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Article

Comparative analysis of profitability and efficiency of conventional and organic pea production: A case of Northwestern Himalayas

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Abstract: The cultivation of vegetables serves as a vital pillar in horticulture, offering an alternative avenue towards achieving economic sustainability. Unfortunately, farmers often lack adequate knowledge on optimizing resource utilization, which subsequently results in low productivity. Furthermore, there has been insufficient research conducted on the comparative profitability and efficient use of resources for pea cultivation. So, the present study was conducted to examine the profitability and resource use efficiency of conventional and organic pea production in Northwestern Himalayan state. Using the technique of purposive sampling, the districts and villages were selected based on the highest area. By using simple random sampling, a sample of 100 farmers was selected, out of which 50 were organic growers and 50 were inorganic growers, who were further categorized as marginal and small. The cost incurred was higher for the cultivation of inorganic vegetable crops, whereas returns and output-input ratio was higher in organic cultivation. The cultivation of peas revealed that the majority of inputs were being underutilized, and there was a need for proper reallocation of the resources, which would result in enhanced production. Further, major problems in the cultivation of vegetable crops were a high wage rate, a lack of organic certification, a shortage of skilled labour and a lack of technical knowledge.

Keywords: economic profitability; resource use efficiency; profitability; marginal value product; factor price ratio; pea; Northwestern Himalayas

1. Introduction

The northwestern Himalayas is a region of India characterized by its mountainous terrain, rich biodiversity, and diverse cultural heritage. This area spans across several states, including Himachal Pradesh, Uttarakhand, and parts of Jammu and Kashmir. Economically, the northwestern Himalayas play a significant role through activities such as agriculture, horticulture, and tourism. The cultivation of crops like apples and various vegetables is a crucial source of livelihood for many local communities. Local farmers in this region primarily grow cold-season vegetables like potatoes, peas, and leafy greens. These crops are well-suited to the cooler climate and are essential staples in the local diet [1].

Organic farming has replaced conventional farming due to a number of issues, including human health, environmental conservation, and the development of sustainable farming practices [2,3]. One way that organic farming stands out is that it uses fewer artificial inputs, including fertilizers and pesticides, which reduces the impact on the environment and prevents chemical runoff into water sources.

Furthermore, putting an emphasis on techniques like crop rotation, covering crops, and adding organic matter improves soil health by promoting improved structure, water retention, and biodiversity. Regarding human health, organic farming does not include the use of artificial chemicals and genetically modified organisms, which is advantageous to growers as well as consumers. The mitigation of climate change and the conservation of natural resources are facilitated by the promotion of biodiversity, the sequestration of carbon through techniques such as cover crops, and effective water management. Growing customer demand for organic products due to increased knowledge of environmental and health concerns allows growers to demand higher rates for their produce. Organic farming's dependence on biological pest control techniques strengthens the resilience of the agricultural system, and its general commitment to preserving soil fertility contributes to the long-term sustainability of agricultural practices.

1.1. Vegetables in horticulture sector

Vegetables constitute a vital component of horticulture, contributing significantly to both nutritional sustenance and economic stability. Their rapid growth cycle, high productivity, rich nutrient content, and profitability make them a cornerstone of farming practices. In previous years, vegetables have consistently held the dominant share, ranging from 59% to 61%, in overall horticultural crop production, which underscores their paramount importance in the agricultural sector. Beyond their nutritional benefits, the cultivation of vegetables has far-reaching economic implications. It serves as a robust source of income and employment, both within and beyond the agricultural sector. Farmers find a reliable stream of revenue through the cultivation of vegetables, which, in turn, bolsters their economic well-being [4–7]. Moreover, the vegetable supply chain, from cultivation to distribution, generates employment opportunities across a spectrum of activities, providing livelihoods for many. This dual role of vegetables, as nutritional powerhouses and economic engines, underscores their critical significance in India's agricultural landscape and the overall well-being of its populace.

