International Journal on Science and Technology (IJSAT)
E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

Scope and Advantages of Sustainable Agriculture in Uttarakhand

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Abstract

In an effort to feed the growing population and raise life standards, the Green Revolution unintentionally led to the institutionalised discouragement of traditional agricultural methods. Although urgently necessary at the time, there was no long-term plan for agricultural sustainability. The term sustainable agriculture is introduced, which is defined as agriculture that focuses on meeting the needs of the current generation without compromising the base of future generation resources. In today's world, where much of the population faces ecological and health challenges, sustainable agriculture – rooted in natural and traditional agricultural methods – becomes essential to addressing these issues. This article discusses the scope and advantages of sustainable agricultural practice in Uttarakhand, which is based on secondary data from government and non-governmental institutions.

Keywords: Green Revolution, Traditional agricultural method, Sustainability, Sustainable agriculture.

1. Introduction

"We must continue to ask ourselves how we feed a growing population in a way that support climate action. Protect natural ecosystem and address food security"

- *Mark Thompson*

Exec. Pres. chief strategy and

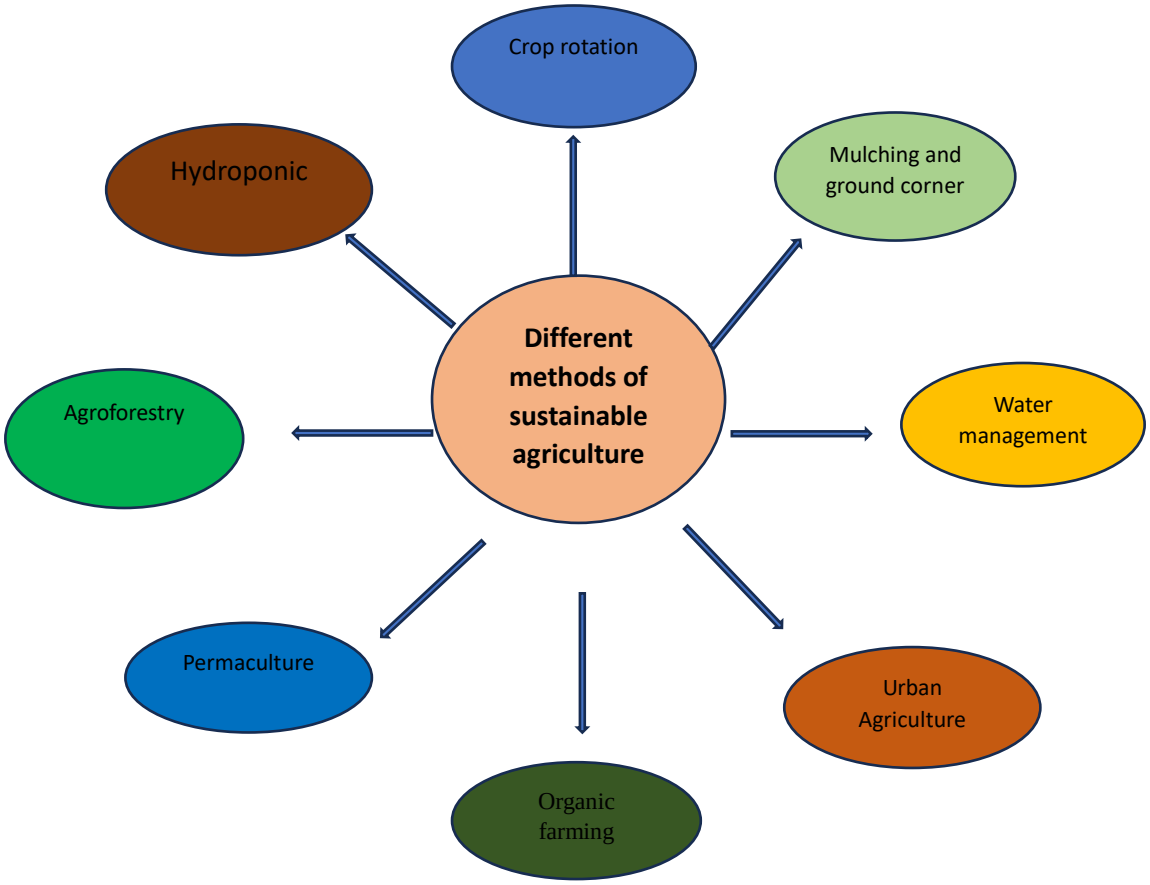
Sustainability officer at Nutrient

With the introduction of the Green Revolution Environmental concerns have increased, which gave rise to the sustainable agriculture movement in the 1980s. With the publication of her book "Silent Spring" in 1962, Rachel Carson brought attention to the harm that pesticides like DDT, boric acid, etc. cause to people, wildlife and the environment (clark, 2021). In this book Carson urged readers to take greater responsibility for their actions and treat the planet like a steward rather than a source of destruction. The development of the organic farming movement was significantly influenced by both Silent Spring and the sustainable agriculture movement (clark, 2021). Sustainable agriculture practices are methods of farming that prioritise the production of food in a way that is socially and environmentally responsible while remaining commercially successful. These methods seek to minimise the use of non-renewable resources, preserve the soil's long-term health and lessen agriculture-

