**Royal International Global Journal of Advance and Applied Research**
Peer Reviewed International, Open Access Journal.
*ISSN: 2998-4459 | Website: https://rlgjaar.com Volume-2, Issue-7 | July - 2025*

Original Article

# Horticultural Transformation in Sikkim: Trends in Crop Production, Productivity and Rural Livelihoods in the Eastern Himalaya

**Dr. Tanka Prasad Dhungel**
Associate Professor, Department of Geography
Sikkim Government College Namchi

**Manuscript ID:**
RIGJAAR-2025-020723

ISSN: 2998-4459
Volume 2
Issue 7
Pp.115-120
July 2025

**Submitted:** 10 June 2025
**Revised:** 25 June 2025
**Accepted:** 15 July 2025
**Published:** 31 July 2025

***Correspondence Address:***
*Dr. Tanka Prasad Dhungel*
*Associate Professor, Department of Geography*
*Sikkim Government College Namchi*
*Email: dhungel.t@gmail.com*

Quick Response Code:

Web. https://rlgjaar.com

DOI: 10.5281/zenodo.24269979

DOI Link:
https://doi.org/10.5281/zenodo.24269979

Creative Commons

***Abstract:***

*This paper examines changes in horticultural crop production, land productivity and selected rural-livelihood conditions in Sikkim, an Eastern Himalayan state with pronounced altitudinal and agro-climatic variation. A secondary-data research design is used to analyse crop statistics reported for 2005–06 and 2015–16, with a district-level case analysis of South Sikkim for 2005–06, 2010–11 and 2015–16. Percentage changes in production and yield are calculated from the reported mean values. The state-level series indicates that output increased for all six horticultural groups considered: fruits, vegetables, potato, large cardamom, ginger and turmeric. The largest proportional increase was recorded for turmeric, while vegetables remained the largest output category. However, production growth did not consistently correspond to yield growth: fruit and turmeric yields declined over the comparison period, and ginger productivity increased only marginally. The South District series similarly shows substantial increases in vegetable and fruit output alongside near-stagnant ginger yield and declining turmeric yield. These results are interpreted alongside research published between 2015 and 2023 on organic transition, large-cardamom agronomy, market channels and household livelihood security. The findings indicate that the next phase of horticultural development should prioritise crop- and elevation-specific productivity, plant-health management, post-harvest infrastructure, producer organisations and farmer-centred organic-transition support. The study is based entirely on secondary data and does not claim causal effects or represent current annual production.*

***Index Terms—****Sikkim, horticulture, crop production, crop productivity, large cardamom, organic agriculture, rural livelihoods, Eastern Himalaya.*

## Introduction

Horticulture has a strategic role in mountain economies because it can generate higher-value output from small and fragmented landholdings while diversifying household food and income sources. In Sikkim, the combination of tropical, subtropical, temperate and higher-elevation environments supports fruits, vegetables, root and tuber crops, spices and flowers. Large cardamom, ginger, turmeric and mandarin orange are especially relevant to commercial farming, while vegetables and potato contribute both to household consumption and market sales [1], [2].

The state's horticultural development is closely linked to its organic-agriculture transition. Sikkim declared itself fully organic in 2016 after a long sequence of policy measures and certification efforts. The transition created a distinctive market identity, but research also identifies risks involving pest and disease management, yield losses, input availability and the distribution of transition costs between the state and farm households [5], [10]. Organic status alone therefore cannot be treated as evidence of higher productivity or improved farmer welfare.

A basic analytical distinction is necessary. Production is the total quantity harvested, whereas productivity in this paper refers to harvested output per unit of cultivated area. Production may rise because more land is planted, because yield improves, or because both change. These pathways have different implications for land pressure, farm labour, income stability and resource efficiency. A research assessment must therefore examine output and yield together rather than treating an increase in total production as an automatic productivity gain.

