



Horticulture Practices and Livelihood in Arunachal Pradesh: A Study

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Abstract— Horticulture has become an exciting and successful industry in Arunachal Pradesh because of the state's great variety of climate and geography. These different climates allow for many types of horticulture, including fruits, vegetables, herbs, and medicinal plants, which leads to many types of farming techniques being used by the farmers. **Objective:** The objective of the study is to examine the horticulture practices and livelihood in Arunachal Pradesh. **Research Methodology:** This study uses a Descriptive and Analytical Research Design. The descriptive element of the study documents agricultural methods being used in the field today; what crops are being grown on which farms, how farmers rely on horticultural crops for income, and so on. **Results and Discussions:** This section has discussed different types of favourable and unfavourable climatic conditions for horticulture practices in Arunachal Pradesh. It also discusses the **livelihood on horticulture practices and suggestions to grow more fruits.** **Conclusion:** Horticulture in Arunachal Pradesh has emerged as one of the most promising sectors for sustainable rural development, owing to the state's rich agro-climatic diversity, abundant natural resources, and traditional farming knowledge.

Keywords— Climate, fruits, vegetables, herbs, medicinal plants, agro-climatic diversity, traditional farming

I. INTRODUCTION

The extreme diversity of climate and geography in Arunachal Pradesh has made it an interesting and prosperous Horticultural Industry. This diversity provides opportunities for various types of horticulture (fruits, vegetables, herbs, and Medicinals), therefore allowing farmers to utilize a variety of techniques. For example, Farmers have the option of utilizing traditional farming techniques (Jhum and Mixed Cropping) and utilizing Modern Farming techniques developed through research processes that are being offered through the Krishi Vigyan Kendras (KVK) and Horticulture Department of Arunachal Pradesh through the Indian Council of Agricultural Research. KVK's and the Horticultural Department provide tools for new techniques of management, new types of

planting materials, organic production, as well as high-value crops such as Kiwi and Citrus (Drema, 2019; Kumar, 2017; ICAR, 2018). Due to these advancements Agriculture has emerged as a primary source of Livelihood and Economic Development and presents excellent opportunities for Rural Development in an environmentally sustainable way and expanding Markets (Government of Arunachal Pradesh, 2020; NIRD, 2016).

OBJECTIVE

The objective of the study is to examine the horticulture practices and livelihood in Arunachal Pradesh.

II. RESEARCH METHODOLOGY

1. Research Design: This study uses a Descriptive and Analytical Research Design. The descriptive element of the study documents agricultural methods being used in the field today; what crops are being grown on which farms, how farmers rely on horticultural crops for income, and so on. The analytical element will allow us to look at why there are problems in horticulture, such as: lack of connectivity; pest problems; and/or post-harvest losses. This two-part approach will allow researchers to document what horticulture is; as well as, how it is affecting farmers in Arunachal Pradesh.

2. Nature of the Study: The study is built on a mixed-methods approach: (i) Qualitative methods to examine traditional ecological knowledge and the role of women in horticulture; land tenure issues, traditional practices, and socio-cultural context. (ii) Quantitative methods to study trends in production; gaps in infrastructure; output of horticulture; and variation across districts by utilizing existing sources of data. Together, the mixed-methods approach offers an enormously broad view of horticulture, both as an economic and socio-cultural activity.

3. Data Sources: (i) Primary (optional): While most of what will be reported in the study is taken from secondary literature, there may be an optional primary component which consists of interactions with: Farmers, Village Horticulture Officials, KVK Report Observations, Informal Discussions with Orchard Owners.

(ii) **Secondary:** This study is based primarily on reports prepared by government agencies (for example, the Horticulture Department, Government of Arunachal Pradesh), reports published by the Indian Council of Agricultural Research (ICAR) and Krishi Vigyan Kendras (KVK), the National Competitive Development Programme (NCCD) and the Mission for Integrated Development of Horticulture (MIDH), journals, books, peer-reviewed articles, district statistical handbooks, and other sources of information about the transition from shifting cultivation to modern agricultural techniques. Opinions regarding

constraints faced by farmers, gaps in the technical capability of farmers, and previous to support from government policies, are analysed through secondary sources of data.

4. Collections Tools & Techniques: The following tools and techniques are used in collecting & compiling the research data: (i) Document Analysis: to perform document types, which include published horticultural survey reports, academic publications, and government. The study has classified different categories of horticultural information about Pest Management Opportunities, Horticultural Livelihoods Impacts, and Policy Gaps.

