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A Comparative Study on Costs and Returns of Inorganic and Organic Vegetable Production using Levene's F-test: A Case Study of Himachal Pradesh

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ABSTRACT

Sustainability is the emerging concept in today's world and organic farming is the backbone of the sustainability in the field of agriculture. It acts as an alternative to achieve the goal of economic as well as environmental sustainability. Organically grown vegetables are having better quality and fetching higher prices in the market as consumers are becoming more aware about nutrition and food safety with increase in education and per capita income. Organic production systems are based on specific standards, precisely formulated for food production and aim at achieving social and ecological sustainability. The results of the study showed that average family size was 4.26 and literacy rate was found quite high (97.54 %). The cultivated land accounted for 90.34 per cent of total land holdings. The cropping intensity was found to be quite impressive that is 176.16 per cent**.** The returns per hectare from organic vegetable farming are higher in cauliflower (₹ 388547.45/ha), peas (₹ 244150.86/ha), potato (₹ 313257.25/ha) and tomato (₹ 309826.06/ha), than the inorganic farming. The organic vegetable cultivation incurs less costs and gives more returns in all selected crops compared to inorganic vegetable cultivation. The results show that we should shift towards organic cultivation of crops in order to attain sustainability. Various scheme and other facilities from the government should be provided in order to adopt organic farming with all its effects.

Keywords: Organic, inorganic, comparative economics, vegetable, sustainability, cropping intensity

Agriculture has its own crucial role in the Indian economy. Amongst the various methods of farming in agriculture, organic farming came as an alternative way to overcome the problems of sustainability, global warming and food security. Since the early 1990s, the term "organic agriculture" has become legally defined in a number of countries. The vegetable and fruit growers in the state are highly dependent on increasing use of pesticides, which not only increases the cost of production but also affect the quality as well as food safety. For the first time, use of the term organic farming is credited to Lord Northbourne. The increase in organic production is mainly due to the increasing international demand. The domestic market is also expanding due to a large population and increase in the wealth (IFAD, 2009). The leading countries practicing organic agriculture are Australia (11.8 million hectare), Argentina (3.1 million hectare), China (2.3 million hectare) and US (1.6 million hectare). In Asia, area under organic cultivation is around 2.9 million hectares (Yussefi *et al*. 2007). The great Indian

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civilization thrived on organic farming and was one of the most prosperous countries in the world, till the British ruled. In traditional India, the entire agriculture was practiced using organic techniques, where the fertilizers and pesticides were obtained from plant and animal products. Organic farming is being practiced in India for thousands of years and is the backbone of the sustainable agriculture (Ananda *et al.* 2002). Acs *et al.* (2006) opined that organic farming is more profitable than conventional farming. Farmers do not have a clear insight into factors which hamper or stimulate the conversion to organic farming. The rise in pollution and food poisoning with harmful chemicals and effect on human health and environment is forcing people to incline towards organic food. Suresh (2001) in the study on performance of organic farming in Karnataka reported that per acre net income obtained on organic farms was higher compared to inorganic farms. This was due to per cent higher yields obtained on organic farms over the inorganic farms. Similarly, the Benefit Cost Ratio (BCR) in case of organic method of cultivation was found higher than inorganic method of cultivation. Many successful organic farmers with the knot tied with NGO's play a crucial role in bringing organic farming to a prestigious level today. India is bestowed with lot of potential to produce all varieties of organic products due to its diversified agro-climatic situations. According to the statistics available, India ranks 8th in terms of world's agricultural land and 1st in terms of total number of producers (FiBL & IFOAM, 2020). India has 3.67 million hectares land under organic certification process and produces near about 2.75 million tonnes of certified organic products (APEDA, 2020). Himachal Pradesh, a diversified state in the north of India stands at second position for largest area under organic certification after Madhya. The centre and state governments are emphasizing on the reduction of chemical use in agriculture to protect the quality of soil, productivity of crops and health hazards. Himachal Pradesh, in its policy document on organic agriculture in the state has a policy framework to cover more area under the organic farming. Both consumers as well as farmers are now slowly and gradually shifting towards organic farming. However, many researchers have performed studies related organic and inorganic farming in India and Himachal Pradesh (Rao, 1979; Thakur *et al*. 1994; Mehta and Chauhan, 1996; Kumar, 1998; Baruah and Barman, 2000; Suresh, 2001; Yadav *et al*. 2004; Sidhu, 2005; Acs *et al*. 2006; Sujatha *et al.* 2006 and Singh and Saxena, 2007) for various time frames. A lot of studies related to such analyses were made earlier, and it is necessary to assess the status and prospects of organic farming the best level possible.