determined effects on the environment. Sustainable agriculture practices can help protect watersheds, maintain and restore important habitats and enhance soil and water quality; however, using unsustainable methods has negative effects on both the environment and people. According to the World Bank, the majority of projections state that by 2050, there will be 10 billion people on the planet. This suggests that in order to feed such a large population, food production needs to rise by 70%. As a result, it's becoming increasingly clear that significant changes in the agriculture industry are needed to guarantee that our food system is prepared to handle the demands of an expanding global population. In particular, we must move from the traditional industrial food system that has long characterised food production in agriculture to sustainable farming. In the long run, switching from a conventional industrial food system to sustainable agriculture can be fairly hopeful for a globe plagued by droughts and issues with energy demand. Even if modern agriculture creates a great deal of employment and provides enormous amounts of food during the harvest season, it also has a number of grave issues that need to be resolved with sustainable farming methods (worldwildelife, n.d.).

Although India is now the world leader in the production of wheat and rice, the Green Revolution has had negative effects on both the environment and the population. Agriculture needs to be made sustainable in an era of population expansion and climate change. To achieve this lofty objective, new methods for agricultural research and policy are needed (Bawa, 2023). The Green Revolution in India throughout the 1960s and 1970s resulted in a notable change in agriculture. Over a period of 20 years the nation became the major exporter of wheat, rice, and cemented its place in the world food market, having previously been among the world's biggest net importers of food grains. But in order to maintain the production of new rice and wheat types, significant amounts of energy, water, and fertilisers were needed (Bawa, 2023). Due to agriculture based on the Green Revolution, soil nutrients have been lost, water resources have been depleted, agrobiodiversity has decreased, and Greenhouse gas emissions have increased impacts on public health, and the ongoing costs associated with purchasing seeds and chemical inputs contributed to the debt traps that many farming families fall into, exacerbating the environmental effects. India's agriculture needs to undergo radical transformation in order to lower greenhouse gas emissions without sacrificing output for ecosystem benefits. India must decrease food waste, increase biodiversity on and around farms, manage its soils, water resources, and agriculture leftovers better, as well as increase carbon sequestration (Bawa, 2023).

