were purposively selected from Ratlam block of Ratlam district by the field survey on the basis of being the prominent garlic producing areas. The sample size for the study was 60 farmers with 20 farmers from each village randomly selected. The samples were drawn from the list of farmers according to the size of land holding, who having more area under garlic crop to their total cropped area. The garlic producing farmers were categorized as small (>2 ha.), medium (2 to 4 ha.) and large (above 4 to 10 ha.), based on land holding size of the farmers.

Analytical Tools

The Cobb-Douglas production function was used to analyse productivity and resource use efficiency of garlic crops. The functional form is as follows:

$$Y = ax_1^{b1} x_2^{b2} x_3^{b3} \ldots\ldots\ldots\ldots x_n^{bn} \quad \ldots(1)$$

$$Y = aX_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} \ldots\ldots X_n^{bn} e^{\mu} \quad \ldots(2)$$

The above function is linearised double-log form as below:

$$InY = ln\beta 0 + \beta 1 lnX1 + \beta 2 lnX2 + \beta 3 lnX3 + \beta 4 lnX4 + \beta 5 lnX5 + \beta 6 lnX6 + \beta 7 lnX7 + \beta 8 lnX8 + \beta 9 lnX9 + \beta 10 lnX10 + \beta 11 lnX11 + \beta 12 lnX12 + Vi\text{-}Ui \quad \ldots(3)$$

Where,

Y = Output (dependent variable);

a = Constant or intercept

$b_1, b_2, b_3, b_4 \ldots\ldots\ldots\ldots b_n$ = Regression coefficients;

$X_1, X_2, X_3, X_4 \ldots\ldots\ldots X_n$ = Initial factors (independent variables)

μ = Error term.

Estimation of costs and returns

Cost A_1: It includes costs and kind expenses actually incurred by cultivators which are as follows:

(i) Wage of hired human labour

(ii) Charges for bullock labour
(iii) Hired labour charges of implements and machinery
(iv) Cost incurred on manures and fertilizers
(v) Seeds
(vi) Plant protection chemicals
(vii) Irrigation charges
(viii) Land revenue
(ix) Depreciation, and
(x) Repair charges on farm assets.

Cost A_2: Cost A_1 + Rent paid for leased in land.

Cost B_1: Cost A_2 + Interest on owned fixed capital assets.

Cost B_2: Cost B_1 + Rental value of owned land.

Cost C_1: Cost B_1 + Imputed value of family labour.

Cost C_2: Cost B_2 + Imputed value of family labour.

Cost C_3: Cost C_2 + 10% of cost C_2 (managerial cost)

Gross Income = Value of total output.

Net Income = It is computed by deducting cost C3 from gross income.

Estimation of Constraints

The Garrett's ranking technique was used to analyse the constraints in production of Garlic in the study area. The Garrett's ranking technique is as follows:

Garrett's ranking technique

$$\text{Percentage position} = \frac{100\left(R_{ij} - 0.5\right)}{Nj} \quad \ldots(4)$$

Where,

R_{ij} = Rank given for the i^{th} item by the j^{th} respondent and

Nj = Number of items ranked by the j^{th} respondent

Benefit – Cost Ratio (BCR) analysis

This ratio was measured in the study in two different ways:

$$BCR = \frac{TR}{TVC} \text{ or } BCR = \frac{TR}{TC}$$

Where,

TR = Total revenue; TVC = Total variable cost; TC= Total cost.

RESULTS AND DISCUSSION

Size of land holding

Land use pattern across the various size groups is given in Table 1. Depict that, total respondents were 60 and each categories. Average size of holding falling in small, medium and large size group was found to be 1.43, 2.95 and 8.64 hectares, respectively and on average land holding was 4.35 hectares.

Table 1: Land use pattern across the various size groups

Particulars	Size of farm groups			Overall (Average)
	Small	Medium	Large	
Size of land holding (ha.)	1.43	2.95	8.64	4.35
Net cultivated area (ha.)	27.8(11)	57.92(23)	167.8(66)	253.52(100)
Total irrigated area (ha)	22.04(12)	40.96(22)	120.7(66)	183.7(100)
Total un-irrigated area (ha.)	5.76(8)	16.96(24)	47.1(67)	69.82(100)
Total land holding (ha.)	28.6(11)	59.09(23)	172.7(66)	261.2(100)

Figures in parentheses indicate percentage to the total.