MATERIALS AND METHODS

The present study was conducted in the mid hill zone of Himachal Pradesh. The zone occupies 10 per cent of total geographical area and about 30 per cent of the total cultivated area of the state. Within mid hill zone of the state, Mandi district was purposively selected because diverse vegetables are cultivated in the district as a result of congenial and diverse agro climatic conditions. The district is divided into ten blocks out of which two blocks, Dharampur and Gopalpur depending upon the vegetable cultivation were selected randomly (Fig. 1). Simple random sampling technique was used to select respondents. A list of organic and inorganic vegetable growers was prepared with the help of agriculture and horticulture departments and other agencies from the selected blocks and a sample of 100 vegetable growers, 50 each from selected blocks were selected randomly for collecting the requisite data. The data from 100 vegetable growers were collected with the aid of structured and comprehensive questionnaire exclusively prepared for the study.

Analytical framework

To fulfill the specific objective of the study and based on the nature and extent of availability of data, analytical tools and techniques have been employed for the analysis of data. Simple tabular analysis was used to examine socio-economic characteristics and returns from the major organic and inorganic vegetable. The dependency ratio, literacy rate and cropping intensity were calculated using the following formulas:

$$\textit{Dependency Ratio} = \frac{\text{Number of dependents in a family}}{\text{Total workers}}$$

$$\textit{Literacy Rate} = \frac{\text{Total number of literate persons}}{\text{Total population}} \times 100$$

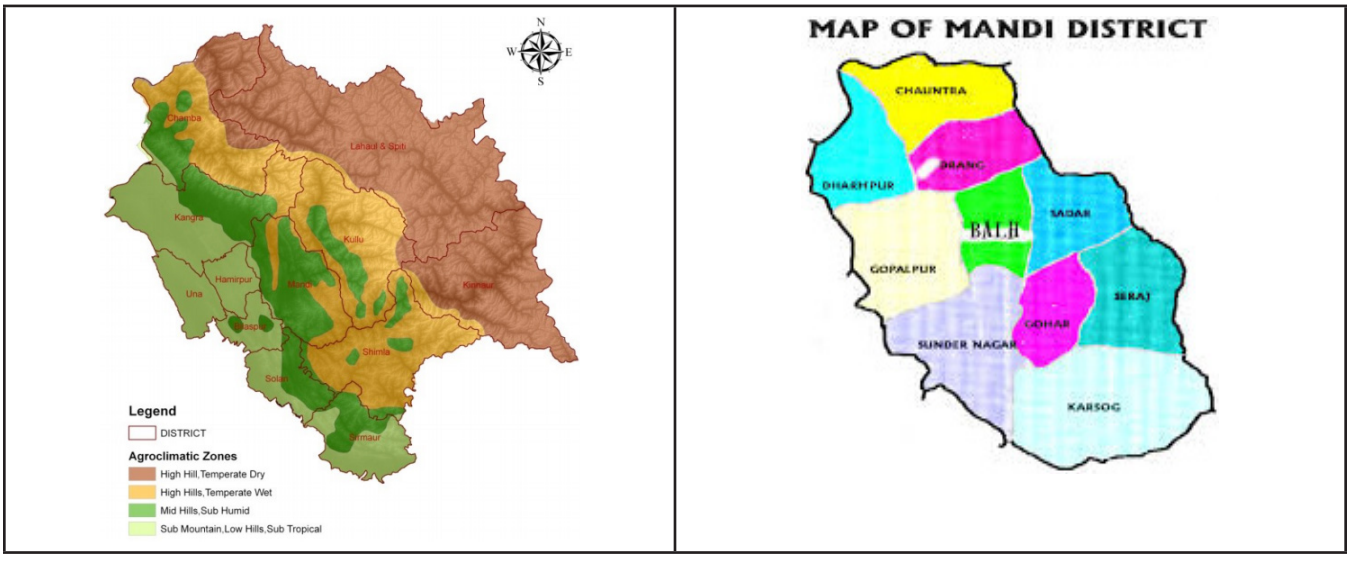

Fig. 1: Map showing mid hill zone of Himachal Pradesh and the study area

$$Cropping\ Intensity = \frac{\text{Gross cropped area}}{\text{Net sown area}} \times 100$$