1.2. Organic farming

Organic farming has been practiced for thousands of years, and it is the backbone of sustainable agriculture [8]. It acts as an alternative way to achieve the goal of economic and social sustainability and to overcome the problems of food security. The growth of organic production is increasing due to increase in international demand, but the domestic market is also strengthening due to an increasing population and wealth [9]. According to the latest survey on organic farming, a total of 72.5 million hectares were organically managed at the end of 2020, depicting a growth of 3.01%, or 2.20 million hectares, compared to 2019. Australia has the largest organic agricultural area (35.7 million hectares), followed by Argentina (3.7 million hectares) and Spain (2.4 million hectares). Due to the large area of organic farmland in Australia, half of the global organic agricultural land is in Oceania (36.0 million hectares). Europe has the second largest area (16.5 million hectares), followed by Latin America (8.3 million hectares). Over 76.4 million hectares of organic agricultural land, including in-conversion areas, were recorded. The regions with the largest organic agricultural land areas are Oceania (36.0 million hectares—almost half the world's organic agricultural land pr 47%) and Europe (17.8 million hectares, 23%). Latin America had 9.9 million hectares (13%), followed by Asia (6.5 million hectares, 8.5%), Northern America (3.5 million hectares, 4.6%) and Africa (2.7 million hectares, 3.5%) [10].

In India, a cumulative area of 29.41 lakh ha, 38.19 lakh ha, and 59.12 lakh ha have been brought under organic cultivation in the last three years (2019–2020, 2020–2021, and 2021–2022) using organic manure and other organic inputs, which constitute 2.10%, 2.72%, and 4.22% of the cultivable land of 140 million ha [11]. India has emerged as one of the top three countries where area under organic agriculture has significantly expanded in 2020. In 2020, the total increase under organic cultivation was recorded at 3 million hectares globally. Out of this, Argentina accounted for 7,81,000 hectares (21% surge), followed by Uruguay at 5,89,000 hectares (28% surge), and India at 3,59,000 hectares (16% surge). Out of the world's total 74.9 mh of land under organic farming, Australia leads at 35.7 mh, whereas India has 2.8 mh. Out of 34 lakh organic producers in the world, 16 lakh farmers in India are into certified organic farming.

Himachal Pradesh, a diversified state in the Northwestern Himalayas, stands at the second position for the largest area under organic certification after Madhya Pradesh. The centre and state governments are emphasizing the reduction of chemical use in agriculture to protect the quality of soil, the productivity of crops, and health hazards. Himachal Pradesh, in its policy document on organic agriculture, has a policy framework to cover more area under organic farming. Both consumers as well as farmers are now slowly and gradually shifting towards organic farming. Thus, keeping in view the above facts, the present study was conducted in Himachal Pradesh, a Northwestern Himalayan state, to estimate the economic profitability and input use efficiency for conventional and organic pea production.

2. Methodology

2.1. Study area and design

The study was undertaken in Himachal Pradesh, a Northwestern Himalayan state. From here, the sub-humid mid hill zone of Himachal Pradesh, which is situated between an altitude of 651 m–1800 m above msl, was also selected. The zone occupies 10% of the total geographical area and about 30% of the total cultivated area of the state. Within the 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. A purposive sampling technique was used to select respondents. A list of conventional (50 growers) and organic (50 growers) pea growers was prepared with the help of agriculture or horticulture departments and other agencies from the selected blocks and a sample of 100 pea growers. The respondents were divided into two farm categories, 59 marginal farmers (<1 ha) and 41 small farmers (1–2 ha). Both primary and secondary data were collected for the statistical analysis. Regression analysis using Cobb–Douglas function was used to determine resource use efficiency. To estimate the cost and returns from conventional and organic pea cultivation, CACP cost concepts were used as framed by the Estimation Committee on Cost of Cultivation, 1981, Directorate of Economics and Statistics, Government of India (**Figure 1**).