Methods of Data Analysis: (i) Qualitative Analysis: The Thematic Interpretations of [Specific Horticulture Practice, Type of Land Tenure, Indigenous Crop Management, Climate-Related Issues, and Socio-Cultural Considerations within the Field of Horticulture.

(ii) Quantitative Analysis: The Percentage of all types of production data that is available by crop, trend analysis for each crop by year of the production data collection (Kiwi, Orange, Apple, Spice).

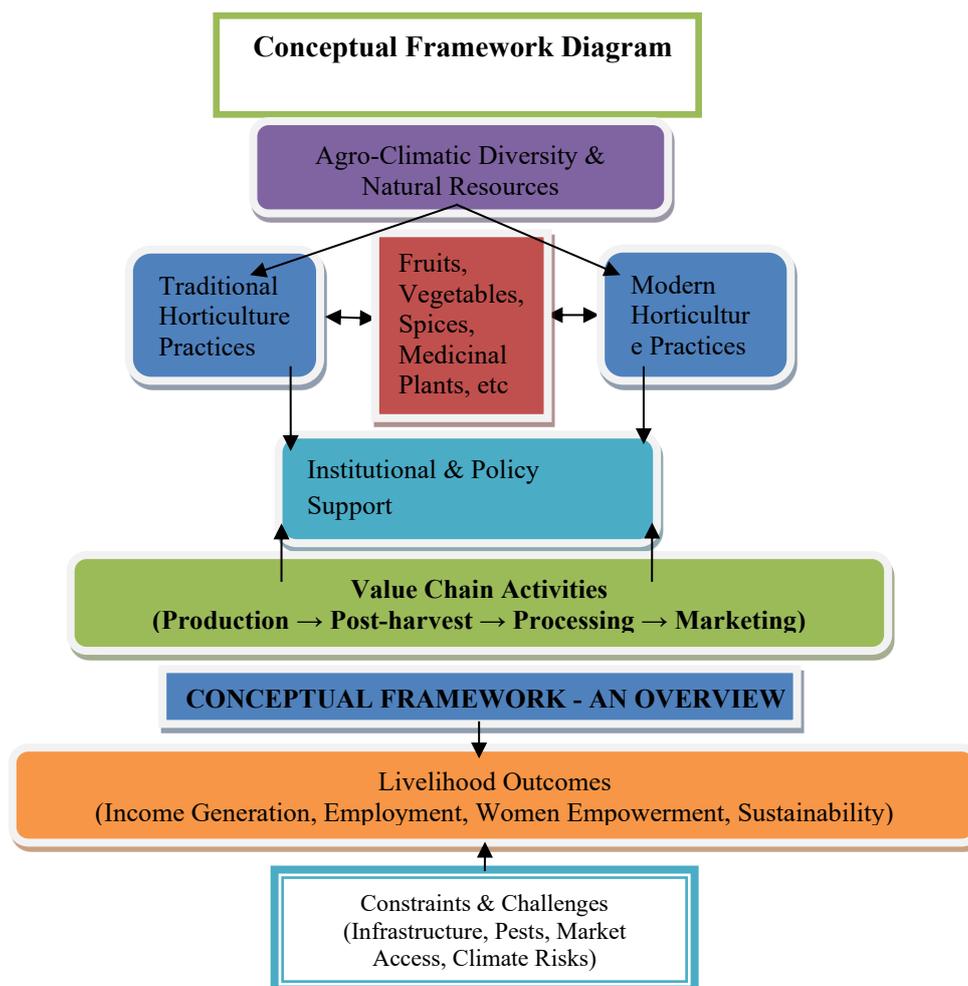
(iii) Triangulation Techniques: The Triangulation Methodology ensures reliability and verifiability of each piece of information collected through multiple author's reports and surveys for a region where data is limited, where the data is limited in the state.

Through a combination of these methods, the study has gained an understanding of the current and future potential for horticulture within Arunachal Pradesh.

III. RESULTS AND DISCUSSIONS

CONCEPTUAL FRAMEWORK

The conceptual framework outlines how agro-climatic characteristics, horticultural methods, institutional assistance (support), obstacles, and livelihood results connect and fit together in Arunachal Pradesh. The basis for this is current research into rural growth developed through horticulture in the Eastern Himalayan Region.