The data were statistically evaluated and the mean returns were calculated using t-test. There were two applications of t-test i.e. testing the difference between independent groups or testing the difference between dependent groups. A t-test for independent groups is useful to compare the difference between means of two groups on the same variable. The aim was to compare the difference between means of the two groups i.e. organic and inorganic farming on the same variable i.e. returns, so independent samples t-test was used while comparing the difference between means of two groups on returns, a t-test for independent groups is useful. In addition to this, test has two specifications, first with equal variances and second with unequal variances.

The equality of variances is tested using the Levene's F-test before performing a t-test

The Levene's test is defined as:

$$H_0: \sigma_1^2 = \sigma_2^2$$

$$H_1: \sigma_1^2 \neq \sigma_2^2$$

Test statistic: Given a variable Y with sample of size N divided into 2 subgroups, where Ni is the sample size of the i^{th} subgroup, the Levene's test statistic (W) is defined as:

$$W = \frac{(N-K)\sum_{i-1}^{k} Ni\left(\overline{Z}i - \overline{Z}\right)^2}{(k-1)\sum_{i-1}^{k}\sum_{j-1}^{Ni}\left(\overline{Z}ij - \overline{Z}i\right)^2}$$

Where, N is the sample size, k is the number of sub-groups i.e. 2, $\overline{Z}_i$ are the sub-group means of Z_{ij} and $\overline{Z}_{ij}$ is the overall mean of Z_{ij}.

If W_{cal} value is greater than table value at 5 per cent level of significance then null hypothesis is rejected.

The hypothesis for independent t – test is:

$$H_o: \mu_1 = \mu_2,$$

$$H_1: \mu_1 \neq \mu_2$$

If the t-value greater than table value at 5 per cent level of significance, then null hypothesis is rejected, which indicates that there exists a significant difference between the means of the two sub-groups.

't' statistic if variance is equal

$$t = \frac{\left(\overline{Y}_1 - \overline{Y}_2\right)}{\sqrt{S^2\left[\frac{1}{n_1} + \frac{1}{n_2}\right]}}$$

$$S^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$$

't' statistic if variance is unequal

$$t = \frac{\left(\overline{Y}_1 - \overline{Y}_2\right)}{\sqrt{\left[\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right]}}$$

Where,

$\overline{Y}_1$ is the mean of first sub-group

$\overline{Y}_2$ is the mean of second sub-group

S^2 is the estimate of common variance

S_1^2 is the variance of first sub-group

S_2^2 is the variance of second sub-group

Coefficient of variation (CV): *t* is used a measure to determine variation between returns obtained from the inorganic and organic vegetable farming in the study area. It is calculated by using the formula:

$$CV\ (\%) = \left(\frac{\sigma}{\overline{x}}\right) \times 100$$

Where, is the standard deviation and $\overline{x}$ is the mean.

RESULTS AND DISCUSSION

Socioeconomic characteristics of organic and inorganic vegetable growers

Analysis of socio-economic variables are presented in Table 1. It included the family size, structure, non - farm workers, dependency of the non – workers, cultivable land, area under various vegetable crops and livestock holdings. The average family size was 4.26 less as compared to national average household size. In the study area, 60.06 per cent workers were involved in agriculture. The cultivated land accounted for 90.34 per cent of total land holdings with the sampled households and about 10.90 per cent of the total land holdings was under vegetable crops. Among vegetable crops, tomato and potato were the main vegetables of *kharif* season and peas and cauliflower were important in *rabi* season. The literacy rate was found quite high (97.54 %) indicating higher knowledge among farmers of the study area which implies engagement with new innovations and technologies. At an overall level, there were higher numbers of ploughs (919), foot sprayers (511) and power sprayers (390). The cropping intensity was found to be 176.16 per cent. The study area had 0.81 Adult Cattle Units of buffaloes, 0.55 Adult Cattle Units of bullocks and 0.46 Adult Cattle Units of cows.