1. Different types of sustainable agriculture



2. Current status of agriculture in Uttarakhand

Uttarakhand Dev Bhoomi, or the land of gods, is situated at the base of the Himalayas. Uttarakhand boasts a varied topography with snow-capped Himalayan peaks in the north and tropical forests in the south. It has been split into two regions: Kumaon Mandal in the east and Garhwal Mandal in the west. There are 13 districts and a total of 95 blocks (StateHorticultureMission, n.d.). According to the Ministry of Agriculture of Uttarakhand, out of the total reported area of 56.72 lakh hectares (approx. 14%) (LUS-2009-2010), are available for cultivation. Because the majority of the state is covered by wasteland and forest. The Tarai region has extremely fertile, nutrient-rich soil. However, because of its high slopes, the hill region is constantly prone to soil erosion, which further reduces its fertility state. Farmers mostly use two types of agricultural practices: irrigated and rain-fed. One of the main economic activities in this rural state area is horticulture practice. Horticulture practice in Uttarakhand has enormous potential to increase employment as well as also to restore the brittle ecosystem. Uttarakhand is a part of the western Himalayas physiographic. Altitude-wise the state is divided into four zones (A, B, C, D). The physiographic detail of Uttarakhand's various zones is given in table 1 (Monika Chhimwal, 2019)

Table 1: Distribution of states in various physiographic zone

Zone	Altitude (m)	Average Rainfall (mm/yr)	Soil	Farming situations	Districts under zone
Zone A (Valleys)	Up to 1000	**1400** **1400** **2000-2400** **2000-2400**	**Alluvial** **Alluvial** **Alluvial sandy** **Residual sandy loam**	**Tarai irrigated** **Bhabar irrigated** **Lower hills irrigated** **Rainfed lower hills**	All other districts except Chamoli and Uttarkashi
Zone B (Mid hills)	1000-1500	1200-1300	Sandy loam	Mid hills south aspect	Almora, Bageshwar, Champawat, Dehradun, Nainital, Tehri Garhwal,
Zone C (High hills)	1500-2400	1200-2500	Red to dark	High hills	Almora, Bageshwar, Chamoli, Pithoragarh
Zone D (Alpine zone)	Less than 2400	~ 1300	Red to dark black clay	Very high hills	Chamoli, Pithoragrah, Uttarkashi

3. Scopes of Sustainable Agriculture in Uttarakhand

With crop biodiversity and variations in altitude, the Uttarakhand Himalayas is a hotspot of agrobiodiversity from ancient times; 86 agronomic and 11 horticultural crops have flourished here. The centuries-old practice of growing Barahanaj "together in cropped land is carried out according to traditional techniques; this is done under the 'Sar system' (Kavita Gururani, 2021). It describes the vertical distribution of crops in the valley regions, mid altitudes and highlands as well as the cropping pattern. It also helps to preserve the diversity of agriculture (Sati, 2017). A vast array of farmers can be found in the traditional agriculture system. According to Altieri (1995), the majority of them are still relatively unknown; mainstream societies are more able to adapt to soil and environmental conditions than modern agricultural systems. Mandua (finger millet), ramdana/chua (amaranthus), rajma (common kidney beans), ogal (buckwheat), urad (black gram), moong (queen gram), naurangi (mix of pulses), gahtah (horse gram), bhat (soybean), lobiya (French beans), khera (cucumber), bhang (cannabis) and

other crops are grown together in a mix-cropping pattern. It optimises productivity and helps in maintaining soil fertility and conserving crop biodiversity (Sati, 2017).

4. Types of sustainable farming method which have enormous scope in Uttarakhand

Horticulture: The agroclimatic condition of Uttarakhand is favourable for the cultivation of a diverse range of fruits, vegetables, cash crops, flowers, and medicinal plants. Horticulture is a very important component of Uttarakhand's economy. This sector is the largest source of income in the state economy. The climate of the hills is ideal for the growth and development of the wide range of other fruits such as pears, peaches, plums, apricots, cherries, strawberries and different kinds of wild herbs, in addition to the many varieties of high-quality apples (StateHorticultureMission, n.d.). In Uttarakhand, the corresponding areas under fruits, vegetables and flowers in 2015-2016 were 1.75 lakh hectares, 0.89 lakh hectares, and 0.02 lakhs, respectively. Fruit productivity is 3.76 t/ha or 26.34% of the average for the country. In a similar vein, vegetable yield is 10.52 t/ha or 62.9% of the national average. Over the course of 16 years there has been a slight gain in fruit production, but the production of vegetables has essentially stayed the same. As a result, it is evident that there is much room to improve horticulture crop yield. And one approach to do so is to use a protected cultivation region (Kumar, et al., 2021). The Uttarakhand government is also working on policies such as the horticulture mission for northeast and Himalayan states and on the mission for integrated development of horticulture for creating more opportunities in the horticulture sector. The annual turnover of horticulture crops in the state is approximately Rs 230 crore, and the horticulture sector has more than a 30% contribution to the state's agriculture sectors. Gross domestic product which shows that state has enormous opportunities for horticulture which will generate employment as well as help in conserving the environment and wastelands. Uttarakhand stands first in the country in the production of pears, peaches, and plums; second in the production of walnuts, followed by Jammu and Kashmier third in the country in the production of apples (StateHorticultureMission, n.d.).