Total area under the net cultivated was reported 253.52 ha in which highest area of 167.8 ha (66 per cent) was found under large group followed by 57.92 ha (23 per cent) and 27.8 ha (11 per cent) under medium and small groups, respectively. Total area under the irrigation was reported 183.7 hectare in which 12% (22.4 ha.) in small size group followed by 22% (40.96 ha.) and 66% (120.7 ha) in medium and large size group, respectively. It is clear from the table total land holding in all categories were 261.2 hectares followed by 11% (28.6 ha), 23% (59.09 ha) and 66% (172.7 ha) in small, medium and large size groups, respectively.

Cropping Intensity

In the study area, cropping intensity was highest in small farm (203.95%) followed by 190.84% and 189.63% in medium and large size groups, respectively. Overall cropping intensity was approaching 191.47% per cent (Table 2). Cropping intensity of Garlic was second largest (88.3%) after the soybean (155.44%).

Table 2: Intensity of cropping under different size group of land holdings

Sl. No.	Crops	Size of farm groups			Overall
		Small	Medium	Large	
A.	*Kharif*				
1	Soybean	14.7	30.6	110.14	155.44
2	Cotton	2.25	6.7	20.4	28.92
3	Urd/Moong/ cowpea	3.0	7.49	12	22.51
4	Maize	3.69	7.47	11.20	22.36
5	Other	3.15	4.26	7.86	15.27
	Sub Total	**27.8**	**55.82**	**161.6**	**244.5**
B.	*Rabi*				
1.	Pea	2.5	1.13	10.7	14.33
2.	Wheat	2.7	7.8	27	37.5
3.	Chickpea	3.1	1.69	17	21.70
4	Garlic	11.1	26.3	51.9	88.3
6	Other	2.5	4.7	15	22.2
	Sub Total	**21.9**	**40**	**121.6**	**183.5**
C.	*Summer*				
1.	Jowar chari	2	4.6	10	16.6
2.	Vegetables	5	10.12	25	40.12
	Sub Total	7	14.18	35	183.5
	Gross cropped area	56.7	110.54	318	485.44
	Net cropped area	27.8	57.92	167.8	253.52
	Cropping intensity (%)	203.95	190.84	189.63	191.47

Economics of Garlic production

Across various size groups, cost of cultivation was estimated based on various cost concepts like Cost-A, Cost-B and Cost-C along with per hectare gross and net income following tabular analysis (Sangtam *et al.* 2012) and are discussed below.

Per hectare cost incurred in cultivation of Garlic

Per hectare cost on various input factor in garlic production was workout and its details are presented in table 3. Table shows that the hired human labour cost in the form of wage was substantially higher in large size farm ₹ 21440 followed by and minimum in small size ₹ 11765 and medium size farm (₹ 19113) and small size farm (₹ 11765). Bullock labour cost was higher in small size group (₹ 750) and minimum of ₹ 545 in large size farm. Machine labour charge was higher in large size group (₹ 6384) and ₹ 6151 (minimum) in small size group. Seed cost was found to be same in all the groups whereas, manures and fertilizers application was lower in small size group (₹ 14783.42), ₹ 15705 in medium and ₹ 15731 (maximum) in large size group. The same behavior was observed in percent distribution of these inputs among the various sizes. Irrigation charge was ₹ 9189 in small size which was increased at the rate of ₹ 9703 in large and medium size group ₹ 9771. State Land revenue or village panchayat tax was ₹ 12 for each size group.

Table 3: Cost incurred per hectare in cultivation of garlic across the various size groups

Sl. No.	Particulars	Size of farm groups			Average
		Small	Medium	Large	
A	*Labour cost*				
1	Value of family labour	16000	11400	8800	12066
2	Value of hired human labour	11765	19113	21440	17440
3	Value of family bullock labour	750	650	545	648.33
4	Value of family machine labour	6151	5445	6384	5939.33
5	Other variable cost	39758	21570	7809	14583.68
	Sub total	**74424**	**58178**	**44978**	**50677.34**
B	*Material Cost*				
1	Value of Seeds	22500	22500	22500	22500
2	Value of fertilizer & manure	14783	15702	15731	15405
4	Irrigation charges	9189	9771	9703	9724
	Sub total	**46472**	**47973**	**47934**	**47629**
C	*In-direct cost*				
1	Taxes, land revenue	12	12	12	12
2	Depreciation	2670	2570	3150	2796.66
3	Interest on working capital	2041	1850	2235	2042
4	Rental value of own land	20000	20000	20000	20000
5	Interest on fixed capital	3540	3250	4000	3596.66
	Sub total	28263	27682	29397	28447.32
	Grant total	149159	133833	122309	126807
	Cost A_1 (A_2)	104057 (69.8)	94061 (70.3)	86684 (70.9)	91600 (67.8)
	Cost B_1(cost A_1 and interest on fixed capital)	107597 (68)	97311 (69)	90684 (69)	95197 (68)
	Cost B_2	127597 (81)	117311 (83)	110684 (84)	115197 (82)