Table 1: Description of socio-economic characteristics of the study area

Particulars	Overall
Average family size	4.26
Average number of workers	3.60
Average number of dependents	0.66
Agricultural workers (%)	60.06
Literacy Rate (%)	97.54
Number of ploughs	919
Number of foot sprayers	511
Number of power sprayers	390
Grossed cropped area (ha)	1.30
Cultivated area (ha)	0.74
Irrigated area (ha)	0.70
Vegetable area (ha)	0.08
Cropping Intensity (%)	176.16
Number of Buffaloes, ACU	0.81
Number of Bullocks, ACU	0.46
Number of Cows, ACU	0.55

Cropping pattern of organic and inorganic vegetable growers in the study area

Table 2 shows that *Rabi* crops grown by organic and inorganic growers were wheat, mustard, cauliflower and pea. Among these, wheat and mustard were the most important in terms of their share towards total cropped area. Wheat was cultivated on 34.93 per cent of the cropped area, whereas, the share of mustard was 6.26 percent.

The *Kharif* crops grown by the organic and inorganic growers were maize, paddy, potato, and tomato. Among these, maize, paddy, potato and tomato were the most important in terms share towards total cropped area. Paddy was cultivated on 33.49 per cent of the cropped area, followed by maize (5.45%), potato (4.42 %) and tomato (1.87 %).

Table 2: Cropping patterns of the households in the study area

Crop	Area (ha)	Per cent of cropped area
***Rabi* Crops**		
Wheat	0.44	34.93
Mustard	0.08	6.26
Cauliflower	0.03	1.95
Pea	0.04	3.23
Others	0.04	3.23
***Kharif* crops**		
Maize	0.07	5.45
Paddy	0.43	33.49
Potato	0.05	4.42
Tomato	0.02	1.87
Others	0.09	5.39
Total cropped area	1.30	100.00

Comparative analysis of returns from organic and inorganic vegetables

There were 50 inorganic and 50 organic vegetable growers for all crops. It is concluded from Table 3, that returns per hectare from inorganic cultivation of cauliflower were ₹ 324767.95 /ha while, for organic cauliflower returns are ₹ 388547.45/ha indicating that the returns of organic farmers is 63779.49 ₹/ha higher than the inorganic farmers. Inorganic cauliflower has more variation in gross returns (47.89%) than the organic cauliflower (41.79%). In case of peas, returns per hectare from inorganic cultivation were ₹ 209556.82/ha, while, for organic pea returns are ₹ 244150.86/ha that means returns of organic farmers is 34594.04 ₹/ha higher than inorganic farmers. Moreover, organic peas have more variation in returns (62.34%) than the inorganic peas (54.40%). The returns per hectare from inorganic cultivation of potato were ₹ 247044.14/ha, while, for organic potato returns are ₹ 313257.25/ha reflecting that in case of potato, returns of organic farmers is 66213.11 ₹/ha higher than inorganic farmers and further, organic potato has more variation in returns (39.17%) than the inorganic potato (26.56%). In case of tomatoes, returns per hectare from inorganic cultivation of tomato were ₹ 255471.95/ha, while, for organic tomato returns are ₹ 309826.06/ha. It shows that in case of tomato, returns of organic farmers is 54354.11 ₹/ha higher than inorganic farmers. Here, inorganic tomato has more variation in returns (49.92%) than the organic tomato (31.07%). It was concluded that for all the four vegetable crops under study, returns of organic farmers were higher than the inorganic farmers.

