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Determinants of organic turmeric (*Curcuma longa*) cultivation in hill states of India: A logit approach

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ABSTRACT

The study demonstrates the economic and social determinants in adoption of organic cultivation of turmeric (*Curcuma longa* L.) in the states of Mizoram, Meghalaya, Manipur and Sikkim. The turmeric production through organic method demonstrated high yield and returns. The yield and returns of turmeric crop were found significantly higher in the adopter state than non-adopter states of the region. The analysis of economic returns showed organic cultivation of turmeric to be economically feasible but it also suggested policy implications like post-harvest arrangements. The factor share analysis stressed on need of pre-harvest arrangements on the turmeric farm of adopter as well as non-adopter states to make the crop more remunerative across the states of NEHR. The ANOVA analysis of yield contrasts provided the way forward to the capability and ability of turmeric yield across the states in the region. The identified technical as well as social factors and determinants through logit analysis have provided the researchable issues to enhance the productivity and production of organic turmeric in the region.

Keywords: Adopter, Determinants, Factors**,** Logit, NEHR, Organic turmeric

The continuous loss of soil fertility and biodiversity, soil erosion, eutrophication, water pollution and water scarcity (Foley *et al.* 2011, Ponisio *et al.* 2015) have led to the need for rejuvenation of the natural resources. Organic agriculture aims at sustainable production along with conservation of natural resources (Velten *et al.* 2015). The organic farming evolution era of emergence was the beginning of organic farming (Behera *et al.* 2012). India is home to 30% of the total organic producers in the world (APEDA 2019). During 2016–17, India ranked at 9th position in terms of World's organic agricultural land (Willer and Lernoud 2017). India is endowed with various naturally viable organic nutrients which are helpful in organic cultivation (Reddy 2010). Per capita consumption of fertilizers and pesticides in India is far below that of developed countries and hence, it is easier for Indian farmers to embrace organic spice farming in its true sense (Mohan *et al.* 2013). The organic spices are highly remunerative because of export demand (Malhotra 2010).

The total area and production of spices in India was 3671 thousand ha and 8122 thousand million tonne (MT), respectively, during 2016–17 (GoI 2017). Spices are low volume and high export-oriented commodity that have great economic significance in India (Sugasini *et al.* 2018). North Eastern Hill Region (NEHR) is the hub of spices which are in great demand (Hnamte *et al.* 2012). The produce of NEHR is recognized as organic by default (Das 2016, Wani *et al.* 2017). Sikkim is the leading state constituting 63.74% of the organic area in NEHR (APEDA 2017, Momin *et al.* 2018). Turmeric (*Curcuma longa* L.) occupies about 6.05% area and 13% of production of spices in the country (Spice Board of India, 2017). NEHR contributes 8.30% and 7.20% of production and area under turmeric, respectively, in India (GoI 2017). Keeping in view the above facts, present study was carried out to analyse the costs incurred and returns realized by the producers and the way of minimising the cost to gain more optimal profit from the organically produced turmeric, and also its adopting determinants.

MATERIALS AND METHODS

The experiment was conducted under ICAR funded project during 2017–2020 in NEHR of India. On the basis of highest area of cultivation of turmeric, three states, viz. Mizoram, Meghalaya, Manipur as non-adopter, and Sikkim (Control) as organic adopter in NEHR were selected. From each state, two districts having the largest area under turmeric cultivation and further, 2–4 major collection centre or blocks of each district were selected. A list of all the villages in the chosen collection centre/block was prepared along with the total number of households and producers of turmeric. A total of 334 turmeric producers out of 3341 total turmeric producers of the state of Mizoram, Meghalaya, Manipur and Sikkim were selected.

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Data: Three year primary data was collected for 2017–20. Data was collected through personal interview approach on well structured pre-tested schedule consisting of land preparation, rhizome quantity, cultivar used, method of cultivation (organic adopter and non-adopter), and determinants of organic cultivation of turmeric.

Analysis of data: Cost and return analysis: The cost concepts, viz. Cost A_1, Cost A_2, Cost B_1, Cost B_2, Cost C_1 and Cost C_2 proposed by Special Expert Committee on 1979, 30th January (GoI 1979) were used.

Factor share analysis: The physical quantity of each factor input when multiplied by its price and then divided by the value of the total product, gives yield factor share input (Dhondyal 1977).

$$FS\_X_i = (P_iX_i)/\mathrm{Vi})$$

where, FS_X_i is factor share of ith input, X_i is quantity of i_{th} input, P_i is per unit price of i_{th} input, V_i is total value of produce.

Comparison of means

One-way analysis of variance (ANOVA): To determine if there was any difference between the yield and returns of each selected spice in the organic vs control, ANOVA was used.

Paired sample t-test: The yield and returns for each selected spice was compared between the organic adopters and non-organic adopters through paired t-test.