Cost C_1	123597	108711	99484	107263
	(78)	(77)	(76)	(77)
Cost C_2	143597	128711	119484	127263
	(91)	(91)	(91)	(91)
Cost C_3	157957	141582	131432	139989

The operational cost known as cost A_1/A_2 accounted for ₹ 104057 (69.8% to total cost) in small size followed by ₹ 94061 (70.3%) in medium size, and ₹ 86684 (64.8% of the total cost) in large farm size. Cost B_1 a sum of cost A_1 and interest on fixed capital amounted for ₹ 3540 in small size, ₹ 3240 in medium and ₹ 4000 in large size group. The same trend was also observed in the case of cost B_2. The cost C_1 and C_2 was found minimum in large size farm (₹ 99484 and ₹ 119484) and maximum in small size (₹ 123597 and ₹ 143597) and medium size farm (₹ 108711 and ₹ 128711). Cost C_3 known as total cost per hectare accounted for ₹ 157957, ₹ 141582 and ₹ 131432 small medium and large size groups, respectively.

On the basis of foregoing discussion the major component of cost C_3 (total cost) and operational cost on the small farm maximum and when size of farm increase to decease the total cost as per size of farm and the same thing happened in B_1 and B_2. Cost C_1 was higher in small size group due to lack of management of labour. Almost the same trend was there in the case of cost C_2. Cost A_1/A_2 was higher in small followed by medium and large size group due to involvement of more human labour, machine power, plant protection, irrigation charge associated with depreciation, repairs and interest incurred on various inputs used in this process.

Per hectare returns structure for the sample farmers of garlic production

The productivity of garlic per hectare was reported to 140.81 in small size group, followed by 142.47q/ha in medium and 124.85 q/ha in large size farm, respectively. Gross income was obtained ₹ 315414 in small size group, ₹ 321982 in medium and ₹ 282286 (minimum) in large size group. The average productivity and gross return per hectare of study area of garlic was recorded 136.04 q/ha and ₹ 306589 respectively. Net return per hectare was recorded in the order of ₹ 166255 for small, ₹ 188149 in medium and ₹ 159977 in large size group. The benefit cost ratio was higher in the case of medium size group 1:2.27 (maximum) followed by 1:2.15 minimum in large and 1:2.00 in small size group (Table 4).

Table 4: Per hectare yield and economic returns of garlic production under different size groups

Particulars	Size of farm groups			
	Small	Medium	Large	Overall
Main product (q/ha)	140.81	142.47	124.85	136.04
Price/quintal	2240	2260	2261	2253.67
Gross income (₹/ha)	315414	321982	282286	306589
Net income (₹/ha)	157457	180400	150854	166600
Benefit cost ratio	1:2.00	1:2.27	1:2.15	1:2.19

Efficiency in production of Garlic by sample farmers

In order to examine the impact of different input resources on gross return, the values of production elasticity (b_1) along with value of coefficient of determination (R^2) were calculated for each size of farm and are presented in Table 5.

Table 5: Estimated Cobb-Douglas production coefficient across the various size groups

Particular	Size of farm groups			Overall
	Small	Medium	Large	
Human labour	0.53*	0.63*	0.37*	0.36*
Irrigation	0.24*	0.89*	0.89*	0.34*
Fertilizer	0.14*	-0.60*	-0.26*	0.02*
Coefficient of determination (R^2)	0.97	0.66	0.92	0.98
Returns to scale (Σbi)	0.91	0.93	1.00	0.72

**Significant at 1% level of significance*

The estimated results of Cobb-Douglas production function is presented in the table 5. This indicates that, the significant and higher (0.98) R^2 value for the sample farmers. Hence, the independent variables included in model could explain the variation in gross return to extent of 98% in overall followed by 97%, 66% and 92% in small, medium and large size of groups, respectively.