Table 3: Comparison of returns per hectare from vegetable crops in the study area (₹/ha)

Crops	Nature of Farming	N	Mean	Std. Deviation	CV(%)
Cauli-flower	Inorganic	50	324767.96 (21992.65)	155511.53	47.89
	Organic	50	388547.45 (22967.73)	162406.37	41.79
Peas	Inorganic	50	209556.82 (16123.44)	114009.92	54.40
	Organic	50	244150.86 (21525.10)	152205.46	62.34
Potato	Inorganic	50	247044.14 (9289.37)	65685.77	26.59
	Organic	50	313257.25 (17351.50)	122693.61	39.17
Tomato	Inorganic	50	255471.95 (17856.52)	126264.67	49.42
	Organic	50	309826.06 (13614.98)	96272.48	31.07

Figures in the parenthesis represent the standard error mean.

Results of F-test and t-test used for the equality of variances and difference in returns of potato

The test has different specifications; one assumes equal variance between the selected two groups while other assumes different variances. So, before conducting t – test, the variances of returns of inorganic and organic farming groups were compared by Levene's F- test. From Table 4, it can be inferred that in case of cauliflower, the Levene's test statistic for equality of variances is 0.53, which was non-significant (0.47) that is greater than 0.05, indicating that the variance of inorganic and organic returns are equal. The t- test assuming equal variances specification was conducted and the calculated t-value is -2.00, which is statistically significant. Similarly, for the peas, the Levene's

Table 4: Results of the Levene's F - test and t - test for equality of variances and difference in returns per hectare

		Independent Samples Test								
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Cauliflower	Equal variances assumed	.529	.469	-2.00	98	.048	-63779.49	31799.26	-126884.09	-674.88
	Equal variances not assumed			-2.00	97.82	.048	-63779.49	31799.27	-126885.57	-673.40
Pea	Equal variances assumed	.485	.488	-2.01	98	.046	-34594.05	17154.71	-68637.019	-551.07
	Equal variances not assumed			-2.01	96.74	.047	-34594.05	17154.71	-68642.55	-545.54
Potato	Equal variances assumed	4.038	.047	-3.36	98	.001	-66213.11	19681.64	-105270.67	-27155.54
	Equal variances not assumed			-3.36	74.96	.001	-66213.11	19681.64	-105421.315	-27004.89
Tomato	Equal variances assumed	5.914	.017	-2.42	98	.017	-54354.10	22454.91	-98915.15	-9793.06
	Equal variances not assumed			-2.42	91.58	.017	-54354.10	22454.91	-98954.22	-9753.99

test statistic for equality of variances is 0.48, which was non-significant (0.49) that is greater than 0.05, indicating that the variance of inorganic and organic returns are equal. The t- test assuming equal variances specification was conducted and the calculated t-value is -2.02, which is statistically significant. In case of potato, the Levene's test statistic for equality of variances is 4.04, which was significant (0.047) that is less than 0.05, indicating that the variance of inorganic and organic returns are not equal. The calculated t-value is -2.0, which is statistically significant. For tomato, the Levene's test statistic for equality of variances is 5.91, which was significant (0.02) that is less than 0.05, indicating that the variance of inorganic and organic returns are not equal. The t- test assuming unequal variances specification was conducted and the calculated t-value is -2.0, which is statistically significant. It indicates that there exists significant difference between returns obtained from the inorganic and organic cauliflower, peas, potato and tomato cultivation.

CONCLUSION

In case of vegetable crops, the returns of organic farmers are higher than the inorganic farmers so, it is advised that the farmers should switch over to organic farming. The organic farming minimizes the environmental degradation. There is a need to explore the prospects of organic farming in vegetable cultivation as major component of sustainable agriculture. The Levene's F- test statistic and t- test were conducted which indicated that there exists significant difference between returns obtained from the inorganic and organic vegetable cultivation. Some farmers have given consideration to organic vegetable growers while some are in the process of transition from inorganic to organic vegetable growers. There is need to explore the prospects of organic farming in vegetable cultivation as major component of sustainable agriculture. Extension strategies of government and non-government regarding promotion of practices of organic farming should be efficiently carried out. Organic agriculture

faces an unfair competition in the market because of the subsidy schemes for conventional production and the failure to get good market prices. Establishing organic markets is among the biggest potentials to improve the profitability of organic farming. Organic agriculture offers numerous environmental, economic and social benefits and contributes to policy framing.

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