The agroclimatic and rich resource potential of Arunachal Pradesh is represented at the bottom of the framework, providing favourable conditions for the growth of many different types of horticultural crops, including fruits, spices, vegetables and medicinal plants. These ecological conditions have influenced traditional forms of horticulture, such as jhum, and modern scientific techniques as a result of the research and extension system. The practices of horticulture have been influenced both by the policy and institutional support provided to farmers and other stakeholders, from agencies such as the government and research institutions (such as ICAR, Krishi Vigyan Kendras) and through various horticultural schemes, such as the MIDH (Mission for Integrated Development of Horticulture) Scheme. Institutions facilitate access to improved planting material and provide training and infrastructure to improve productivity and crop diversification. The framework defines the importance of the value chain associated with horticultural activity, particularly the activities of production, post-harvest handling, processing and marketing. A more efficient value chain will minimise post-harvest losses and enable the farmer to earn higher returns by adding value to his produce,

either through collective marketing mechanisms or Farmer Producer Organisations. The main objective of horticultural development is to improve the livelihood outcomes for the farmers in the state. Specific livelihood outcomes associated with horticulture-led development in Arunachal Pradesh include household income increases, creation of employment throughout the value chain, increased participation of women, and the long-term sustainability of the environment. At the same time, the framework recognises the many challenges associated with horticultural practices and the ultimate livelihood outcomes, i.e., the many constraints that hinder horticultural development and create barriers to achievement, such as poor connectivity, inadequate cold chain infrastructure, incidence of pests and diseases, climate variability and land tenure issues. These constraints are, therefore, feedback factors that influence horticultural practices and livelihood outcomes and require continuous intervention by policy and institutional organisations.

PROSPECTS OF HORTICULTURE PRACTICES

1. Positive Climatic Environment: Arunachal Pradesh's climatic environment is suitable for a variety of horticultural crops that have a high-value. Arunachal Pradesh has a

complicated geographic structure with multiple geo-physical, altitude, and agro-climatic variations, thus creating multiple regions and horticultural clusters throughout the state, providing many opportunities for growth in horticultural production such as Kiwis, Apples, Citrus Fruits, Temperate Fruits, and niche-market products including Insects and Forest-Based Resources, (GAP, 2021; ICAR, 2017). The geo-physical characteristics allow for the establishment of location-based Horticultural Clusters that can be developed and marketed efficiently to consumers in regional, national, and global marketplaces (Nongdam & Tikendra, 2014).

2. Production of Quality Fruits: Arunachal Pradesh is a geographically diverse area with a good opportunity for expanding the production of high-quality fruits like Kiwi, Apple, Peach, Pear, and other temperate/sub-tropical fruits. The "Kiwi Mission 2025–2035" demonstrates the commitment of Arunachal Pradesh to improving the capacity to produce Fruit by providing training to Farmers, promoting good agricultural practices and creating a branding identity for Arunachal Pradesh on an international level (Dept. of Horticulture, State of Arunachal Pradesh, 2023). Through the research and extension support from the Indian Council of Agricultural Research (ICAR) and the Krishi Vigyan Kendras (KVKs), the productivity and quality of Apples and Citrus fruits in Arunachal Pradesh have increased significantly and have shown significant potential for creating Export-Value Chains (ICAR, 2017; KVKs, 2019).

3. Development of Organic Farming Potential: Traditional low-input systems with little reliance on synthetic inputs and a wealth of agro-biodiversity help form an excellent basis for developing organic agriculture as a significant sector within Arunachal Pradesh. The techniques that are the foundation of all traditional farming systems in the state are naturally consistent with organic farming practices, thus providing an opportunity to develop robust frameworks for achieving certification and entering into the marketplace (ICAR 2020). The successful certification of kiwi fruit for sale within India's domestic markets as well as in export markets has opened up opportunities for the successful certification and premium sale of ginger, turmeric, large cardamom, medicinal herbs, and temperate fruits from Arunachal Pradesh (GAP 2021).

4. Opportunities to Grow Spice Crops: The high elevation, temperate climate, and other ecological factors in Arunachal Pradesh's mid and upper elevations, combined with the increasing demand for high value aromatic and medicinal spices nationally and internationally, have created many new opportunities for rural communities to convert traditional agricultural practices to more productive

systems that generate high income (SDIOPR 2019). In addition to improving sustainability, integrating spices into agroforestry systems creates significant benefits related to soil fertility and enable the continued successful development of various crops in the region based on local cultural and climatic traditions (Nongdam and Tikendra 2014).