Agroforestry: Agroforestry involves combining trees and crops on the same piece of land to enhance sustainability and productivity of the farming system. While also increasing income. It is a land use management approach that plays a crucial role in promoting the sustainable development of a region (K. K. Vikrant, 2022). Situated in the Himalayan foothills, Uttarakhand is a region rich in our natural beauty, characterised by dense forest, clean rivers, and terraced farmland. Agriculture and forestry form the backbone of its economy. Yet challenges such as deforestation, climate change and soil erosion are putting both the environment and the region’s economic stability at risk. Agroforestry, an approach that combines the cultivation of tree crops and livestock, has gained attention as a sustainable solution that helps restore ecological health while boosting local incomes. Uttarakhand's age-old farming methods showcase a strong bond between people and the natural environment (agroforestry in uttarakhand balancing ecology and economy in the himalayas, n.d.). For generations, the Hill community has engaged in farming, growing crops alongside trees that offer shade, fodder and timber. Some agroforestry plants in Uttarakhand which were practised in old age are Bhimal (Grewia oppositifolia), Banj oak (Quercus leucotrichophora), eucalyptus (Eucalyptus camaldulensis), Kaphal (Myrica esculenta), Tejpata (Cinnamomum tamala), and Bhimal (Grewia oppositifolia) (Sarangi, n.d.). Baj oak is prevalent in higher altitudes. This species is significant for biomass carbon stock and supports ecological balance. Tej Patta cultivator along farm boundaries: its leaves are used as spice and have medical

properties. Sukhi lifts us going around the side, popular in mixed forestry systems, contributing to biomass production and CO_2 mitigation. Kafal and evergreen trees produce edible pears native to the Himalayan region and culturally significant in Uttarakhand. Bhimal is one of the most important and widely used multipurpose tree species in Uttarakhand, especially in the mid-hill regions of the Garhwal and Kumaon seasons. Agroforestry in Uttarakhand supports an integrated farming system that is more sustainable, protective and eco-friendly, especially suited for the fragile Himalayan ecosystem.

Organic farming: The potential for organic farming is currently greatest in Uttarakhand since farmers there continue to practice rain-fed agriculture, which does not involve the use of fertiliser or pesticides. The government is also taking proactive steps to promote organic farming and sustainable development; the Uttarakhand Organic Commodity Board (UOCB) was founded as the state nodal organisation for organic farming promotion. Uttarakhand's organic farming industry has a bright future because of its many advantages for both farmers and customers. Uttarakhand is making tremendous strides towards becoming a totally organic state as customers' awareness of sustainable development and health grows (Organic Farming and its Future in Uttarakhand, 2021). The Himalayan state of Uttarakhand produces an array of certified organic products that are exported globally. Some of the organic spices, herbs and pulses grown in Uttarakhand are soybeans (Glycine soja), maize corn (mungari), mustard (sarsoon), pigeon pea (tor), sesame (til) kukam powder, onion, pearl millet (junyali), madua atta, etc.