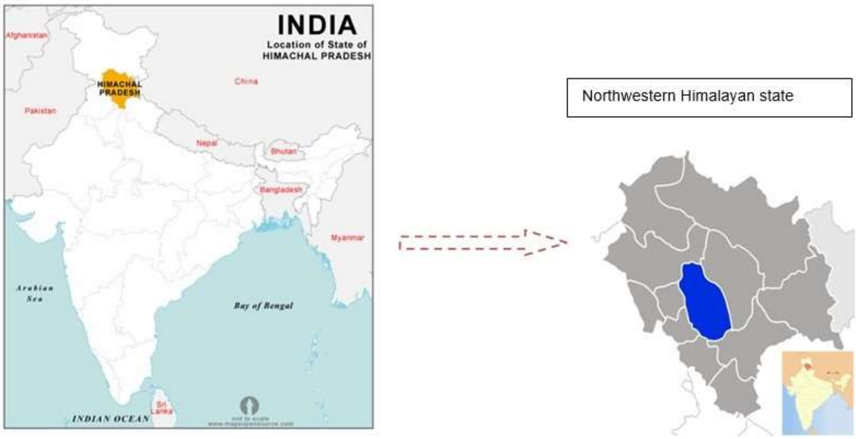

Figure 1. Northwestern Himalayan state depicting study area.

2.2. Economics and profitability

Cost A_1: Seed/seedling cost + value of manures, fertilizers and plant protection chemicals + hired human labour + bullock labour + owned and hired machinery + irrigation charges + depreciation on implements, farm buildings and irrigation structures + interest on working capital + other miscellaneous charges.

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

Cost B_1: Cost A_1 + interest on the fixed capital.

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 + value of management input (10% of Cost C_2).

Income measures: For working out the profitability different income measures were worked out:

Farm business income (FBI) = Gross income – Cost A_1.

Family labour income (FLI) = Gross income – Cost B_2.

Farm investment income (FII) = Farm business income – farm labour wages.

Net income (NI) = Gross income – total cost.

2.3. Cobb–Douglas production function

The Cobb–Douglas regression model was employed to evaluate resource use efficiency in inorganic and organic vegetable farming [12,13].

$$Y = \beta_0 X_1^{\beta 1} X_2^{\beta 2} X_3^{\beta 3} X_4^{\beta 4} U_t$$

where,

Y = gross returns (Rs.) per hectare.

X_1 = expenditure on seeds (Rs.) per hectare.

X_2 = expenditure on fertilisers (Rs.) per hectare.

X_3 = expenditure on plant protection (Rs.) per hectare.

X_4 = expenditure on labour (Rs.) per hectare.
β_0 = intercept.
U_t = the error term.
β_i = the elasticity coefficient (i = 1, 2, 3.....).

2.4. Estimation of resource use efficiency

The marginal value product of a particular resource represents the expected addition to the gross returns by using an additional unit of a resource, while other inputs are kept constant [14,15]. The marginal value products (MVPs) of the resources employed in conventional and organic pea production were estimated by multiplying the marginal physical product (MPP) by the unit price of the output (y).

$$MVP_{xi} = MPP_{xi} \times P_y$$

where, MVP_{xi} = marginal value product of ith input.
MPP_x = marginal physical product of the ith input.
P_y = price of unit output.

2.5. Estimation of MVP-factor cost ratio

$$r = \frac{MVP_{xi}}{MFC}$$

where, r = allocative efficiency.
MVP_{xi} = marginal value product.
MFC = marginal factor cost.
If $r = 1$ resource is efficiently used; $r > 1$ resource is under utilized and $r < 1$ means resource is over utilized.

2.6. Estimation of *D* value

Finally, the relative percentage change in *MVP* was calculated by using following formula:

$$D = \left(\frac{1 - MFC}{MVP}\right) \times 100$$

Or,

$$D = \left(1 - \frac{1}{r}\right) \times 100$$

where, D is absolute value percentage change in *MVP* of each resource [16].

3. Results and discussion

The profitability was estimated, and the costs of A_1, B_2, and C_3 were Rs. 39,569.48, Rs. 63,456.60, and Rs. 100,874.50 per hectare for conventional pea production. The estimated net income was Rs. 97,061.70 per hectare. However, in the case of organic pea, the total cost incurred and net income obtained were Rs. 94,715.52 and Rs. 150,934.48 per hectare, respectively. Thus, it was found that the output-input ratio in organic cultivation of pea (2.59) was higher than in inorganic cultivation of pea (1.96) (**Table 1**). The yield obtained in organic cultivation of pea was higher than in inorganic cultivation. Similar findings were reported by Wachter et al. and Durham and Mizik [17,18].