5. Development of Medicinal and Aromatic Plants (MAPs): In Arunachal Pradesh, there is a vast opportunity for commercialisation of medicinal and aromatic plants as a result of the state's large and diverse range of forest ecosystems and associated plant resources. A range of different forest types in the state provide suitable environments for producing different types of both essential oil and herbaceous plants such as those from citronella, lemongrass, patchouli, and other indigenous herbs, (National Medicinal Plant Board, 2018). Producing multiple products with an MAP-based enterprise would allow opportunity for livelihood diversification, eco-processing, and value addition at village level. This also contributes to achieving Sustainable Rural Development (SDIOPR, 2019).

6. The Development of Infrastructure Will Enhance Opportunities for Developing and Marketing a Brand: With the increased support from rural organisations for developing market-oriented infrastructure, farmers are now able to move away from subsistence horticulture towards commercial production systems. Support from the Mission for Integrated Development of Horticulture in Mission Mode has aided the establishment of pack-houses, cold chain facilities, and nurseries to help decrease post-harvest loss and added value at many points throughout the supply chain (Ministry of Agriculture & Farmers Welfare, 2022). Additionally, the investment in cold chain-related infrastructure has enhanced access for farmers to more regional, national, and export-level markets, thereby increasing opportunities for branding, and higher price realisations (NCCD, 2020).

7. Facilitating the Formation of Farmer Producer Organisations and Collective Action: By promoting the formation of Farmer Producer Organisations (FPOs) and tribal cooperatives, farmers can work together to aggregate, co-operate, and collectively market their produce as well as to negotiate better prices, and also provide farmers with improved access to institutional financing, insurance, and even farming inputs (SDIOPR, 2019). By utilising the FPO and co-op-led promotional/ branding of organic or niche horticultural products will promote the broadening of existing supply chain integration and the facilitation into much higher valued domestic and export markets,

ultimately improving farm income, as well as building increased resilience in rural areas (SFAC, 2021).

8. Sustainable "Jhum" Transitioning from Climate-Resilient Environmentally Friendly, Forestry-Based Land-Use Transformation Opportunities: Horticulture has begun to be accepted as an alternative to the traditional practice of Jhum (or "shifting cultivation") in the hilly areas of Meghalaya and Arunachal Pradesh. Horticultural-based systems of Land Use include Fruit Orchards and Agroforestry Models help to stabilize soil, conserve Biodiversity, or provide Long-Term Produce through Multi-Year Cycles as well as reduce the Land Degradation that results from Jhum's Short Fallows (Kumar 2016; NIRD & PR, 2015). These Production Systems established with Perennial Crops will Improve Climate Resilience by Minimizing Risks for Soil Erosion and Enhancing Carbons Sequestration, Supporting long-term Ecological Sustainability in Sensitive Hill Ecosystems (Kumar 2016).

9. Opportunity for Research & Extension Support by Developing Institutional Partnerships: Research & Extension Support from Institutions such as the Indian Council of Agricultural Research (ICAR), Krishi Vigyan Kendra (KVK) and the State Horticulture Department are essential to Horticultural Development in Arunachal Pradesh. These Institutions Support Farmers through the Availability of Better Planting Materials, Dissemination of Practising Orchard Management, Integrated Pest and Disease Management, and Providing Skills Programmes (ICAR 2017; KVK 2019). Continued Development of Local Research and Adaptive Research Infrastructure and Regional Availability of Locally Appropriate Horticultural Technologies and Inputs to Small and Marginal Farmers would further Promote Horticultural Development in Arunachal Pradesh (ICAR 2020).

10. Consumer Market Demand for Specialty Fruits is Growing in India and Globally: There has been rapid growth in the demand for specialty and exotic fruit, such as kiwifruit, avocado, and dragon fruit, over the last several years by both Indian and worldwide consumers. Changing dietary habits and increased health consciousness have created great opportunity for Arunachal Pradesh to capitalize on its favourable agro-climatic conditions and "organic certification" through the production of exotic fruits (Arunachal Observer, 2013; Ministry of Commerce & Industry, 2021). The creation of a unique brand identity for the exotic fruit products of Arunachal Pradesh can also strengthen the state's position as a premier horticultural product supplier at the national level (Government of Arunachal Pradesh, 2021). The Demand for Value Added & Processed Fruit Products is increasing.