***Creative Commons (CC BY-NC-SA 4.0)***
*This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International Public License, which allows others to remix, tweak, and build upon the work noncommercially, as long as appropriate credit is given and the new creations ae licensed under the idential terms.*

***How to cite this article:***
*Dhungel, T. P. (2025). Horticultural Transformation in Sikkim: Trends in Crop Production, Productivity and Rural Livelihoods in the Eastern Himalaya. Royal International Global Journal of Advance and Applied Research, 2(7), 115–120. https://doi.org/10.5281/zenodo.24269979*

Royal International Global Journal of Advance and Applied Research
Peer Reviewed International, Open Access Journal.
ISSN: 2998-4459 | Website: https://rlgjaar.com Volume-2, Issue-7 | July - 2025

The purpose of this study is to assess the historical pattern of horticultural production and productivity in Sikkim and to examine how these trends relate to selected livelihood and value-chain conditions documented in research published from 2015 to 2023. The study addresses four questions: (1) how did production and yield of major horticultural crops change between 2005–06 and 2015–16; (2) what crop-specific patterns are visible in South District; (3) what do recent studies indicate about the agronomic, market and institutional factors affecting large-cardamom and organic farming livelihoods; and (4) what development priorities follow from the combined evidence?

**Literature Review**

Research on Sikkim's organic transition emphasises that a state-wide sustainability programme must be evaluated through both ecological and farmer-welfare outcomes. Meek and Anderson [5] describe how the transition involved changes in production scale, farmer cooperation and education. Bhatt and John [10] find that government support concentrated substantially on certification, while farmers faced challenges associated with pests, diseases and limited income protection against crop losses. These studies caution against equating certification coverage with secure livelihoods.

At the farm-system level, Lepcha et al. [3] report an integrated organic farming approach in a tribal village in East Sikkim, combining resource recycling and livelihood diversification. The case demonstrates the relevance of mixed farming and local-resource management, although a single village case should not be interpreted as a representative estimate for all Sikkim farm households. Chiphang and Singh [6], using survey data from 150 organic farm households in East Sikkim, identify landholding, distance to market and livestock possession as significant determinants of livelihood security. Their findings underline that access to markets and complementary farm enterprises matter alongside crop choice.

Large cardamom has received particular attention because of its importance as a cash crop and its sensitivity to site conditions. Yadav et al. [4] identify weaknesses in drying practices, market infrastructure, producer capacity and access to overseas-market information within the cardamom value chain. Golay and Singh [7] compare marketing channels in West Sikkim and report a higher producer share in the channel that bypasses village traders. Singh et al. [8] find large-cardamom cultivation economically viable in their sample of 90 growers, while recommending improved access to disease-free planting material. More recently, Lepcha et al. [9] show that cultivar performance varies with elevation and that cultivar selection should be aligned with the elevation range suited to each type. Together, these studies show that productivity is shaped by agronomy, altitude, plant health and market organisation—not simply planted area.

**Study Area and Data**

**A. Study Area**

Sikkim lies in the Eastern Himalaya and contains steep elevation gradients and diverse agro-climatic conditions. These conditions create opportunities for crop specialisation, but also mean that a single production recommendation is unlikely to be suitable across all locations. Large cardamom is typically associated with shaded, moist agroforestry environments, whereas ginger and turmeric are grown in comparatively open and drier locations. The 2023 cultivar study of large cardamom sampled cultivation sites from 975 to 2069 m above sea level, providing evidence of meaningful elevation-related variation within the state [9].

**B. Data Sources and Scope**

The quantitative dataset comprises state- and district-level horticultural statistics for 2005–06, 2010–11 and 2015–16, attributed to the Sikkim Gazetteer and the Government of Sikkim's departmental records [1]. The analysis uses the reported crop means for 2005–06 and 2015–16 for six crop groups: fruits, vegetables, potato, large cardamom, ginger and turmeric. South District data are examined at three points—2005–06, 2010–11 and 2015–16—using the reported area, production and yield tables. As a separate check on the large-cardamom series, official Spices Board estimates for 2015–16 and 2016–17 are also reported [2].

The literature review is restricted to publications dated 2015–2023. These references are used to interpret organic-transition policy, integrated farming, cardamom economics and marketing, livelihood security and elevation effects [3]–[10]. No post-2023 publication or statistic is used in the analysis. Historical observations from 2005–16 are retained as historical observations; they are not presented as current-year estimates.

**Research Methodology**

**A. Research Design**

The study adopts a descriptive, comparative and secondary-data design. It combines (i) a state-level comparison of horticultural production and yield between two benchmark years, (ii) a three-point South District comparison, and (iii) a structured synthesis of empirical studies published from 2015 to 2023. The approach is appropriate for identifying broad changes and crop-specific contrasts, but not for testing causal effects of particular government schemes or organic certification.

