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RESEARCH ARTICLE :

Resource–use efficiency and technical efficiency of turmeric production in northern Karnataka

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SUMMARY : The present study is an attempt to assess the resource-use and technical efficiency in turmeric production in Northern Karnataka. For the study, 96 farmers practicing the cultivation of turmeric in both Bagalkot and Belagavi district were selected randomly. The data collected from the respondents were analysed using Cobb-Douglas (CD) production function and Timmer's output based measure of technical efficiency. The study revealed that, the MVP: MFC ratio was found more than unity in case of planting material, chemical fertilizers and plant protection chemicals in Belagavi district and bullock labour, machine labour and chemical fertilizers in Bagalkot district and nearly 50 per cent of the farmers were operating under less than 90 per cent technical efficiency ratings, mainly due to use of traditional cultivation practices. The major production and post-harvest constraint as opined by the sample farmers in both the districts were pest and disease attack and price fluctuation, respectively.

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KEY WORDS :
Garrett's ranking, Resource-use efficiency, Technical efficiency, Turmeric

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BACKGROUND AND OBJECTIVES

India is popularly known as the "spice bowl of the world" as a wide variety of spices with premium quality are grown in the country since ancient times. In Vedas, as early as 6000 BC, scruples evidences are available regarding various spices, their properties and utility. Among the commodities that were traded during that period, spices occupied a major portion due to their superior quality and diversity which attracted foreigners to India. Turmeric is also called as golden spice-is widely cultivated in different countries such as India, China, Myanmar, Nigeria, Bangladesh, Pakistan, Sri Lanka, Taiwan, Burma, Indonesia, etc. Among these countries, India occupies first position in both area (233 thousand hectares) and production (1190 thousand tonnes) of turmeric during 2013-14 (Anonymous, 2015). In India, turmeric is grown in 18 states and Andhra Pradesh, Tamil Nadu, Karnataka, Orissa and West Bengal are the major turmeric-producing states. Karnataka is the third largest producer of turmeric in India after Andhra Pradesh and Tamil Nadu with an area of 24912 ha and with production of 250829 tonnes in 2010-11 with a share of 8.5 per cent to the India's total production. In Karnataka, the major districts which are producing turmeric are Chamarajanagar, Mysore, Bagalkot, Belagavi and Bidar. Chamarajanagar is the leading district with an area of about 9708 ha with a production of 50808 tonnes followed by Mysore (6389 ha and 100310 tonnes), Bagalkot (4161 ha and 62898 tonnes) and Belagavi (1695 ha and 10352 tonnes) (Anonymous, 2013). It is widely grown and consumed spice in the world and has got good international market. Prices of turmeric show considerable volatility that could pose profit risk to different stakeholders. During 2012-13, the price of the turmeric has steadily fell down to around Rs. 5565 per quintal from Rs. 17,000 per quintal mark during 2010-11, due to increased acreage under turmeric mainly in Gobichettypalayam, Kodumudi and Bannari regions of Tamil Nadu state. Due to this Government of India announced the minimum support price for turmeric during May 2012 to safeguard the interest of the turmeric growers against further fall in the price of turmeric. Central government announced Rs. 4,092 per quintal for polished turmeric and in addition to that the Karnataka state government announced additional amount of Rs. 908 per quintal. Thus, the government purchased turmeric at the price of Rs. 5000 per quintal.

The increase in production is possible mainly through improvement in productivity of the crop that could be achieved by efficient utilization of available resources. In this context, assessment of the existing level of resource-use and technical efficiency in production of turmeric assumes paramount importance. Hence, the present study was conducted with the overall objective of assessing the efficiency of turmeric production in Northern Karnataka, with the following specific objectives: (i) to find resource use efficiency in turmeric production, (ii) to estimate technical efficiency of turmeric farms, (iii) to identify the constraints in production of turmeric, and (iv) to suggest appropriate policy measures for improvement.