11. Increased Opportunities for Value-Added and Processed Fruit Products: There is great potential to develop value added and processed fruit pulp; juice; dried fruit; spices; essential oils; herbal extracts; and jam based products in Arunachal Pradesh through the establishment of processing facilities at the village level. These processing clusters will lead to improved quality of products, reduced post-harvest losses and the creation of employment and income generating opportunities in the local communities (Government of Arunachal Pradesh, 2021). The food processing sector provides significant opportunities for women entrepreneurs and tribal self-help groups, thereby supporting rural development in an inclusive and decentralised manner (Ministry of Food Processing Industries, 2020).

12. Support for and Promotion of Sustainable Horticulture through Government Policy- Long-Term Policy: The Government of Arunachal Pradesh has developed and continues to invest in many initiatives and programs aimed at promoting and supporting horticulture development in the state. Additionally, other Central Government schemes are being strengthened through the Central Horticulture Mission, PM-KISAN, PM-FME and the Farmer Producer Organization; these initiatives include substantial investments from both State and Central Government in nursery development, micro-irrigation programs, capacity-building programs and market infrastructure. These investments will help sustain the growth of the horticulture sector over the future (Government of Arunachal Pradesh, 2021; Ministry of Agriculture & Farmers' Welfare, 2022; NCCD, 2020).

IV. LIVELIHOOD ON HORTICULTURE PRACTICES

1. Agro-climatic Diversity In Arunachal Pradesh: The diversity of agro-climatic conditions and elevations in the state of Arunachal Pradesh provides the opportunity for rural households to grow many types of horticultural crops. By cultivating fruit, vegetable and spice crops, rural households can sell their surplus to generate additional income for their household and provide a more secure livelihood for themselves. Because of the favourable conditions and ecology of Arunachal Pradesh for growing perennial crops, horticulture provides a stable source of income for Indigenous communities located there.

2. Economic Resilience Through Horticulture: Due to the gradual decline in the practice of shifting cultivation, rural families have begun growing horticultural crops that are grown commercially, for example, kiwis, large cardamom, oranges, apples, etc., which has increased the stability of household income from that of former jhum

cultivators. Horticulture allows for a more predictable income stream, thus, providing a more resilient economy to the rural farming communities.

3. Economies Expanding Due to Commercially Produced Fruits: Kiwi, banana, orange, pineapple, and apple cultivations have been developed as a means to increase household income in Arunachal Pradesh. Some regions of Arunachal Pradesh also benefit from the intensive cultivation of kiwi as a reliable contributor to farm income and provide for multiple forms of livelihood of farming households (Dutta, 2020). Similarly, orange cultivation in Wakro and Roing provide the local community a significant source of income (Dutta, 2020).

4. The Growing Market Potential for High-Value Spices: Increasing demand for high-value spices such as Cardamom, ginger, and turmeric has made them commercially viable as low-cost, high-return agricultural crops. Due to their cultivation, tribal farmers have increased access to local and regional markets, thus helping them better realise price and create additional income (Choudhury, 2017).

5. Job Opportunities Through the Entire Value Chain of Horticulture: The production and marketing of horticultural products is a source of employment opportunities along the entire value chain. Nursery management, orchard maintenance, harvesting, post-harvest handling, grading, packaging, transportation, and marketing are all ways to generate employment opportunities for both skilled and unskilled labourers that will allow people to expand their livelihood options beyond just subsistence agriculture (Taba, 2019).

6. Supporting Women's Participation and Empowerment in Horticulture: Women are an integral part of horticultural production because they participate in home gardening, spice production, post-harvest processing, and local marketing of horticultural products. In addition to increasing household income, women's involvement in these activities provides them with greater economic independence and ultimately increases the overall livelihood security of their families (Nani, 2018).

7. Traditional Knowledge Systems and Horticulture-Based Livelihoods: Indigenous knowledge systems, including traditional agricultural practices of crop production, seed preservation, intercropping, and Indigenous pest management, play a significant role in horticulture-based livelihoods. These practices help reduce the reliance on purchased inputs and contribute to ecological balance and sustainability of the farming systems (Tamang, 2015).

8. Ways Government Programs and Institutions Support Horticulture: Government programs have helped

develop horticulture as an income source via the Mission for Integrated Development of Horticulture, the Chief Minister Sashakt Kisan Yojana, Krishi Vigyan Kendras and Farmer Producer Organisations. These programs provide farmers with financial assistance to support improvements in productivity and to develop skills in orchard management, marketing, and organic farming practices and thus to produce better quality crops through financial resources and technical training (Das, 2021).