Logit regression analysis: To determine the factors that influence the producers to adopt organic farming, the logit regression analysis was run. The analysis was run by using SPSS 21 version software. Mathematically, the logit regression analysis is expressed as follows:

$$\text{logit (y)} = \ln \frac{p}{1-p} = \beta_0 + \beta_1 * x$$

Where, Y is binomial independent variable, 1 is 'organic' and 0 is 'otherwise'. *P* is probability that a farmer will adopt organic farming.

RESULTS AND DISCUSSION

Costs and returns of turmeric production in NEHR: Cost of turmeric production in organic state of Sikkim was lowest among the states. It was more or less same in the state of Meghalaya (₹16.44/kg). The selling price of the

Table 1 Cost and returns of different form of turmeric (rhizome) and conversion factors in NEHR

Particulars	Adopter state	Non-adopter state		
	Sikkim	Mizoram	Meghalaya	Manipur
Raw turmeric (rhizome) (₹/kg)				
Cost of production	17.38	23.70 (36.36)	16.44 (-5.41)	13.20 (-24.05)
Selling price	34.45	32.77 (-4.88)	26.92 (-21.86)	21.38 (-37.94)
Net return	17.07	9.07 (-46.87)	10.48 (-38.61)	8.18 (-52.08)
Dry flake (₹/kg)				
Cost of production	62.38	89.70 (43.80)	63.50 (1.80)	51.50 (-17.44)
Selling price	169.00	135.00 (-20.11)	160.00 (-5.32)	165.00 (-2.36)
Net return	106.62	45.30 (-57.51)	96.50 (-9.49)	113.50 (6.45)
Powder turmeric (₹/kg)				
Cost of production*	72.80	99.70 (36.95)	73.50 (0.96)	61.50 (-15.52)
Selling price	258.00	225.00 (-12.79)	246.00 (-4.65)	195.00 (-24.41)
Net return	185.20	125.30 (-32.34)	172.50 (-6.86)	133.50 (-27.92)

Conversion factor of raw turmeric to final product (kg)

Type of final product	Adopter State				Non-adopter States			
	Sikkim		Mizoram		Meghalaya		Manipur	
	Raw product	Final product	Raw product	Final product	Raw product	Final product	Raw product	Final product
Dry flake	3.50	1.0	3.70	1.0	3.74	1.0	3.75	1.0
Turmeric powder	4.70	1.0	4.90	1.0	4.96	1.0	4.96	1.0

State difference in yield of turmeric

State	Yield			Economic returns		
	Mean difference (MT/ha)	t-value	p-value	Mean difference (₹/ha)	t-value	p-value
Sikkim *vs* Mizoram	1470.91	6.322	0.000***	61252.45	6.13	0.000***
Sikkim *vs* Meghalaya	598.89	5.47	0.000***	55702.85	6.11	0.000***
Sikkim *vs* Manipur	286.84	2.46	0.016**	80943.85	9.73	0.000***

Note: *P<0.10, **P<0.05, ***P<0.01

Table 2 Factor share and factors of organic adoption of turmeric

Factors of production	Non-adopter States									Adopter State		
	Mizoram			Meghalaya			Manipur			Sikkim		
	Value (₹/ha)	Turmeric*	Factor share (%)	Value (₹/ha)	Turmeric*	Factor share (%)	Value (₹/ha)	Turmeric*	Factor share (%)	Value (₹/ha)	Turmeric*	Factor share (%)
Output	110764.26	3.38	100	135657.85	5.04	100	112460.94	5.57	100	189817.63	5.51	100
Seed	28051.73	0.86	25.33	33127.52	1.23	24.42	22999.44	1.08	20.45	34863.63	0.01	18.37
Manure	3808.55	0.12	3.43	1535.17	0.06	1.13	2340.56	0.11	2.08	3943.00	0.11	2.07
Hired Labour	11489	0.35	10.37	11726	0.44	8.64	6486.00	0.30	5.76	5385.00	1.16	2.83
Family labour	29988	0.92	27.07	29748	1.11	21.93	32440.00	1.52	28.85	46341.00	1.35	24.41
Total human labour	41477	1.27	37.45	41474	1.54	30.57	38926.00	1.82	34.61	51726.00	1.5	27.25
Depreciation	443.21	0.01	0.4	506.21	0.02	0.37	388.80	0.02	0.34	350.95	0.01	0.18
Interest on working capital	3284.44	0.1	2.96	3517.12	0.13	2.59	2416.11	0.11	2.14	33470.72	0.1	1.76
Rental value of land	3031.84	0.09	1.99	2703.49	0.12	1.99	2340.00	0.11	2.08	1524.62	0.04	0.80

Note: *Prices of turmeric per tonne ₹32770.49, ₹26916.24, ₹21380.41 and ₹34449.66 in the state of Mizoram, Meghalaya, Manipur and Sikkim, respectively.