B. Indicators and Calculations

Production is measured in thousand tonnes (kt), while productivity is measured in kilograms per hectare (kg/ha), following the units used in the departmental statistics. Percentage change is calculated separately for production and yield as follows:

$$\text{Percentage change} = [(X_2 - X_1) / X_1] \times 100 \quad (1)$$

where $X_1$ is the reported value for 2005–06 and $X_2$ is the reported value for 2015–16. For the index chart, each crop's 2005–06 value is set to 100 and its 2015–16 index is calculated as (2015–16 value / 2005–06 value) × 100. Indices above 100 denote an increase relative to the base year; values below 100 denote a decrease.

**C. Analytical Procedure and Data Quality**

The state and district series are analysed separately because their spatial coverage and reporting formats differ. Reported means are used for direct comparison. Standard deviations and standard errors are not recalculated because the underlying annual observations, sample sizes and aggregation procedure are not fully documented. A small

Royal International Global Journal of Advance and Applied Research
Peer Reviewed International, Open Access Journal.
ISSN: 2998-4459 | Website: https://rlgjaar.com Volume-2, Issue-7 | July - 2025

number of entries appear to contain typographical or arithmetic inconsistencies; calculated percentages are therefore treated as descriptive comparisons rather than results of inferential tests. Spices Board estimates for large cardamom are retained as a separate series because they differ from the horticulture-department estimates and may use different definitions of area or yield [1], [2].

**Results And Discussion**

**A. State-Level Production Trends**

**Table I. State-Level Horticultural Production (Kt)**

| Crop | 2005–06 | 2015–16 | Change (%) |
|---|---|---|---|
| Fruits | 13.47 | 23.53 | +74.7 |
| Vegetables | 44.97 | 80.96 | +80.0 |
| Potato | 33.14 | 49.93 | +50.7 |
| Large cardamom | 3.16 | 4.12 | +30.4 |
| Ginger | 35.63 | 55.45 | +55.6 |
| Turmeric | 1.91 | 5.68 | +197.4 |

All six crop groups recorded higher reported output in 2015–16 than in 2005–06 [1]. Vegetables remained the largest category, increasing from 44.97 kt to 80.96 kt (+80.0%). Ginger rose from 35.63 kt to 55.45 kt (+55.6%), while potato and fruits increased by 50.7% and 74.7%, respectively. Turmeric recorded the largest relative increase (+197.4%), although its 2015–16 output (5.68 kt) remained much lower than that of vegetables, ginger and potato. Large-cardamom output increased by 30.4% in the same series.

These figures indicate expansion in horticultural output, but do not establish that the expansion was caused by yield improvement. Changes in cultivated area, crop mix, farmer participation, reporting coverage and yield may all contribute. The productivity comparison below is therefore essential to interpreting the production figures.

**B. State-Level Productivity Trends**

**Table Ii. State-Level Horticultural Productivity (Kg/Ha)**

| Crop | 2005–06 | 2015–16 | Change (%) |
|---|---|---|---|
| Fruits | 1,483 | 1,342 | -9.5 |
| Vegetables | 4,633 | 5,218 | +12.6 |
| Potato | 4,350 | 4,873 | +12.0 |
| Large cardamom | 158 | 235 | +48.7 |
| Ginger | 5,363 | 5,482 | +2.2 |
| Turmeric | 3,357 | 2,914 | -13.2 |

The productivity series presents a more differentiated picture than the production series [1]. Vegetable yield increased by 12.6%, potato by 12.0%, and large cardamom by 48.7%. Ginger yield increased only 2.2%, suggesting that its sizeable production gain was not matched by a comparable improvement in output per hectare. In contrast, reported fruit yield declined by 9.5% and turmeric yield by 13.2%, despite increases in their total production.

The divergence between production and yield is the principal quantitative finding. For fruit and turmeric, increased output co-existed with lower reported yields, which is consistent with—but does not prove—an area-expansion contribution. Ginger displays a similar, though less pronounced, pattern of near-stagnant productivity. The data therefore support a policy distinction between expanding horticultural area and raising the efficiency of existing cultivated land.