9. Increased Opportunities for Organic Farming: There is a low level of chemical inputs used in horticulture and there is a rich biodiversity in Arunachal Pradesh, which provides a good opportunity for organic horticulture. The increase in both national and global demand for organic ginger, turmeric and orange products has enabled farmers to sell organic products at premium prices and allows them to earn higher incomes and provide greater livelihood sustainability for their producers (Goswami, 2019).

10. Value-Added and Processed Products: Value-added production and processing activities such as juice extraction, fruit and vegetable processing, spice drying, and packaging create new opportunities for increased income for farmers and also lower post-harvest losses. Local small-scale processing facilities managed by local entrepreneurs have opened up additional opportunities for increased income for farmers and small and medium-sized businesses in rural areas (Lollen, 2020).

11. Market Linkages, Cooperatives, and Collective Income Generation: The establishment of market linkages, farmer groups and cooperatives has enabled farmers to collectively market their produce and share the costs of transportation and storage. Agricultural cooperatives are more likely to reduce the chances of exploitation because of their collective bargaining power and consequently have increased rural incomes (Morang, 2018).

12. Challenges: The challenges faced by horticultural farmers include poor roads, inadequate cold storage, post-harvest loss, food safety concerns, and fluctuating market prices among various others. As these factors impact their ability to sustain horticulture as a means of income in the long term (Rebong, 2020), addressing these issues is important to maintaining horticulture as a viable source of sustainable income.

13. Agri-Tourism and Eco-Horticulture: Agri-tourism and eco-horticulture are beginning to grow and develop into alternative means for generating income in several districts, including Ziro, Tawang, West Kameng. Farmers have the potential to increase their income by using agricultural tourism to integrate both tourism and horticulture into their farms through activities such as orchard visits, farm stays and hands-on experiences for the visitors (Basar, 2021).

14. Perennial Horticultural Crops: Perennial horticultural crops help provide soil conservation, climate change mitigation and long-term livelihoods by reducing reliance on shifting cultivation and providing a degree of economic security while creating environmentally sustainable practices in fragile hill ecosystems (Pertin, 2017).

V. PROBLEMS FOR HORTICULTURE PRACTICES

1. The Transportation of Fruits, Vegetables, and Spices from Farms to Markets: Transportation of fruits, vegetables and spices from Arunachal Pradesh's farmlands to Marketplaces within the state is made extremely difficult by mountainous terrain/high elevation land-mass combined with historically poor (low-quality; low capacity) connectivity within its rural areas. Poorly connected & limited-quality road infrastructure adds time and cost to the transport of agricultural products and breaks into the profits of the gift to farmers who suffer large quantities of Post Harvest Losses. Transportation also means restricted and limited marketing access for Farmers into the outside world (Rebong, 2020).

2. Cold Storage/Infrastructure Related to Post Harvest Losses: The State of Arunachal Pradesh is a large producer of numerous types of soft fruits, such as Kiwi, Orange and Pineapple, among others; however, because of a lack of cold storage facilities/ripening chambers and unchecked agricultural infrastructure related to the storage of these fruits, Farmers lose approximately 25% to 30% of these specific crops in Post Harvest Losses when spoiled and/or when Farmers are forced to sell at Very Low Prices to move products before spoilage occurs (Das, 2021).

3. Pest and Disease Infestation in Orchards: Orchards of Citrus, most notably located in the Orange Growing areas of Wakro and Roing, have suffered greatly from both the aggressive problems of Trunk Borer and Disease Infestation, leading to a rapid/rapidly declining condition of these orchards. Similar problems also exist for large cardamom & apple orchards, threatening Farmer Livelihood Security. The absence of timely telephone communication and/or timely advisory communication services related to pest management creates a larger number of problems for citrus – picker, who experiences many crop failure/environmental factors associated with poor production as a result of pest infestation, than do other Orchards (Singh, 2018).

4. Limited Supply of Quality Seedling/Nursery Stock: As only a few Farmers have certified and sustainable nursery locations to supply seedlings, certified & sustainable seeds, many Farmers are forced to use inferior/traditional seed stock or their only alternative,

which ultimately leads to lower Production Efficiency, lower Crop Quality and higher susceptibility to Pest/Disease Problems associated with higher production & Profit Losses due to pest/disease problems than do other Farmers. The absence of a formalized nursery regulation system in Arunachal Pradesh creates additional limitations on the viability of Farmers to produce quality standards of orchards or produce (Lollen, 2020).