Table 1. Economic profitability estimates of conventional and organic cultivation of selected vegetable crops (Rs ha^{-1}).

Particulars	Conventional pea	Organic pea
Cost A_1	39,569.48	35,618.74
Cost B_2	63,456.60	70,036.28
Cost C_3	100,874.50	94,715.52
Yield (q ha^{-1})	89.97	98.26
Gross income	197,936.20	245,650.00
FBI	158,366.70	210,031.26
FII	134,479.60	175,613.72
Net income	97,061.70	150,934.48
Output-input ratio	1.96	2.59

FBI = Farm business income, FLI = Farm labour income, FII = Farm investment income.

Figure 2 shows the comparative cost and return structure of conventional and organic pea cultivation. It clearly shows that the costs incurred for the cultivation of pea under both systems of cultivation were dissimilar. The cost incurred during organic cultivation is higher due to the fewer inputs required as compared to inorganic cultivation [19,20]. Organic farming refrains from utilizing synthetic pesticides, herbicides, and fertilizers, choosing instead to employ natural alternatives such as crop rotation, cover cropping, and the application of organic manure. By doing so, the requirement to invest in costly synthetic inputs is eliminated, leading to a decrease in the overall expenditure on inputs. The central emphasis in organic farming revolves around nurturing and preserving soil health through the incorporation of organic matter. A robust soil health condition generally entails a reduced need for inputs and improved nutrient retention, diminishing the necessity for expensive external fertilizers. However, the income structure comparison of conventional and organic pea depicts that organic cultivation led to higher income than conventional pea cultivation. There is an increasing market desire for organic goods, and farmers stand to obtain premium prices for their organic peas. This has the potential to balance out a portion of the production expenses, rendering organic cultivation financially sustainable.

Cobb–Douglas production function analysis and input utilization: The efficiency of the input used by the farmers was estimated by functional analysis, and the results have been presented in this section. In inorganic pea, the estimated Cobb–Douglas production function was statistically significant for maximum inputs and explained 96% of the variation in inorganic pea cultivation. Seed (0.58), plant protection (0.25), and labour (0.19) were the significant factors in inorganic pea cultivation. The sum of the elasticity coefficients (Σ bi = 1.02) was greater than unity, indicating an increasing return to scale. "Return to scale" is about figuring out how much a production process can make when all the resources are increased by the same amount. Simply put, it tells whether more or less is obtained when inputs are used to scale up your operations. When more is obtained, it's increasing returns to scale; otherwise, it's decreasing returns to scale. For organic pea, the estimated function was statistically significant for fertilizers [21,22] and plant protection inputs only and explained 97% of the variation in the cultivation. The sum of the elasticity coefficients (Σbi = 0.56) was less than unity, indicating a decreasing return to scale (**Table 2**).

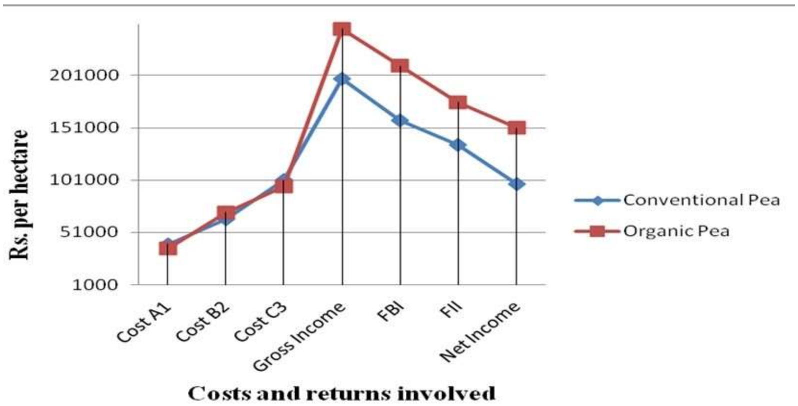

Figure 2. Comparative cost and return structure of conventional and organic pea.

Table 2. Regression coefficients of different production variables of pea.