RESOURCES AND METHODS

Multi stage sampling technique was employed for selection of districts, taluks and villages. The present study was conducted in Bagalkot and Belagavi districts of Northern Karnataka as these two districts were having highest area under turmeric in Northern Karnataka. In the second stage two taluks from each district were selected based on the highest area under turmeric. Thus Jamakhandi and Mudhol taluks in Bagalkot district and Gokak and Raibag taluks in Belagavi district were topped the list and were selected for the study. In the third stage two villages from each taluk were selected again based on the area under turmeric. For the selection of sample farmers, random sampling method was adopted and from each village twelve farmers practicing the cultivation of turmeric were selected randomly, thus the total sample size of the respondents was 96. Primary data were collected using pre-tested interview schedule through personal interviews. The data pertained to the 2011-12 agriculture year.

The resource-use efficiency of the inputs used by the turmeric-growing farmers was estimated using Cobb-Douglas (CD) production function, as given below:

$$Y = aX_1^{b1}X_2^{b2}X_3^{b3}X_4^{b4}X_5^{b5}X_6^{b6}X_7^{b7}e^u \quad \ldots\ldots. (1)$$

where, Y is the gross returns from the turmeric production (Rs./Acre), a is intercept (efficiency) term, X_1, X_2, X_3, X_4, X_5, X_6 and X_7 denotes cost (Rs./Acre) of planting material, farm yard manure, human labour, bullock labour, machine labour, chemical fertilizers and plant protection chemicals, respectively. e^u is the random error term and bi's are output elasticities of respective factor inputs, i = 1, 2….7.

Resource-use efficiency :

Given the technology, allocative efficiency exists when resources are allocated within the farm according to market prices and it implies the proper level of input use in production. To decide whether a particular input is used rationally or irrationally, its marginal value product will be computed. If the marginal value product of an input just covers its acquisition cost it is said to be used most efficiently.

The marginal value product (MVP) was calculated at the geometric mean levels of variables by using the formula.

$$\text{MVP } i^{th} \text{ resource} = b_i \frac{\overline{Y}}{\overline{Xi}} \quad \ldots\ldots.. (2)$$

where,

$\overline{Y}$ = Geometric mean of the output

$\overline{X}_i$ = Geometric mean of i^{th} independent variable

b_i = The regression co-efficient of the i^{th} independent variable

In order to determine the efficiency of allocation of the resources or price efficiency, the value of the marginal product obtained by multiplying the marginal product (b_i) by the price of the product was compared with its marginal cost. A ratio of the value of marginal product to the factor price more than unity implied that the resources were advantageously employed. If the ratio was less than one, it suggested that resource was over utilized.

Timmer's output based measure of technical efficiency :

Timmer (1971) imposed the Cobb-Douglas production function on the frontier and computed an output-based measure of efficiency. The approach adopted here is to specify a fixed parameter frontier amenable to statistical analysis. This takes the following general form.

$$Y = f(x)\ eu,\ u<0 \qquad \text{…. (3)}$$

and the Cobb-Douglas production function in natural logarithmic form would be:

$$\ln Y = a + \sum_{j=1}^{n} b_j \log x_j + u,\ u \leq 0 \qquad \text{..... (4)}$$

In estimating the above equation, the corrected ordinary least squares (COLS) regression is chosen as the most convenient means. This method is briefly outlined as under.

As a first step, the foregoing equation is estimated by the method of OLS yielding the best linear unbiased estimates of b_i's co-efficients. The intercept 'a' is then corrected by shifting the function until no residual is positive and one case is zero. This is done by adding the largest error term of the fitted model to the intercept. Greene (1980) has shown that a consistent, though biased, estimate of 'a' which imposes the sign uniformity on the residuals will be generated by this procedure.

Thus, Timmer measure of technical efficiency (TEi) of a farm 'i' is the ratio of actual output to potential (Frontier) output, given the level of input use on farm 'i'. It thus indicates how much extra output could be obtained if farm 'i' were on the frontier with the given technology and level of input.