C. South District: Crop-Specific Evidence

South District provides a more detailed view of how the state-wide pattern is expressed locally. Vegetable production in South District rose from 14.41 kt in 2005–06 to 26.89 kt in 2015–16, with 15.74 kt reported for 2010–11. Ginger output changed little between 2005–06 and 2010–11 (13.36 and 13.39 kt) before increasing to 17.89 kt in 2015–16. Potato increased from 8.47 kt to 12.28 kt, while fruit output increased from 2.71 kt to 7.90 kt [1].

**Table Iii. South District Production (Kt)**

| Crop | 2005–06 | 2010–11 | 2015–16 |
|---|---|---|---|
| Fruits | 2.71 | 3.08 | 7.90 |
| Vegetables | 14.41 | 15.74 | 26.89 |
| Potato | 8.47 | 8.63 | 12.28 |
| Large cardamom | 0.61 | 0.51 | 0.81 |

Royal International Global Journal of Advance and Applied Research
Peer Reviewed International, Open Access Journal.
ISSN: 2998-4459 | Website: https://rlgjaar.com Volume-2, Issue-7 | July - 2025

| Crop | 2005–06 | 2010–11 | 2015–16 |
|---|---|---|---|
| Ginger | 13.36 | 13.39 | 17.89 |
| Turmeric | 0.86 | 0.95 | 1.81 |

**Table Iv. South District Productivity (Kg/Ha)**

| Crop | 2005–06 | 2010–11 | 2015–16 |
|---|---|---|---|
| Fruits | 1,534 | 1,237 | 2,261 |
| Vegetables | 4,627 | 4,663 | 5,340 |
| Potato | 4,528 | 4,600 | 4,892 |
| Large cardamom | 160 | 201 | 234 |
| Ginger | 5,565 | 5,560 | 5,482 |
| Turmeric | 3,308 | 3,456 | 2,915 |

Vegetables were the dominant horticultural output category in South District, and the reported yield rose from 4,627 to 5,340 kg/ha over the comparison period. Fruit output increased markedly, while reported fruit yield recovered from 1,237 kg/ha in 2010–11 to 2,261 kg/ha in 2015–16. In contrast, ginger output increased by 33.9% between the endpoints while its reported yield declined slightly from 5,565 to 5,482 kg/ha. Turmeric output more than doubled, but yield fell from 3,308 to 2,915 kg/ha. These contrasting patterns reinforce the need for crop-wise and location-specific productivity interventions.

Departmental records describe off-season vegetable production as a livelihood activity in several South District clusters and identifies village-level specialisation in crops such as cabbage, tomato, cauliflower, chayote, radish and leafy vegetables [1]. These observations are consistent with the economic logic of staggered production and market timing, but the dataset does not include farm-gate prices, costs or household income. The present paper therefore treats the livelihood connection as a documented pathway rather than a measured income effect.

**D. Large Cardamom: Productivity, Altitude and Markets**

**Table V. Sikkim Large-Cardamom Estimates Reported By Spices Board**

| Year | Total area (ha) | Production (t) | Yield (kg/ha) |
|---|---|---|---|
| 2015–16 | 23,082 | 4,466 | 255 |
| 2016–17 (P) | 23,482 | 4,684 | 258.25 |

The Spices Board reported an increase in Sikkim large-cardamom area from 23,082 ha in 2015–16 to a provisional 23,482 ha in 2016–17, alongside production rising from 4,466 to 4,684 t and yield from 255 to 258.25 kg/ha [2]. The horticulture-department series reports 235 kg/ha for 2015–16 [1]. Because these two estimates differ, they are presented as separate source series rather than silently harmonised. This discrepancy illustrates the importance of consistent definitions and transparent reporting when building long-run crop statistics.

Recent agronomic evidence shows that altitude and cultivar interactions are important for large-cardamom yield. Lepcha et al. [9] studied 41 sites across 975–2069 m and found that cultivar performance differed by elevation band; the authors recommend matching cultivars to their suitable elevation ranges. This has direct practical significance in Sikkim, where elevation, shade, moisture and local microclimates vary substantially across short distances. Uniform planting-material distribution without site matching may therefore fail to maximise yield.

