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A study on economic viability of tomato (*Solanum lycopersicon*) cultivation by organic system of farming

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ABSTRACT

The study based on primary data collected from Jalpaiguri district of West Bengal reveals that tomato produced by organic system of farming requires an investment of Rs. 37884.45 per ha which is estimated to be 9.17 % higher than that produced by conventional (applying chemical and organic inputs) system of farming. But the total return realized from organic tomato is found to be 5.84 % below conventional average. Cost of production is estimated to be Rs.172 and Rs.155.31 q^{-1} in the same order. Higher prime cost of cultivation coupled with lower physical yield accounting 9.08 % have rendered the organic growers to obtain 28.19% lower net return per ha compared to its counter parts in conventional system. The return-cost ratios are also observed to be less in the former (1.67) than the later (1.93). Relatively greater expenditures on organic manures and fertilizers, human labours and other components including seeds, irrigation etc measuring 10.05, 10.84 and 5.47 % respectively are responsible for higher prime cost of cultivation in organic farms in comparison to conventionally managed farms. Higher premium prices deserved by organic products for its beneficial impacts on human health, soil fertility and environment along with input subsidy as in the case of chemical fertilizers is necessary to offset the loss arising out of the lower physical yield and higher prime cost of organic tomato production and also to make it economically viable over conventionally grown tomato.

***Keywords*:** Conventional farming, organic farming, prime cost, yield gap

Organic farming has emerged as a panacea of all evils arising out of indiscriminate use of fossil-fuel based chemical fertilizers and plant protection chemicals, micronutrients which are thought to be responsible for environmental pollution and natural deprivation, reduction in soil fertility and health hazards. Organic farming is claimed to be an ideal form of eco-friendly production system that can be more conducive to food security and will ensure sustainability in the long term (UNEP-UNCTA, 2008). In most of the definition, more emphasis has been given on ecological, biological and soil fertility related issues bypassing most important aspects in regard to production, productivity, food security, employment, farm income etc., *i.e.*, have remained unattended. The most important question regarding adoption of organic farming is that whether it would be possible to produce sufficient food grains to meet the required amount of food for people of the world's second most populous country after China and will replace by the mid of twenty first century when population will be more than 1.4 billion (Dyson, *et al*., 2004). Besides this, there is a plethora of criticism leveled against the superiority of organic products over output produced following inorganic or conventional system as claimed by proponents of organic farming. But those advocating organic form of crop cultivation have refuted the allegations outright depending on the logic that more food is not required to ensure global food security as we have enough food to feed the world and long term food security relies on sustainable form of food production. Not only that, it is also claimed that organic farming system has the potential to compete with conventional in terms of production and profitability. But due to increased cost of inorganic fertilizers and their detrimental effects on soil fertility and human health, supplementing the nutrients through organic sources has become necessary to sustain production and improve or maintain soil health (Devi *et al.* 2012). Clark (1999) has reported that the yield of low input system is comparable to the conventional system in all crops tested such as tomato, safflower, corn and bean and in some instances, yield is higher than conventional system and corn production in the organic system has an higher variability than conventional system, with lower yield in some areas and higher in other. Again, organic farming has also the potentiality to earn higher profit than most common conventional cropping system either through premium prices or through higher productivity (Welsh, 1999). It is also alleged that organic foods are more expensive than non-organic food because of high cost associated with the purchasing of enrich organic manures and plant protection products, human labour cost that push the cost of cultivation and makes organic products expensive. Under this context, the present study is a modest attempt to judge the relative profitability of tomato produced by organic method over conventional system in which both chemically and organically

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produced inputs are applied for supplying essential plant nutrients. The specific objectives of the study are presented as follows:

a) To study the costs and returns structure of tomato cultivation by both two farming systems *i.e.*, organic and conventional system of farming applying prime cost concept;

b) To estimate the variations in physical yield, total and net return *etc.* of tomato produced these two system;

c) To find out factors responsible for variations in the above mentioned parameters, and

d) To suggest some policy measures for stepping up of this eco-friendly crop production system in West Bengal as well as India.

MATERIALS AND METHODS

Primary data related to the cultivation of tomato by organic and conventional systems of farming have been collected from farmers belonging to five villages of purposively selected Jalpaiguri Sadar Block of Jalpaiguri district of West Bengal. Two out of five villages are designated as bio-villages' under the supervision of concerned agricultural department. The total farm land of these two villages has been brought under organic cultivation system to avoid contamination of synthetic chemicals from neighboring fields. A total 60 farmers, 30 from each of the two groups growing tomato practicing organic and conventional means is selected following Simple Random Sampling without replacement (SRSWOR) technique for collection of relevant information. Data collection has been done with the help of pre-tested schedule through personal interview method. Simple tabular and percentage techniques are employed in the present analysis. Yield gap analysis is made by applying formula presented as follows:

$$\text{Yield Gap} \quad \frac{\text{Organic - Conventional}}{\text{Organic}} \quad 100$$

Multiple regression technique used to identify factors responsible for variations in economic parameters is presented in the following form:

$$\Delta Y = a + b_1\Delta X_1 + b_2\Delta X_2 + b_3\Delta X_3 + b_4\Delta X_4 + b_5\Delta X_5 + b_6\Delta X_6 + b_7\Delta X_7 + b_8\Delta X_8 + \mu$$

Where,

ΔY= differences in total return (Rs. ha^{-1}).