Timmer measure of technical efficiency is given by:

$$TEi = \frac{Y}{Y^*} \leq 1 \qquad \text{...... (5)}$$

where, Y is actual output and Y* is potential output obtainable for given level of inputs.

Garrett's ranking technique :

The constraints in turmeric production were analysed using Garrett's ranking technique. The ranks given by each respondent were converted into per cent position by using following formula

$$\text{Per cent position} = \frac{100\,(R_{ij} - 0.5)}{N_j} \qquad \text{.....(6)}$$

where,

R_{ij} = The rank of the i^{th} item by j^{th} individual and

N_j = The number of items ranked by the j^{th} individual.

By referring the Garrett's table, the per cent position estimated was converted into score. Then, for each factor the scores of various respondents were added and the mean score was calculated. The factor with the highest mean score was considered to be the most important factor.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Resource use efficiency in turmeric production :

The estimated co-efficients of the Cobb-Douglas production function are presented in Table 1 for turmeric production in the selected districts. Perusal of the table clearly narrates that, the variables included in the function satisfactorily explained the variation in the dependent variable to the extent of 93.80 per cent and 90.10 per cent in the case of Bagalkot and Belagavi districts, respectively. The regression equation was estimated in order to capture the nature and magnitude of the effects of the independent variables on the returns of turmeric production.

It is evident from the table that, in case of Bagalkot district the output elasticities for bullock labour (0.4299) and machine labour (0.5128) were positive and significant; this implied that these two inputs have positive impact on the gross returns from turmeric production. Since turmeric required more cost on usage of machine labour on the operations such as land preparation, transportation of FYM and most importantly in case of processing of turmeric. Whereas for planting material (0.0191), human labour (0.0128), chemical fertilizers (0.0308) and plant protection chemicals (0.0027) were also positive but found non-significant and in the case of FYM, the output elasticity was (-0.0022) negative and non-significant.

Similarly in the case of Belagavi district, the output elasticities for planting material (0.3588), human labour (0.5336) and chemical fertilizers (0.0702) were positive and found significant. Which implies that, the increased usage of planting material, human labour and chemical fertilizers increases the gross income from turmeric production, since there is lack of availability of the quality planting material in the study area and if the improved varieties enter in the study area, farmers may use those varieties by spending more cost on that, which significantly contributes towards increased yield and thus the income. Though the output elasticities for FYM (0.0303) and plant protection chemicals (0.0311) were positive but they were non-significant. The output elasticities for bullock labour (-0.0352) and machine labour (-0.0694) were negative and non-significant. The results of the study are in line with the results of Narala and Zala (2010) in rice farms under irrigated conditions in central Gujarat.

The returns to scale (Σbi) was found to be more than unity in the case of Bagalkot district (1.01) indicating increasing returns to scale in the turmeric production whereas, it was less than one in the case of Belagavi district (0.92) implies decreasing returns to scale. This showed that an increase use of selected variables would result in more than adequate increase in the gross returns from turmeric production in Bagalkot district. The results obtained in respect of human labour are in conformity with the results of Sekhon *et al.* (2010).

Allocative efficiency :

The allocative efficiency of resource use was computed using ratio of marginal value productivity (MVP) and marginal factor cost (MFC) and is presented in the Table 2. It could also be seen from the table that, in Bagalkot district, the ratio was found more than one in the case of bullock labour (49.123), machine labour (9.484) and chemical fertilizers (3.203) ratio whereas, in the case of Belagavi district planting material (1.769), human labour (4.616), chemical fertilizers (5.681) and plant protection chemicals (1.880) were found greater than unity in Belagavi district. It indicates that these resources are being used at suboptimum level and there exists the possibility of enhancing the yield of turmeric by increasing their use. On the other hand, the ratio for planting material (0.116), human labour (0.117), plant protection chemicals (0.516) and FYM (-0.113) in Bagalkot district and the ratio for FYM (0.738), bullock labour (-4.976) and machine labour (-1.153) in Belagavi district were found less than unity indicating heavy and imbalanced use of these inputs in turmeric production.