Economic and marketing studies add two further dimensions. Singh et al. [8] found large-cardamom production economically viable in a 90-grower sample, reporting a benefit-cost ratio of 2.54 and an internal rate of return of 50.72% for the overall farm-size category. Golay and Singh [7], based on 100 farmers in West Sikkim, found that the producer's share in the consumer rupee was higher in a channel that moved produce from producer to wholesaler without the village-trader stage. Yadav et al. [4] identify quality control, drying practices, aggregation, branding and market information as constraints in the value chain. These are local study findings and should not be assumed to represent every village or season, but they collectively show that farm profitability depends on both field performance and post-harvest market arrangements.

E. Organic Farming and Rural Livelihoods

Integrated organic farming can improve resilience when crops, livestock, biomass recycling and other local resources are managed as a connected farm system. The East Sikkim case documented by Lepcha et al. [3] illustrates such diversification, while Chiphang and Singh [6] show that landholding, market distance and livestock possession are statistically associated with the livelihood-security levels of surveyed organic households. This points to a broader livelihood model in which horticulture is combined with livestock, local input cycles and accessible markets.

At the same time, the organic transition should not be evaluated only by the number of farms certified. Bhatt and John [10] identify gaps between the state's certification-focused measures and farmer needs relating to pest and

disease pressures and income support against crop losses. Meek and Anderson [5] similarly show that the organic transition involves changes in production scale, collective marketing and farmer education. Together, these studies support an interpretation of organic farming as an institutional transition that requires continuous technical and economic support, not merely a change in input rules.

**Synthesis And Policy Implications**

The evidence points to four connected priorities. First, Sikkim needs a crop- and elevation-specific productivity strategy. For large cardamom, this includes cultivar placement by elevation, rejuvenation of ageing plantations, disease-free planting material, shade and moisture management, and systematic plant-health surveillance [8], [9]. For ginger and turmeric, the historical data suggest that area expansion has not automatically produced higher yield; extension support should therefore focus on seed quality, soil health, disease management and locally tested crop rotations.

Second, the state should strengthen decentralised post-harvest infrastructure. The cardamom value-chain studies identify drying quality, aggregation, information and marketing arrangements as determinants of producer value capture [4], [7]. Comparable arrangements for fruits and vegetables—collection points, sorting and grading, suitable packaging, cold-chain access where feasible and reliable transport—could reduce avoidable losses and improve the timing of sales. Infrastructure plans should reflect road accessibility and seasonal production calendars rather than relying only on statewide capacity targets.

Third, farmer organisations should be supported as commercial and service institutions. Producer groups, cooperatives and farmer-producer organisations can aggregate small volumes, negotiate with buyers, share equipment, maintain quality records and strengthen market information. Their effectiveness should be assessed using measurable indicators such as producer share of the final price, payment delays, quality rejection rates and participation of women and marginal farmers. The documented importance of market distance for livelihood security [6] makes local aggregation and accessible market facilities particularly relevant.

Fourth, organic-transition policy should combine certification and environmental objectives with explicit risk management. This includes timely access to approved planting materials and bio-inputs, diagnostic services for pests and diseases, practical training, affordable group certification and transitional income support where farmers face temporary losses. The policy lesson from [10] is that farmer welfare must be designed into the transition rather than treated as an indirect outcome of certification.

**Limitations And Future Research**

The analysis is constrained by the temporal coverage and quality of the secondary data. The state-level comparison uses two benchmark years, while the South District series contains three observations. The available records do not reveal annual volatility, weather shocks, price cycles or the timing of individual interventions. Although mean values and measures of dispersion are reported, the underlying annual observations and aggregation procedures are not fully documented. Some entries appear internally inconsistent, and the reported large-cardamom yield for 2015–16 differs between the horticulture-department and Spices Board series [1], [2]. These limitations are retained as part of the interpretation.

A stronger follow-up study should construct a harmonised district-by-crop panel from official annual records for 2015–2023, retaining consistent definitions of area, bearing area, production and yield. It should also collect farm-level input costs, hired and family labour, farm-gate prices, post-harvest losses, market destinations and household income. A stratified survey across altitude zones could then test whether cultivar choice, plant-health status, organic-management practices and market access explain productivity and livelihood differences. Such work would permit more rigorous econometric analysis than the descriptive comparisons possible here.