Agritourism: Agritourism has emerged as a promising and dynamic sector in India, blending agriculture and tourism to create a unique bridge between urban and rural communities. It offers farmers a sustainable source of livelihood while providing visitors with an authentic experience of rural life. Through agritourism, farmers can engage tourists in traditional agricultural practices, local customs, and everyday farm activities, all while showcasing the warmth and hospitality of the countryside (Agritourism in India: Importance, Benefits, Types, Challenges!, n.d.). Agrotourism has great potential in Uttarakhand due to its abundance of well-liked tourism attractions, which include stunning rivers, mountains, glaciers, lakes, distinctive hill stations, historic temples, hiking trails, and forests teeming with wildlife and flora (Chunera & Joshi, 2021). A few examples of agrotourism in Uttarakhand are the Silent Valley, Dyo the Organic Village Resort, R.O.S.E. (Rural Opportunity for Social Elevation), and Goat Village. The goal of the Goat Villages project was to involve state youth and reduce migration in Uttarakhand. Tourists visiting Goat Village experience farming, animal husbandry, and goat rearing along with all the diversity and beauty of natural resources around them. Tourists seeking a farm-to-table experience can be attracted by showcasing traditional livestock rearing practices alongside scenic landscapes. Such as "fresh butter tasting" or "homestay experiences with sheep shearing demonstrations, etc (Chetan Shah, 2020)."

Permaculture: Permaculture is a recent concept developed by Bill Mollison and David Holmgren in the 1970s and early 1980s. It is an ethically driven design approach that focuses on mindfully integrating many aspects such as plants, animals, technologies, social systems, and economics. The goal is to address human needs while respecting natural ecosystems (Niyogi, 2017). Permaculture is based on three essential ideas. **Earth care** entails nurturing all living systems to ensure their survival and expansion, with the recognition that human well-being is dependent on a healthy environment. **People care** – ensuring that everyone has access to the basic resources they require to survive. **Fair care** entails using only what you really need and redistributing any extra. These principles help the others by, for

example, recycling garbage back into the system and making it useful again (tractorjunction, 2024). Permaculture is emerging as a promising and sustainable option in Uttarakhand, as global awareness of the good impacts of traditional farming for both the environment and human health grows. Throughout the state, other permaculture projects have evolved, emphasising sustainable agricultural methods and supporting local food networks that are no more than the biodiversity farm founded by Dr Vandana Shiva in town. Valley promotes organic farming and seed sovereignty. Earthwise, set in the lush hills, is a permaculture learning institution that provides courses in regenerative agriculture, sustainable living, and natural architecture. Gaon Bacho, a permaculture farm in Almora, practises regenerative agriculture and educates visitors on sustainable living through hands-on programmes, Vanya Jeevan, grassroots, etc (travelsetu).

Medicinal and aromatic plant: Medicinal and aromatic plant Uttarakhand, often called the herbal state of India, is home to over 5000 species of vascular plants, with about one third known for their medicinal plants (Himanshu Bargali, 2022). Uttarakhand is home to a diverse range of herbs, medical and aromatic plants. The state government aims to leverage this natural wealth. Recently there has been a noticeable rise in the cultivation of medicinal and aromatic plants in the region. This type of farming plays a crucial role in preserving biodiversity while also supporting rural livelihoods. In addition, the growing and conservation of medicinal plants is given as an alternative source of income to the villagers. In addition to human use, many varieties of these plants are important for livestock, serving as the primary source of healthcare for livestock (Anuj Kumar, 2018). According to the UMPDB (Uttarakhand Medic Veterinary Plant Database), Uttarakhand, also known as the herbal state, is a rich source of inedible and aromatic plants. In Uttarakhand, there are 1127 records of medicinal plants, which belong to 153 plant families in 13 districts of Uttarakhand. Medicinal and aromatic plants offer many opportunities for the economic and social development of the state. Uttarakhand can be a centre for cultivating and processing high-demand medicinal plants like Ashwagandha, Giloy and Tulsi. This can create jobs in planting, extraction and production of herbal products. The state's diverse climate nourishes aromatic plants such as lavender, lemongrass and roses. This can be used for the production of essential oils for perfume, cosmetics and aromatherapy products, which provide an increasing global market. There is a rich tradition of Ayurveda and other herbal drug systems in Uttarakhand. By cultivating and processing the map used in these methods, the state can meet the increasing demand for natural healthcare solutions. Promoting map cultivation gives farmers an attractive alternative income compared to traditional crops. This can empower rural communities and improve livelihoods. Using the possibility of a map, Uttarakhand can place itself as a leader in the global market for natural well-being products while promoting sustainable development and economic prosperity for its people.

