



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
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NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; SP-9(13): 04-07
Received: 06-05-2026
Accepted: 09-06-2026

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Enhancement in production and profitability of garden pea through introduction of scientific organic interventions in Namchi district, Sikkim: A case study

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i13a.6139>

Abstract

Sikkim, recognized as India's first fully organic state since 2016, has successfully eliminated the use of synthetic fertilizers and pesticides in agriculture. Despite its ecological advantages, organic vegetable production in the region often suffers from low productivity due to traditional farming practices, limited adoption of improved varieties, inadequate nutrient management, and challenges in pest, disease, and weed control. This case study examines the enhancement of production and profitability of garden pea in Namchi district through the introduction of scientific organic interventions. The study highlights the transition from conventional organic practices to improved scientific approaches, including the use of high-yielding and disease-resistant varieties, biofertilizers such as *Azotobacter* and phosphate-solubilizing bacteria, and liquid organic formulations like Jeevamrit and Panchagavya. Integrated Pest Management strategies involving biopesticides, pheromone traps, and cultural practices were implemented to effectively manage pests and diseases. Additionally, improved agronomic practices such as proper spacing, crop scheduling, and the use of modern tools enhanced crop management efficiency. Water management techniques, including drip irrigation and rainwater harvesting, further contributed to optimal resource utilization. The adoption of these scientific organic interventions resulted in improved crop yield, better quality produce, and increased market value, thereby enhancing farmers' income. Although initial investment costs and the need for technical knowledge posed challenges, the long-term benefits in terms of sustainability and profitability were significant. The findings suggest that integrating scientific methods within organic farming systems can substantially improve the productivity of garden pea cultivation in Sikkim and serve as a model for other regions practicing organic horticulture.

Keywords: Biofertilizers, Jeevamrit, organic horticulture, panchagavya, sustainability

Introduction

Sikkim is India's first 100% organic state, officially declared in 2016. Today, all agricultural lands in the state are organically certified, benefiting over 66,000 farmers. There is complete ban on use of synthetic inputs, including chemical fertilizers and pesticides in crop cultivation in the state. Various organic-based inputs namely compost, biofertilizers, bio-pesticides (like plant- and microbial based extracts and formulations) are commonly used for crop management. Some of the major advantages of organic farming include sustaining soil fertility, maintenance of ecological balance, and production of healthy, chemical-free foods. However, it is also associated with several disadvantages like initial low crop yields, higher cost of production, more labour intensive, difficult pest and disease management, limited availability of various organic inputs, and marketing and transportation related constraints (Khajuria, 2025)^[1].

Due to its diverse agro-ecological conditions, cultivation of various vegetable crops is possible in Sikkim. In harmony with the undulating topography, vegetable cultivation extends from foothills to elevations up to 2000 m above sea level in the state. Some of the popular vegetables crops of the state include leafy vegetables (like lettuce, spinach, mustard greens, and Pok Choi), fruit vegetables (like tomato, capsicum, cucumber, and zucchini), root vegetables (like radish, carrot, and beetroot), Cole crops (like cabbage, cauliflower, and broccoli), and legume

vegetables (like garden pea, cowpea, French bean, and Faba beans). Probable reasons for low productivity in organic vegetable includes low adoption of improved varieties/hybrids, nutrient management constraints, pest and disease pressure, weed management difficulties, lower and variable yields, and lack of knowledge and skills on organic cultivation techniques, including the use of bio-fertilizers and bio-pesticides (Shanu and Lakshminarayana, 2025)^[2].

Organic vegetable production through traditional methods in Sikkim under organic conditions

Sikkim farmers generally the lack knowledge and skill of organic management practices recommended to them for efficient productivity improvement and crop pest management (Singh *et al.*, 2021)^[3]. Farmers of the state generally use their traditional varieties for crop production and lack awareness regarding improved varieties/hybrids. They lack the knowledge and skills necessary for improved nutrient management practices. For example, the nutrients required for crops are met only through the manures they traditionally use, which are slow-releasing and should be given as basal doses in the soil. In organic crop cultivation, chemical pest management practices are strictly restricted, which can be more efficient than other pest management methods. Usually, in integrated pest management practices, an efficient approach to pest management starts with cropping patterns, cropping seasons, intercropping, trap cropping, and mixed cropping, which are not taken seriously by Sikkim farmers. Other methods, such as trap usage is also not followed by the majority of farmers. So, it makes the organic pest management difficult. Weeds in the field, which are a great enemy of farmers, are most often controlled effectively by the herbicide spray, depending on the weed species found in the crop field. But it is again not recommended and strictly restricted in organic farming. So, weed management has to be carried out by other methods, such as cultural, physical, and biological means, which are not widely followed by Sikkim's farmers, except for hand weeding and residue burning. The farmers of this state lack knowledge of the usage of biofertilizers and biocontrol agents in crop production, which should be recommended to them for efficient productivity improvement and crop pest management.