**Conclusion**

The analysis finds that horticultural production in Sikkim expanded across fruits, vegetables, potato, large cardamom, ginger and turmeric between 2005–06 and 2015–16. However, the productivity record is mixed: vegetable, potato and large-cardamom yields improved, while fruit and turmeric yields declined and ginger yield changed only slightly. South District displays the same central distinction between output growth and yield growth. These findings demonstrate why horticultural transformation should be assessed through both the quantity harvested and the efficiency with which land is used.

Research published from 2015 to 2023 shows that rural livelihood outcomes also depend on the quality of planting material, cultivar suitability to elevation, livestock and integrated farming, distance to markets, value-chain structure and the extent to which organic-transition programmes respond to farmer risks. Sikkim's horticultural future therefore requires a shift from expansion alone toward a balanced strategy of productivity, resilience and value capture. The priorities are better crop-specific extension, strengthened plant health, post-harvest investment, producer institutions and farmer-centred organic support. The present paper provides a historical evidence base for this agenda but does not substitute for a current district-level production survey.

**Acknowledgement**

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research work entitled "Horticultural Transformation in Sikkim: Trends in Crop Production, Productivity and Rural Livelihoods in the Eastern Himalaya."

I extend my heartfelt thanks to my respected research guide, teachers, and academic mentors for their valuable guidance, encouragement, and continuous support throughout the preparation of this study. Their insightful suggestions and constructive feedback have helped me develop a deeper understanding of horticultural development, agricultural transformation, and rural livelihood systems in the Eastern Himalayan region.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

The authors declare that there are no conflicts of interest regarding the publication of thesis paper.

**References**

1. Food Security and Agriculture Development Department, Government of Sikkim, Annual Progress Report 2015–16, Namchi, Sikkim, India, 2016.
2. Spices Board India, Ministry of Commerce and Industry, Government of India, Annual Report 2016–17, Cochin, India, 2017, p. 29.
3. B. Lepcha, R. Avasthe, R. Singh, P. Phukan, and N. Johnson Singh, "Enhancing livelihood of tribal farmers of Sikkim through integrated organic farming system: A case study," Indian Research Journal of Extension Education, vol. 18, no. 1, pp. 84–87, Jan. 2018.
4. H. Yadav, M. S. Jairath, and T. Chaturvedi, "Value chain of organic large cardamom of Sikkim," Journal of Hill Agriculture, vol. 9, no. 1, pp. 1–6, 2018, doi: 10.5958/2230-7338.2018.00002.2.
5. D. Meek and C. R. Anderson, "Scale and the politics of the organic transition in Sikkim, India," Agroecology and Sustainable Food Systems, vol. 44, no. 5, pp. 653–672, 2020, doi: 10.1080/21683565.2019.1701171.
6. S. Chiphang and R. Singh, "Livelihood security determinants of the organic farm household in Sikkim, India: Ordered logistic regression approach," Current Journal of Applied Science and Technology, vol. 39, no. 20, pp. 138–143, 2020, doi: 10.9734/cjast/2020/v39i2030848.
7. S. Golay and S. B. Singh, "Production and marketing of organic large cardamom in West District of Sikkim," Indian Research Journal of Extension Education, vol. 21, no. 1, pp. 63–66, Jan. 2021.
8. S. P. Singh, J. P. Hazarika, H. Gogoi, E. Y. Chanu, and A. Aruna, "Economic evaluation of large cardamom cultivation in Sikkim," Journal of Krishi Vigyan, vol. 11, no. 1, pp. 424–432, 2022, doi: 10.5958/2349-4433.2022.00107.6.
9. P. Lepcha, K. S. Gaira, A. Pandey, et al., "Elevation determines the productivity of large cardamom (Amomum subulatum Roxb.) cultivars in Sikkim Himalaya," Scientific Reports, vol. 13, Art. no. 21673, 2023, doi: 10.1038/s41598-023-47847-6.
10. A. Bhatt and J. John, "Including farmers' welfare in a government-led sector transition: The case of Sikkim's shift to organic agriculture," Journal of Cleaner Production, vol. 411, Art. no. 137207, 2023, doi: 10.1016/j.jclepro.2023.137207.