5. Advantages of sustainable agriculture in Uttarakhand:

Ecological benefits of sustainable agriculture are:

1. Conservation of soil: Practising organic farming in Uttarakhand prioritises the use of natural fertilisers and pest control. Control methods reduce soil erosion and prevent the contamination of water bodies, contributing to the conservation of soil and water resources.

2. biodiversity conservation: Sustainable agriculture presents a win-win situation for Uttarakhand. By promoting biodiversity conservation, it can ensure a healthy environment for future generations while fostering a more productive and resilient agricultural sector for the state's economic well-being.

3. Reduce environmental pollution: by eliminating the complete use of fertilisers and pesticides, we can prevent the pollution of air, water, and soil, which leads to a cleaner ecosystem and reduces negative impacts on human and animal health.

Economic benefits of sustainable agriculture:

1. market demand and premium prices – The increasing global demand for organic products provides economic opportunities for farmers of Uttarakhand who can command premium prices for their organic product produce.

2. Tourism and ecotourism – The promotion of organic farming, agroforestry, and horticulture can attract more eco-conscious and nature-loving tourists, which can contribute to the growth of sustainable tourism, providing additional income and employment opportunities to natives.

7. Conclusion: -

Sustainable agriculture offers a transformative approach to addressing the environmental, economic, and social challenges faced by contemporary agriculture in India, particularly in ecologically fragile regions like Uttarakhand. The Green Revolution, while successful in increasing food production, has led to long-term ecological degradation, loss of biodiversity, and unsustainable farming practices. In contrast, sustainable agriculture-rooted in traditional knowledge and natural farming techniques-presents a viable solution to enhance productivity while preserving the ecological integrity of agricultural landscapes. Uttarakhand, with its diverse agro-climatic zones, rich agrobiodiversity, and traditional farming systems, holds significant potential for promoting sustainable agricultural practices. The state already exhibits promising developments in areas such as organic farming, agroforestry, horticulture, agritourism, permaculture, and the cultivation of medicinal and aromatic plants. These practices not only conserve natural resources but also offer economic benefits by diversifying rural livelihoods and enhancing market opportunities. To realise this potential fully, there is a need for coordinated efforts from policymakers, agricultural institutions, and local communities. Strengthening institutional support, expanding awareness and training programmes, and promoting market access for sustainably produced goods are crucial steps. Moreover, integrating sustainable agriculture into regional development strategies will ensure long-term food security, ecological balance, and economic resilience.

References

1. Anuj Kumar, R. K. (2018, Jan). Uttarakhand Medicinal Plants Database (UMPDB): A Platform for Exploring Genomic, Chemical, and Traditional Knowledge. DOAJ, 3(1), 7. doi:https://doi.org/10.3390/data3010007
2. Bawa, K. S. (2023, july 18). Sustainable pathways toward reimagining India’s agricultural systems. Communications Earth & Environment, 4. doi:https://doi.org/10.1038/s43247-023-00902-6
3. Chetan Shah, S. S. (2020, Aug). Agritourism as a Local Economic Development Tool for Rural Hill Regions. In Extension Strategies for Doubling Farmer Income (1 ed., pp. 19-33). New Delhi:

BIOTECH BOOKS. Retrieved from https://www.researchgate.net/publication/343569529_Agritourism_as_a_Local_Economic_Development_Tool_for_Rural_Hill_Regions