Improvement in vegetable crop productivity through scientific intervention in Sikkim under organic conditions

High-yielding and disease-resistant seeds: These can be used to increase production and ensure better quality vegetables. Off season cultivation of vegetables can be done under protected cultivation under controlled environments, protecting them from extreme weather and pests and giving them the required conditions for growth (Sahu *et al.*, 2020)^[4]. Proper adoption of recommended spacing and crop scheduling improve plant growth, reduce the competition with weeds, protect them from pest incidence and increase yield. Usage of modern tools and implements such as power tiller, hand held mechanical weeder, etc., help in efficient planting, weeding, and harvesting, saving both time and labour.

Nutrient Management: Organic nutrient management doesn't completely depend on the manurial application and in addition to the high-quality organic manures to improve soil fertility and microbial activity, biofertilizers such as *Azotobacter*, PSB can also be used for fixing nitrogen and make phosphorus available to plants respectively. Liquid manures such as Jeevamrit, Panchagavya, etc., enhance plant growth and boost immunity naturally to the plant which can be given as foliar spray as well as basal application along with manures (Chongtham *et al.*, 2025)^[5].

Pest & Disease Management: Biopesticides such as Trichoderma, neem oil can be used for controlling pests and diseases without harmful chemicals. Sticky traps, pheromone traps can also be used for helping monitor and reduce insect population effectively. By using Integrated Pest Management (IPM) practices, combination of biological, cultural, and mechanical methods for sustainable pest control can be used for better crop production (Zhou *et al.*, 2024)^[6].

Water Management: Smart irrigation practices such as drip irrigation, sprinkler systems can be utilized for efficient water use by supplying water directly to plant roots. Rainwater harvesting structures can be stored and used in the dry season effectively in the hilly regions, which is like Sikkim.

Advantages of adoption of improved practices in organic cultivation

Produces more uniform, healthy, better quality and marketable vegetables with higher yield and productivity compared to traditional practices. Year-round vegetable production by the usage of protected cultivation structures which allows off-season production. Better market value and income through high-quality produce year-round.

Limitations

Building protected cultivation structures, irrigation systems, and organic inputs are costlier initially while adopting improved organic cultivation methods. Adoption of improved organic cultivation method by farmers requires technical knowledge and training for using them effectively (Manyaku *et al.*, 2024)^[7].

Case study of garden pea cultivation

A field demonstration on garden pea cultivation was conducted at three locations in Thangsing village, Namchi district, Sikkim, during 2024–2025 under the Rural Horticultural Work Experience (RHWE) Programme – Village Attachment (Course Code: READY-412) as part of the B.Sc. (Hons.) Horticulture curriculum of the College of Horticulture, Birmiok, Sikkim. The demonstration assessed and compared the prevailing farmers' cultivation practices with recommended scientific organic practices under on-farm conditions. Students executed both methods side by side to evaluate their impacts on crop productivity, economic returns, and overall profitability, while demonstrating the benefits of improved scientific organic technologies to the farming community. The treatment details for the two cultivation practices are presented in Table 1.