Particulars	Conventional pea	Organic pea
Seeds	0.58* (0.09)	0.37 (0.32)
Fertilizers	0.05 (0.04)	–0.22** (0.08)
Plant protection	0.25* (0.08)	0.78** (0.31)
Labour	0.19* (0.06)	0.09 (0.15)
Σbi	1.02	0.56
R square	0.96	0.97
Adjusted R square	0.96	0.97
F cal	296.52	545.81

*, **, *** denotes significance at 1%, 5%, and 10%; figures in the parenthesis are the standard errors.

Marginal value product (MVPs) and factor price: The efficiency ratio (r = MFC), i.e., 24.70 for seed, 26.51 for plant protection and 1.45 for fertilizer, was greater than unity, indicating the underutilization of the resources in inorganic pea cultivation (**Table 3**). Thus, there is a need for adjustments in the MVP of these resources by 95.95% in seed, 96.23% in plant protection, and 30.80% in labour. In organic pea, the efficiency ratio, i.e., –12.26 for fertilizer and 22.21 for plant protection, showed overutilization and underutilization, respectively. So, in the production there is a need to increase the use of fertilizer by 107.93% and decrease the use of plant protection by 95.50%.

Table 3. Estimated marginal value product (MVPs) and factor price ratio.

	Inputs	Coefficients	MFC	*r*	*D*-value
Inorganic pea	Seed	0.58**	24.70	24.70	95.95
	Plant protection	0.25*	26.51	26.51	96.23
	labour	0.19*	1.45	1.45	30.80
Organic pea	Fertilizer	–0.22***	–12.26	–12.26	107.93
	Plant protection	0.78**	22.21	22.21	95.50

*, **, *** denotes significance at 1, 5, and 10%. MIC = Py = 1.

4. Conclusion

Organic farming is backbone of the sustainable agriculture and acts as an alternative way to achieve the goal of economic and social sustainability and also to overcome the problems of food security. The study compared the economic performance of conventional and organic pea cultivation, revealing notable differences in costs and income. In conventional pea production, costs per hectare were Rs. 39,569.48, Rs. 63,456.60, and Rs. 100,874.50 for A_1, B_2, and C3, respectively, with a net income of Rs. 97,061.70. Organic pea cultivation incurred total costs of Rs. 94,715.52 and yielded a higher net income of Rs. 150,934.48 per hectare. The output-input ratio was 2.59 for organic cultivation, surpassing the 1.96 ratio for inorganic cultivation. Although organic cultivation incurred higher costs due to reduced inputs, the study emphasized the higher income structure and profitability in organic pea cultivation. Additionally, the Cobb-Douglas production function analysis revealed significant factors in both cultivation methods, with inorganic cultivation showing increasing returns to scale and organic cultivation indicating decreasing returns. Adjustments in input utilization were suggested for both systems to optimize resource efficiency. The findings underscored the economic and efficiency considerations associated with organic versus conventional pea cultivation. Therefore, it is suggested that the farmers switch over to organic farming, which assists them for double their farm income, enhance sustainability, and reduce environmental stress.

The government should focus on the provision of certification for organic produce and demonstration practices to encourage organic cultivation. To promote organic pea cultivation in India, a multifaceted policy approach is crucial. This should include subsidies and incentives to aid farmers in transitioning, covering certification and input costs. Research should focus on tailored organic techniques for pea farming, including pest management and organic fertilization. Capacity building through training programs is essential for educating farmers on specific organic practices for peas. Accessible certification processes and support for certification fees are vital for market entry. Extension services must be strengthened with organic farming experts to guide farmers. Encouraging organic inputs like biofertilizers and biopesticides through subsidies and quality control is imperative. Crop insurance tailored for organic farming can mitigate financial risks. Market linkages and value-adding opportunities, such as direct sales and processing units, should be created. Establishing organic farming zones can prevent contamination. A regulatory framework is needed for monitoring and enforcing organic farming standards, and public awareness campaigns should be launched to drive consumer demand for organic peas. Through these policies, India can foster an environment conducive to widespread organic pea cultivation, promoting sustainable agricultural practices.

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