Thus, the returns can be increased by increasing the use of planting material, chemical fertilizers and plant protection chemicals in Belagavi district and bullock labour, machine labour and chemical fertilizers in Bagalkot district. The findings are in conformity with those of Anand (2011) and Dodke *et al.* (2002) where resource use efficiency of turmeric in Chandrapur district of Maharashtra for human labour showed negative value indicated excess use.

Technical efficiency :

The technical efficiency in turmeric cultivation was worked out by using Timmer's method. The distribution of sample farmers in the selected districts according to different technical efficiency ratings for turmeric has been presented in Table 3. A perusal of table reveals that in Bagalkot district about 37.50 per cent of the sample farmers falls under the category of 90-95 per cent efficiency rating followed by 80-90 per cent efficiency rating (25.00%), 70-80 per cent efficiency rating (18.75%), 95-100 per cent and 50-60 per cent efficiency rating (8.33%) and 50-60 efficiency rating (2.08%). Similarly, in the case of Belagavi district also more number of sample farmers (35.42%) falls under 90-95 per cent efficiency rating category, followed by 80-90 per cent efficiency rating (29.17%), 95-100 per cent efficiency rating (16.67%), 70- 80 per cent efficiency rating (10.42%), 60-70 per cent efficiency rating (6.25%) and 50-60 per cent efficiency rating (2.08%). Thus, the study revealed that nearly 50 per cent of the farmers were operating under less than 90 per cent technical efficiency ratings, mainly due to use of traditional cultivation practices. The lack of technical knowledge about package of improved practices, low level and imbalanced use of fertilizers non-availability and high cost of recommended inputs especially labour for timely application even use of low yielding varieties might have also contributed to this phenomenon. It clearly indicates that there is a scope to improve the operation of farmers and move in to high technical efficiency level by adopting suitable cultivation practices. These findings are in line with those of Mary Louis and John (2010); Kachroo *et al.* (2010) and Kulkarni (2008). Bhendi and Kalirajan (2007) who have shown that mean technical efficiency was 86 per cent in sorghum and 84 per cent in maize (Wakili, 2012). Further Karthick *et al.* (2013) showed that technical efficiency of about 69 per cent of sample farmers has been found more than 80 per cent and suggested the possibility of increasing the yield of turmeric by adopting better technology.

Production and post harvest constraints in turmeric production :

An opinion survey was conducted to identify the problems faced by the farmers at different stages of production and marketing of turmeric in the study area. Problems were analysed using Garrett's ranking techniques and the results of the study are presented in Table 4.

Perusal of the table revealed that the major production problems opined by the sample farmers in both the districts were pest and disease attack, non-availability of labour during the peak season, higher cost of production in turmeric and non-availability of quality planting material. That means in the study area there was problem of rhizome rot, problem of termite and shoot borer, this problem was even more in the case of Belagavi district. This might be due to non-availability of resistant

Table 1 : Estimated Cobb-Douglas production function co-efficients

Sr. No.	Explanatory variables	Parameter	Districts	
			Bagalkot	Belagavi
1.	No. of observations	N	48	48
2.	Intercept	a	3.6699 (0.9485)	2.9082 (1.9376)
3.	Planting material (Rs.)	X_1	0.0191 (0.0368)	0.3588** (0.1001)
4.	FYM (Rs.)	X_2	-0.0022 (0.0025)	0.0303 (0.0190)
5.	Human labour (Rs.)	X_3	0.0128 (0.0742)	0.5336* (0.0276)
6.	Bullock labour (Rs.)	X_4	0.4299** (0.0750)	-0.0352 (0.0162)
7.	Machine labour (Rs.)	X_5	0.5128** (0.0065)	-0.0694 (0.0649)
8.	Chemical fertilizers (Rs.)	X_6	0.0308 (0.0251)	0.0702* (0.0178)
9.	Plant protection chemicals (Rs.)	X_7	0.0027 (0.0028)	0.0311 (0.0301)
10.	Co-efficient of multiple determination	R^2	0.938	0.901
	Returns to scale	Σb_i	1.01	0.92