A = intercept,

ΔX_1= differences in expenditure on seeds (Rs. ha^{-1}).

ΔX_2= differences in expenditure on organic manures (Rs.ha^{-1}).

ΔX_3= differences in expenditure on Organic fertilizers (Rs.ha^{-1}).

ΔX_4= differences in expenditure on inorganic fertilizers (Rs.ha^{-1}).

ΔX_5= differences in expenditure on plant protection chemicals (Rs.ha^{-1}).

ΔX_6=differences in expenditure on irrigations(Rs.ha^{-1}).

ΔX_7= differences in expenditure on animal labour (Rs.ha^{-1}).

ΔX_8= differences in expenditure on human labour (Rs.ha^{-1}).

μ refers to error term and b_1, b_2, b_3, b_4, b_5, b_6, b_7 and b_8 are the co-efficients.

RESULTS AND DISCUSSION

For the purpose of estimation of costs and returns structure of tomato cultivation following organic and conventional systems of farming, the concept of prime cost is adopted which includes the total labour input, seeds, manures, fertilizers, repairs and depreciation of implements and depreciation of livestock and irrigation charges (Panse and Bokil, 1966). Table-1 depicts that the total expenditure on various components of prime cost of tomato cultivation adopting organic farming system is estimated to be Rs. 37884.45 ha^{-1} and expenses on human labour is the dominant cost component accounting 34.08 per cent of prime cost ha^{-1}. Farmers have made 33.34 per cent of the total cost on organic manures and the share of other components namely organic fertilizers, irrigation and miscellaneous items in the total cost of cultivation are worked out to be 7.58, 5.93 and 4.49 per cent respectively. Farmers have realized a total return of Rs. 63343.38 ha^{-1}from sale of 194.90 q of organic tomato. The net return and return–cost ratio are worked out to be Rs. 25458.93 per ha and 1.67 respectively. In case of conventional farming, the sample farmers have obtained a net return of Rs. 32635.32 by incurring an expenditure of Rs. 34408.69 ha^{-1}. Here again, human labour appears to be the dominant cost component claiming 33.46 per cent of the prime cost followed by manures (22.38%) and subsequently followed by chemical fertilizers (15.83%). The physical yield obtained by the sample farmers is observed to be 223.48 q ha^{-1} valuing Rs. 67044.01 ha^{-1}. Return per rupee investment represented by return-cost ratio is Rs. 1.95 *i.e.*, farmers have earned a net return of Rs. 0.95 from an expenditure of Rs.1.00. The cost of production is found to Rs. 153.97q^{-1} which is lower than that of organic farming due to lower yield and relatively

higher prime cost of cultivation in case of the later. Here it is to be noted that in spite of producing lesser output and incurring comparatively lager prime cost associated the cultivation of organic tomato, the total return is not proportionately lower compared to conventionally grown tomato. This because of the existence of premium prices for organic products to compensate low income of the organic growers arising out of reduced yield. Premium pricing is the practice of keeping price of a product artificially high to encourage favorable perceptions among buyers based solely on prices (Gillings, 2002). The practice is intended to exploit the buyers' psychology assuming that expensive goods enjoy an exceptional reputation or high quality.

Table 1: Estimation of prime costs tomato cultivation in organic and conventional system of farming.

Sl. No.	Particulars	Organic farming	Conventional farming
A.	**Costs components of Prime Cost (Rs. ha^{-1})**		
i.	Seed	2034.39 (5.37)	1878.71 (5.46)
ii.	Manure	12630.68 (33.34)	7700.66 (22.38)
iii.	Organic fertilizers	2871.64 (7.58)	1476.13 (4.29)
iv.	Organic insecticides	1341.11 (3.54)	0.00 (0.00)
v.	Inorganic fertilizer	0.00 (0.00)	5446.90 (15.02)
vi.	Inorganic PPCL	0.00 (0.00)	1163.01 (3.31)
vii.	Irrigation charges	2246.55 (5.93)	1878.71 (5.46)
viii.	Bullock labour	1765.42 (4.66)	1803.02 (5.24)
ix.	Hired human labour	12911.02 (34.08)	11513.15 (33.46)
x.	Miscellaneous cost	2053.34 (4.67)	1555.27 (1.48)
B.	**Prime Cost of cultivation (Rs.ha^{-1})**	37884.45	34408.69
C.	**Return structure**		
i.	Physical output (q ha^{-1})	194.90	223.48
ii.	Total return (Rs.ha^{-1})	63343.38	67044.01
x.	Net return over prime cost (Rs.ha^{-1})	25458.93	32635.32
xi.	Return cost ratio over prime cost	1.67	1.95
xii	Cost of production over prime cost (Rs.q^{-1})	194.31	153.97

Note: Figures within parentheses indicate percentage to total.