The summation of output elasticity indicates that, the increasing and decreasing return to scale. The on average elasticity was found to be decreasing return to scale (0.72) followed by small (0.91) and medium (0.93) and large (1.00) size group. Large size group indicate the constant return to scale. Based on this

Table 6: Ranking of identified constraints in cultivation of garlic across the various size groups

Sl. No.	Constraints relating to	Small (N= 20)	Medium (N= 20)	Large (N= 20)	Total (N= 60)	Ranking
1	Lack of irrigation when needed	19(90)	12(57)	15(83)	46(76.66)	I
2	Costly and irregular supply of electricity	17(81)	12(57)	16(89)	45(75.00)	II
3	Lack of labours in peak time	18(86)	11(52)	15(83)	44(73.33)	III
4	Costly labour	19(90)	10(48)	14(78)	43(71.66)	IV
5	Lack of improve seed	19(90)	12(57)	10(55)	41(68.33)	V
6	Costly equipment	15(71)	14(67)	12(66)	41(68.33)	VI
7	Lack of capital	17(80)	11(52)	9(50)	37(61.66)	VII
8	Lack of insect and disease resistance seed	15(71)	12(57)	10(55)	37(61.66)	VIII
9	Lack of knowledge	16(76)	10(48)	8(44)	34(56.66)	IX
10	Lack of supply of input	9(42)	6(28)	5(28)	20(33.33)	X
11	Need of more irrigation	6(28)	5(24)	8(44)	19(31.66)	XI

result, it can be concluded that the decrease the all inputs factors of production included in the production model.

The estimated coefficients on average human labour (0.36) and irrigation (0.34) coefficient were found to be positive and highly significant at 1% level of significant. Categories wise human labour and irrigation was also be found positive and significant at the 1% level of significance.

On an average fertilizer coefficient (0.02) was found to be positive and significant at the 1% level of significance followed by small (0.14) farm group while on medium and large farm found to be negative and significant at the 1% level. It means garlic production incremental higher quantity of fertilizer did not contribution to the garlic yield level in desired manner.

Constraints in cultivation of garlic

Production of garlic is not free from limitations. Some of the constraints like canal irrigation is not available when needed, costly and irregular supply of electricity, lack of labours in peak time etc. are categorized on the basis of respondents ranking by Garrett's ranking method.

Table 6, indicates that the farmers were facing a lot of the problem in the production of garlic. Among the list of 11 constraints, on average majority of the farmers (76.66%) expressed the lack of irrigation when needed was as ranked I followed by small 90%, medium 57% and large 83%. Costly and irregular supply of electricity as ranked II (75%) followed by 81%, 57% and 89% in small, medium and large, respectively. Lack of labours in peak time ranked III (73.33%) followed by small (86%), medium (52%) and large (83%). Costly labour as ranked IV (71.66%) followed by small (90%), medium (48%) and large (78%). 68.33% majority of farmers faced the lack of improve seed as fifth ranked followed by 90%, 57% and 55% in small, medium and large, respectively. Costly equipment ranked as VI (68.33%) followed by 15%, 14%, and 15% in small, medium and large, respectively. Lack of capital as ranked VII (61.66%) followed by small (80%), medium (52%) and large (50%) farm groups. Lack of insect and disease resistance seed was as ranked VIII (61.66%) followed by 71%, 57% and 55% in small, medium and large farm groups, respectively. 56.66% farmers faced the lack of knowledge ranked IX followed by 76%, 48% and 44% in small, medium and large farm groups. Lack of supply of input and need of more irrigation were also observed constraints but at the lower scale ranking (rank X and rank XI) respectively.

CONCLUSION

The result obtained in this research study concludes that the investment on human labour, manures followed by fertilizer and irrigation should highly be considered. Factors having higher elasticity of production value would be looked after carefully and increase their input level for securing a higher return. To minimize the cost of cultivation of garlic crop in small size farm cost involved on human labour use to be decreased but this avenue is opened for larger size farms. The result of this

study indicates that the most serious constraints as perceived by the farmers in garlic production were lack of irrigation when needed, costly and irregular supply of electricity, lack of labours in peak time costly labour etc. There need to intensify current production level through improved production practices and efficient use of resources was the main reason behind this study particularly. These farm resources include irrigated farm size, available garlic seed, fertilizers & manure and farm labour which all have implications its production.

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