4. Chopra, R. (June 2021). Uttarakhand: Development and Ecological Sustainablity. New Delhi: Oxfam India.
5. Chunera, A., & Joshi, D. (2021). Agrotourism Revitalization of Uttarakhand Hills. Indian Farming, 71(2), 11-13. Retrieved from https://epubs.icar.org.in/index.php/IndFarm/article/view/114347/44568#:~:text=Agrotourism%20can generate%20direct%20marketing,Under%20the%20guidance%20of%20Col
6. clark, R. (2021, 10 15). Organic Farming: History, Timeline, and Impact. Retrieved from https://www.treehugger.com/organic-farming-history: https://www.treehugger.com/organic-farming-history-timeline-and-impact-5189324
7. Grow Billion Trees. (n.d.). Retrieved from https://growbilliontrees.com/: https://growbilliontrees.com/pages/agroforestry-in-uttarakhand-balancing-ecology-and-economy-in-thehimalayas?srsltid=AfmBOopiFYrrgRbBeRNuwsqS9Lv9soipObAfMQnHwt0ARmwf4n18mDCS
8. Himanshu Bargali, A. K. (2022, Jan). Plant studies in Uttarakhand, Western Himalaya–A comprehensive review. ScienceDirect. doi:https://doi.org/10.1016/j.tfp.2022.100203
9. K. K. Vikrant, D. S. (2022). Assessment of Agroforestry Area and its Carbon Storage Potential Along Altitudes of Tehri Garhwal District, Uttarakhand, in North-Western Indian Himalaya. In Climate Change (pp. 243-263). Springer, Cham. doi:https://doi.org/10.1007/978-3-030-92782-0_12
10. Kavita Gururani, S. S. (2021, jan 27). Mainstreaming Barahnaja cultivation for food and nutritional security in the Himalayan region. Retrieved from nih national library of medicine: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7838019/
11. Kumar, P., Kar, A., Singh, D. R., Perumal, A., Shivamurthy, S. G., Reddy, K. V., . . . Pachiyappan, P. (2021). Protected Cultivation of Horticultural Crops in Uttarakhand: An Economic Analysis. Agronomy, 11(4), 692. doi:https://doi.org/10.3390/agronomy11040692
12. Monika Chhimwal, R. K. (2019). Status of agriculture and horticulture farming in the hill state of India- Uttarakhand. Journal of Pharmacognosy and Phytochemistry, 8(4), 1626-1631. Retrieved from https://www.phytojournal.com/archives/2019.v8.i4.9181/status-of-agriculture-and-horticulture-farming-in-the-hill-state-of-india-uttarakhand
13. Niyogi, D. G. (2017, Nov 27). Down To Earth. Retrieved from www.downtoearth.org.in: https://www.downtoearth.org.in/climate-change/-potential-for-permaculture-in-india-is-huge--59232
14. Organic Farming and its Future in Uttarakhand. (2021, 10 12). Retrieved from PahadiLala: https://www.pahadilala.com/blog/organic-farming-and-its-future-in-uttarakhand
15. Sarangi, S. K. (n.d.). leisaindia. Retrieved from https://www.leisaindia.org/: https://www.leisaindia.org/field-notes/
16. Sati, V. P. (2017). Enhancing Food Security through Sustainable Agriculture in Uttarakhand Himalaya. Productivity, 58(2). Retrieved from https://www.researchgate.net/publication/319979406_Enhancing_Food_Security_through_Sustainable_Agriculture_in_Uttarakhand_Himalaya
17. Stainton, D. H. (n.d.). Tourism Teacher. Retrieved from https://tourismteacher.com/: https://tourismteacher.com/agritourism/

18. StateHorticultureMission. (n.d.). State Proflie. Retrieved from State Horticulture Mission Govt. of Uttarakhand: https://shm.uk.gov.in/pages/display/6-state-profile
19. SWASYA LIVING. (n.d.). Retrieved from https://www.swasyaliving.com: https://www.swasyaliving.com/post/agritourism-in-india
20. tractorjunction. (2024, Feb 10). Permaculture Farming in India: Principles, Techniques & Benefits. Retrieved from https://www.tractorjunction.com/blog/permaculture-farming-in-india/
21. travelsetu. (n.d.). Permaculture Initiatives: Uttarakhand's Sustainable Farming Revolution. Retrieved from https://travelsetu.com/apps/blog/permaculture-initiatives-uttarakhand-s-sustainable-farming-revolution
22. worldwildelife. (n.d.). Retrieved from https://www.worldwildlife.org/industries/sustainable-agriculture