A comparative analysis of tomato cultivation by two alternative means presented in table-2 reveals that the yield of organic tomato is 9.08 per cent below conventional average which have resulted in 5.84 per cent reduction in total return. On the other hand, expenditure on various components of prime cost is 9.17 per cent higher in the former case compared to later. Lower physical yield and higher prime cost of cultivation have resulted in 28.19 per cent deceleration in net return over conventional average. Higher premium prices for organic tomato, though marginal, have failed to offset the set back in yield and prime cost of cultivation. Relatively lower yield of crop grown in organic farms are not uncommon. Organic yields are 30-40 per cent lower relative to conventional overage (Lampkin *et al*., 1994). Dubgaard (1994) supplemented more precise information regarding yield variation by commenting that organic crop yields are about 40 per cent below the conventional average. Several other studies also have reported lower yield in organic farming than conventional agriculture (Padel and Uli, 1994; Henning, 1994; Anderson, 1994). Although, the observation of present study on cost of cultivation contradicts the finding from most of the past studies (Vine and Bateman, 1981; Murphy, 1992; Wyman, 1990). So, in order to make organic tomato production comparable with conventional farm, premium prices should be elevated to such level to offset lower yield as well as higher prime cost of cultivation. The premiums of 10-25 per cent would be needed to achieve gross margins per ha comparable to conventional system (Lowmgam, 1989; Youmie, 1989). Comparatively higher expenditure on human labour along with manures and fertilizers in organic farms compared to conventional system are mainly responsible for greater prime cost of cultivation. Table-4 portrays that sample

Table 2: Estimation of differences in physical yield, total return, net return and prime cost of cultivation of tomato between organic and conventional system of farming.

Sl. No.	Particulars	Organic	Conventional	Percentage Difference
1	Physical yield (Rs.ha^{-1})	194.90	212.60	-9.08
2	Total return (Rs.ha^{-1})	63343.38	67044.01	-5.84
3	Prime cost (Rs.ha^{-1})	37884.45	34408.69	9.17
4	Net return over prime cost (Rs.ha^{-1})	25458.93	32635.32	-28.19

Table 3: Differences in cost components constituting prime cost of cultivation of tomato produced by organic and conventional system of farming.

Sl. No.	Particulars	Organic	Conventional	Percentage Difference
1	Manures and fertilizers (Rs.ha^{-1})	15502.32	14623.69	5.67
2	Human labours (Rs.ha^{-1})	12911.02	11513.15	10.82
3	Others* (Rs.ha^{-1})	9471.11	8271.85	12.66
4	Prime cost (Rs.ha^{-1})	37884.45	34408.69	9.17

*Note: *Others include seed, organic insecticide, inorganic insecticide, irrigation, Animal labour Miscellaneous costs components*

farmers have incurred 10.84 and 10.05 per cent higher expenses on human labour and organic manures and fertilizers respectively over conventionally managed farm. Labour is the only cost on organic farms which differ significantly from conventional coverage (Murphy, 1992; Lampkin, 1993; Alvermann and Padel, 1991). It can be attributed to the fact that the most of the agronomical practices are done manually by employing human labour as against chemical control in conventional farms. Multiple regression analysis results representing the impact of factors on observed difference in yield of tomato reveals that chemical fertilizers and plant protection chemicals haves positive and significant influence on productivity variations whereas the impact of seed, organic manures and fertilizers, organic insecticides and bullock labour, though significant but negative (Table-4). The fitted equation is presented as follows:

$$Y = 52.95 - 18.72^{*}X1 - 0.323X2 - 44.386^{**}X3 + 2.831^{**}X4 + 14.304^{*}X5 - 2.959X6 - 1.406^{***}X7 + 0.007X8$$

*Note: *, ** and *** indicates significance at 1, 5 and 10% respectively.*

Organic tomato cultivation itself though provides a net return to sample farmers, but less remunerative compared to that produced by conventional system of farming. Higher premium price of organic produce is essential to motivate farmers to adopt organic farming. Creation of demand in the domestic market through extensive campaign about the beneficial effect of organic products and policy for promotion of export to the western countries where the demand is rapidly increasing can assure higher premium prices for the product. Again, supply of costly inputs at subsidized rate

Table 4 : Coefficient of factors responsible for variations in economic parameters

Sl. No	Variables	Coefficients	Standard Error	t value
1.	Constant	52.95		
2.	Seed	-18.72*	17.686	0.951
3.	Organic manures	-0.323	0.790	0.408
4.	Organic fertilizers	-4.386**	4.117	0.774
5.	Inorganic fertilizers	2.831**	2.098	0.873
6.	Inorganic plant protection chemicals	14.304*	7.965	1.796
7.	Irrigation	-0.359	5.250	0.564
8.	Animal labour	-1.406***	1.262	0.846
9.	Human labour	0.007	0.592	0.011

*Note: *,** and *** indicates significance at 1, 5 and 10% level respectively.*

to reduce cost of production is also necessary to make it comparable to conventional farm and the governments also will not hesitate to provide required subsidy as in case of chemical fertilizers considering the contribution of this eco-friendly crop production system to the society, specifically, beneficial effect on environment, soil fertility and above all, on human health.

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