Note: * and ** indicate significance of values at P=0.05 and 0.01, respectively
Figures in the parentheses indicate standard errors of co-efficients

Table 2 : MVP to MFC ratios of resources in turmeric production in the selected districts

Sr. No.	Explanatory variables	Parameter	Districts	
			Bagalkot	Belagavi
			MVP:MFC	MVP:MFC
1.	Planting material (Rs.)	X_1	0.116	1.769
2.	FYM (Rs.)	X_2	-0.113	0.738
3.	Human labour (Rs.)	X_3	0.117	4.616
4.	Bullock labour (Rs.)	X_4	49.123	-4.976
5.	Machine labour (Rs.)	X_5	9.484	-1.153
6.	Chemical fertilizers (Rs.)	X_6	3.203	5.681
7.	Plant protection chemicals (Rs.)	X_7	0.516	1.880

Table 3 : Distribution of turmeric farmers according to technical efficiency ratings in the selected districts

Sr. No.	Relative efficiency (%)	Districts			
		Bagalkot		Belagavi	
		Number	Per cent	Number	Per cent
1.	50-60	1	2.08	1	2.08
2.	60-70	4	8.33	3	6.25
3.	70-80	9	18.75	5	10.42
4.	80-90	12	25.00	14	29.17
5.	90-95	18	37.50	17	35.42
6.	95-100	4	8.33	8	16.67

varieties in northern Karnataka. Even the farmers opined that, due to non-availability of suitable pesticides, lack of information about the pesticides and availability of spurious chemicals in the market were the major threats in controlling the pest and diseases attack in the area. The other problem expressed by the sample farmers was non-availability of human labour during peak season, since turmeric is highly labour intensive crop it needs more quantity of labour during planting, weeding, harvesting and processing. The farmers expressed their sadness towards the non-availability of labour during these operations. Even they are available, the labours demand more wage in the various operations of turmeric than any other crops. All these reasons and high cost of planting material lead to higher cost of production of turmeric. The results of the above findings are aligned with the findings of Rajur (2007) where he reported that 81 per cent of the farmers expressed the problem of pest and disease in chilli production in Karnataka, Karpagam (2000) reported high cost of inputs and scarcity of labour were the major problems of turmeric in Tamil Nadu (Sawant, 2002).

The table also depicts the major post-harvest problems faced by the sample farmers in the study area; it is evident from the table that, in both the selected districts major post-harvest problems as opined by the sample respondents were, price fluctuation, lack of remunerative price for the produce, inaccessibility to regulated market and transportation problem. During the year 2011-12 there was sharp decline in the price of the turmeric to less than Rs. 5000 from Rs. 17000 per quintal during 2010-11 mainly because of fourfold increase in the production of turmeric in all the major turmeric growing states in India, but later to some extent this problem was solved by the government through market intervention scheme by announcing a price of Rs. 5000 per quintal. The other major problem expressed by the sample farmers was inaccessibility of regulated market since the roads from their villages to regulated markets were not good and moreover, the regulated markets were