Table 1: Treatment details of Farmers' practices and Scientific organic practices for Demonstration on Garden pea cultivation in Namchi, Sikkim during 2024-2025

Aspect	Farmers' practices	Scientific organic practices
Variety	Local variety	Kashi Uday
Seed rate	120 kg/ha	80 kg/ha
Seed treatment	Nil	<i>Trichoderma viride</i> @ 5 g/ kg seed
Spacing	No definite spacing	30 cm x 15 cm
Nutrient management	FYM @ 3 t/ha	- FYM @ 5 t/ha + Biofertilizer consortia - Rock phosphate @ 150 kg/ha
Insect pest management	Nil	- Neem oil (1500 ppm) @ 4 ml/l water - Yellow Sticky trap
Disease management	Nil	Copper oxychloride (50% WP) @ 2 g/l water
Water management	Rainfed supplemented with life saving irrigation	Irrigation as per requirement

Data presented in Table 2 clearly indicate that garden pea cultivation through scientific organic interventions noticeably increased production, productivity, and economic returns, resulting in higher profits compared to farmers' practices. Productivity in the scientific cultivation at location 1 was 18.18% higher than that of traditional cultivation practices. In location 2, it was 24.53% higher than traditional, followed by location 3 at 17.59%. On average, productivity increased from 602 to 748 kg/ha, representing an overall improvement of 24.25% over the farmers' practice. The enhanced yield can be attributed to the use of an improved variety, an optimal plant population, balanced nutrient management, and effective pest and disease control, which collectively promoted better crop establishment and pod development. Similar observations were reported by Ayyadurai *et al.* (2026) ^[8], Mohapatra and Dash (2024) ^[9], and Recrop cost (2025) ^[10].

Cost of Cultivation in scientific cultivation of location 1 was 3.53 times higher than the traditional cultivation practices. In location 2, it was 9.73% higher than traditional, followed by location 3 at 27.84%. Gross income in scientific cultivation of location 1 was 18.18% higher than the traditional cultivation practices. In location 2, it was 24.53% higher than traditional, followed by location 3 at 17.59%. Net Income (rupees/ha) in scientific cultivation of location 1 was 110.45% higher than the

traditional cultivation practices. In location 2, it was 41.41% higher than traditional, followed by location 3 at 1.47%. Although the cost of cultivation under scientific organic practices was higher due to the adoption of improved inputs and crop management interventions, the additional investment was compensated by higher returns. Scientific organic practices generated an average gross income of ₹1,49,600/ha, which was ₹29,200/ha (24.25%) higher than the farmers' practice (₹1,20,400 ha⁻¹). Consequently, the average net income increased from ₹24,292/ha to ₹42,461/ha, registering an increase of ₹18,169/ha (74.79%).

The Benefit-Cost Ratio (BCR) in the scientific cultivation at location 1 was 18.18 times higher than that of traditional cultivation practices. In location 2, it was 16.67% higher than traditional, followed by location 3 at 12.52%. The average benefit-cost (B:C) ratio also improved from 1.40 under farmers' practices to 1.50 under scientific organic practices, indicating that every rupee invested under the improved technology generated higher economic returns. Overall, the results demonstrate that although scientific organic cultivation requires a modest increase in production cost, it substantially enhances productivity, profitability and economic sustainability, making it a more remunerative production system for garden pea cultivation under the organic farming conditions of Sikkim.

Table 2: Yield and economics of garden pea cultivation at different locations during 2024-2025

Location	Method	Area (ha)	Production (kg)	Productivity (kg/ha)	Cost of Cultivation (₹/ha)	Gross Income (₹/ha)	Net Income (₹/ha)	BCR
Location 1	Scientific organic practices	1	1100	1100	1,89,844	2,20,000	30,157	1.1
	Farmers' practices	1	900	900	1,83,150	1,80,000	-3,150	0.9
Location 2	Scientific organic practices	1	530	530	56,500	1,06,000	49,500	1.8
	Farmers' practices	1	400	400	51,000	80,000	29,000	1.5
Location 3	Scientific organic practices	1	614	614	75,075	1,22,800	47,725	1.6
	Farmers' practices	1	506	506	54,175	1,01,200	47,025	1.8
Average	Scientific organic practices	1	748	748	1,07,140	1,49,600	42,461	1.50
	Farmers' practices	1	602	602	96,108	1,20,400	24,292	1.40

Conclusion

The demonstration showed that scientific organic practices markedly increased the productivity and profitability of garden pea under the organic farming conditions of Sikkim. Adoption of the scientific organic interventions enhanced average productivity and gross income by 24.25%, net income by 74.8%, and the benefit-cost ratio from 1.40 to 1.50 compared with farmers' practices. Although the improved technology incurred higher cost of cultivation, it produced considerably higher monetary returns, indicating its technical feasibility, economic viability and potential for wider adoption to enhance garden pea production and farmers' income in Sikkim.

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