Logistic results for factors influencing adoption of organic turmeric

Particular	Land Holding	Yield	Seed rate	Input Cost	Education	Assistance
B	42.54	0.010	0.170	-0.011	0.986	3.45
Sig.	0.000***	0.000***	0.062*	0.008**	0.048*	0.001**
Exp(B)	1.070	1.011	1.017	0.848	2.682	1.078

Note: *P<0.10, **P<0.05, ***P<0.01

produce was observed to be more in the organic state than the non-adopter states. The cost and returns of by-products of turmeric varied spatially as per the cultivar of the crop. also. The cost of dry-flakes of turmeric varied from ₹51.50 to ₹89.70 in the non-adopter states. Cost of processing of raw turmeric into powder has been estimated and found to be higher in the non-adopter states than the adopter state Sikkim. The price offered by consumers was higher for organic produce (Table 1). Hence, from the analysis of cost of production of turmeric and its by-product it is clear that the processed product has fetched higher returns. Therefore, establishment of slice/flakes makers, dryers, grinders and packing machines is need of the hour.

Yield and returns from organic cultivation: From the factor share analysis of turmeric production, it can be observed that many of the factors taken in the study had almost similar share in contributing to the yield of turmeric in each state except for organic manure. The economic returns of turmeric between the selected states were highly significant at 1% level of significance. The difference in the economic returns might be due to cultivar use. The F value in both the cases of yield and returns was high which means that the variation among group means is more than expected to see by chance (Table 1). The positive mean difference signifies the higher yield of turmeric in Sikkim than other states. The turmeric producers of the organic state of Sikkim easily accessed bio-control measures and bio-fertilizers unlike the other selected states. Similarly, significant difference at 1% level was observed for returns of turmeric in adopter than the non-adopters. Therefore, model of Sikkim state for turmeric production needs to be replicated in all non-adopter states.

Factor share analysis of turmeric production: Human labour was the key factor of production in turmeric in across all the states. The lowest factor share of human labour in turmeric production was observed in Sikkim (27.25%) compared to the other non-adopter states (Table 2). In all the selected states, a higher share in the human labour was contributed by family labour, which appeals for intervention of machinery to reduce human labour use. *Rhizome* (seed) was another major factor contributing in the productivity of turmeric. The rhizome factor share was 25.33%, 24.42%, 20.45% and 18.37% in Mizoram, Meghalaya, Manipur and Sikkim, respectively. In Sikkim, the organic rhizomes played a major part in turmeric production. Similarly, in the state of Meghalaya the rhizome of *Lakadong* variety of turmeric which had the highest *curcumin* content played a major role. Therefore, proper seed supply system needs to be initiated. The usage of organic manure was found to be significant in Mizoram with an estimation of 3.43%. Organic manure helps in enhancing yield (Sharma and Reynnels 2018). Therefore, the application of organic manure should be encouraged in cultivation of turmeric as it has manifold benefits for turmeric growers. The share of depreciation ranged from 0.1 to 0.4. Usage of new innovative farm tools and implements should be encouraged as farm assets exert a considerable influence on farm activities. The factor share of depreciation in productivity of turmeric did not vary much among the selected states.

Determinants of adoption of organic turmeric cultivation: To determine the factors influencing organic agriculture, the logit model depicted that factors of landholding and yield of turmeric were highly significant factors at 1% level of significance in persuading turmeric producers to adopt organic methods. The model further depicted that for every unit increase in the landholding and yield, the odds of adopting organic system among the turmeric producers of NEHR increased by 1.07% and 1.01%, respectively. Other factors like input cost and support from institutions was estimated to be significant at 5% level of significance. Thus, one unit increase in assistance from the government increased the level of adoption by 1.08%. Therefore, with every unit decrease in the input cost, the odds of adopting organic system among the turmeric producers increases by 0.84%. Factors like seed rate and education were significant at 10% level of significance. Hence, for every unit increase in seed rate and education, the odd of adoption of organic farming was increased by 1.02% and 2.68%, respectively (Table 2). Intuitively, the level of costs that a certain farming system necessitates has a high influence on the decision making of producers to adopt organic farming. Thus, there is a need for assistance in form of subsidies and incentives for organic inputs to encourage and promote organic system.

The organic method of turmeric production has been found to be economically beneficial. Post-harvest management of turmeric needs more thrust as the turmeric flakes and powder fetches more economic returns. The factor share and logit analysis has provided apparent way forward for research and development on determinants like economic, social and technical. Technical issues in pre-harvest, viz. small machinery for land preparation and harvesting of turmeric, and post-harvest interventions like slice cutters, dryers, grinder and packaging are need of the hour. The yield analysis has given way forward for research and development on variety and cultivar of the crop. The education of the farmer was a significant determinant in adoption of organic method of turmeric cultivation. Therefore, educating turmeric growers through awareness programmes must be done. The replication of organic model of Sikkim state in other states of the region is the pivotal policy implication of the study.

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