Table 4 : Constraints faced by the farmers in production of turmeric

Sr. No.	Problems	Districts			
		Bagalkot		Belagavi	
		Garrett score	Rank	Garrett score	Rank
Production constraints					
1.	Non – availability of suitable varieties	47.98	IV	13.11	VIII
2.	Non – availability of quality planting material	45.97	VI	12.04	IX
3.	Non – availability of labour during peak season	96.99	II	91.67	III
4.	Non – availability of fertilizers during appropriate time	47.98	V	41.97	IV
5.	Pest and disease attack	98.04	I	98.32	I
6.	Higher cost of production	79.17	III	94.49	II
7.	Financial constraints	8.33	VIII	14.25	VII
8.	Lack of awareness about IPM	5.51	IX	18.01	VI
9.	Lack of support from department	9.17	VII	32.42	V
Post-harvest constraints					
1.	Lack of market infrastructure	12.04	XIII	19.39	XIII
2.	Lack of market information and intelligence	13.11	XII	20.93	XII
3.	Involvement of large number of intermediaries	27.15	X	22.32	XI
4.	Lack of remunerative price for the produce	97.37	II	96.99	II
5.	Inaccessibility to regulated market	93.86	III	56.03	V
6.	Non- availability of grading facility	14.25	XI	30.61	VIII
7.	High commission charges	63.85	IV	59.99	IV
8.	Unauthorized deduction	38.06	VI	36.15	VII
9.	Malpractices in weighment	30.61	VII	22.32	X
10.	Inadequate storage facilities	28.86	IX	23.88	IX
11.	Transportation problems	59.99	V	72.85	III
12.	Lack of processing facilities	30.61	VIII	56.03	VI
13.	Price fluctuations	98.82	I	99.55	I

located far away from the cities and in northern Karnataka there was no facility for turmeric trade due to absence of traders in the regulated markets. The farmers of these two districts were heavily dependent on Sangli market, even by incurring more transportation and commission charges.

The high commission charge, as reported by the farmers was another major problem. As per the bye laws, commission agents should get 2 per cent of the value of produce from the traders as their commission and the farmers need not have to pay anything as commission. But in reality the commission agents are receiving commission from both the farmers as well as traders. As reported by the farmers, they have paid commission which ranged from 2 to 4 per cent. This was because of linking of credit with marketing *i.e.* majority of the farmers get the credit facilities from the commission agents both in the form of cash and inputs like, seeds, fertilizers and pesticides with an agreement of selling their produce to them only. The other post-harvest problems faced by the farmers were inadequate storage facilities, lack of processing facilities, grading facilities and involvement of large number of intermediaries. Despite of the developmental efforts taken by the Spices Board, there is no improvement in the post-harvest handling. The traditional way of preparing the produce for market led to poor quality and contamination with undesirable foreign bodies may lead to rejection of the export consignment due to high level of pesticide residue and aflatoxins in the turmeric. Similar results were obtained by Madan *et al.* (2002) in turmeric and chilli cultivation in Andhra Pradesh and Srivastava *et al.* (2012) in case of Saffron in Jammu and Kashmir. Moktan and Mukherjee (2008) also stated in their study low value of the produce, poor marketing and trade policy and involvement of large number of middleman were the major post harvest problems faced by the spice growers in Darjeeling district, which in turn resulted in market imperfection, inefficiencies, exploitation and high post-harvest losses.

Conclusion :

The technical efficiency analysis indicated that, the expenditure on the usage of various inputs can be reduced by following concerted efforts for dissemination of improved technology for a proper as well as judicious use of inputs. It also revealed that the efficiency of majority of the farmers was more than 80 per cent and hence output of turmeric can be increased by improving the technical efficiency of less efficient farms through suitable extension services delivery. The technical efficiency is mainly influenced by education level and farming experience of farmers and thus there is the need to educate farmers through adult education programme so as to increase their productivity and income levels.

The major problems opined by the farmers were pest and disease attack in the production of turmeric. The prophylatic measures to protect the crop against pest and disease incidence which includes use of resistant varieties, seed and soil treatment including soil solarisation of seed beds, application of neem cake, bio control agents *etc.* In order to popularise the above techniques demonstration programmes may be taken in both the districts. Price stabilization measures need to be more pro-active rather than reactive, panic mechanisms. Price risk reduction measures such as providing adequate, timely dependable and farmer centric market intelligence through the collective efforts of all stake holders like farmers, traders, exporters, promotional agencies and R and D institutions assume importance in this context.

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