5. Limited Marketing Options: Horticultural producers face limitations on their marketing opportunities because there are no organised aggregation mechanisms or regulated mandis. As a result, many farmers rely heavily on local traders who take advantage of their limited access to markets and offer them very low farm-gate prices. Farmers are also less profitable due to the absence of farmer-managed collection centres, high volatility of prices, and a high incidence of middlemen intervention (Morang, 2018).

6. Lack of Adequate Financial Support: A significant proportion of farmers are unable to obtain formal credit because of characteristics such as geographic isolation, lack of access to collateral and limited financial literacy. Therefore, most farmers are forced to borrow through informal means, at high interest rates, to have the ability to invest in the development of their orchards and maintain their long-term horticultural enterprises (Choudhury, 2017).

7. Traditional Farming Techniques: Farmers continue to rely on traditional farming techniques and there is a low rate of adoption of modern horticultural techniques such as high-density planting, drip irrigation, pruning and canopy management. As a result, farms with low exposure to new technologies have lower levels of productivity and poorer fruit quality (Tamang, 2015).

8. Natural Disasters and Extreme Climate Events: Natural disasters, such as heavy rainfall, landslides, cloudbursts, and frost at greater elevations, commonly interfere with and subsequently damage the harvesting of fruits from orchards, remove topsoil, and exacerbate erosion. The changing climatic patterns associated with these types of events result in difficulty in estimating the timing of harvests due to irregular patterns of flowering and fruiting, and lack of a long history of climate data to provide useful information (Dutta, 2020).

9. Traditional Land Ownership System: In Arunachal Pradesh, farmers have a tradition of owning land communally, and as a result, landholdings are usually fragmented and frequently not registered. Since it can take many years for farmers to acquire formal land titles for their landholdings, if they do establish formal title, they do not want to establish or expand their orchards, as they cannot be sure that it will be possible for them to retain their land and develop their orchards (Mibang, 2018).

10. Processing Units Inadequate for Value Addition:

Although there are many products from horticulture, such as kiwifruit, oranges, ginger, turmeric, and pineapples, that could be processed into value-added products, the state has very few processing units for these products. Because the processing infrastructure does not exist, farmers are losing value by not being able to produce value-added products (Goswami, 2019).

11. Lack of Effective Extension Services and Technical Assistance:

Extension and technical services in remote areas are not adequate; farmers do not have access to science-based management practices, pest control measures, nutrient applications, or post-harvest management. This lack of information has caused decreased productivity and poor management of orchards (Taba, 2019).

12. Shortage of Labor During Critical Growing Times:

Due to the high number of young people leaving villages and the decreasing interest in farming, orchards will suffer during critical periods like planting, pruning, and harvesting due to a shortage of labor (Pertin, 2017).

13. Lack of Farmer Organization and Collective Marketing:

Most horticultural farmers are not involved in Farmer Producer Organizations. Because there is no organizational strength among farmers, they have no bargaining power, lack access to government incentive programs, and are not able to effectively market their products collectively (Basar, 2021).

14. High Costs of Inputs and Orchard Maintenance:

The costs of transportation for fertilizers, tools, packaging materials, and machines are high for small, remote villages. Also, the initial capital needed to establish and maintain an orchard deters small- and marginal-sized farmers from engaging in large-scale horticulture (Nani, 2018).

15. Insufficient End-user Distribution, Storage and Packaging Space:

The ability of national markets to compete with Arunachal Pradesh's horticultural goods has been hampered significantly because there are limited resources available to horticulturists to create standard-quality packaging, grading equipment, storage facilities and transport systems. Additionally, continued reliance on outdated and inefficient means of packing products will continue to result in product spoilage and lower-quality produce (Lollen, 2020).

VI. SUGGESTIONS

1. Road Connectivity: Improving rural transport infrastructure will reduce the time and cost to transport goods from rural areas to urban markets and provides more access to large urban markets for rural farmers. Increased

access to transport infrastructure for rural farmers will reduce the "post-harvest" losses of horticultural crops and increase farm profit through greater access to larger urban markets (Rebong, 2020). The construction of rural roads that are available for all-weather use will require an increase in public investment for the development of this infrastructure.

2. Cold-Storage Facilities: The construction of cold-storage facilities and post-harvest processing units at cluster levels will ultimately lead to a reduction in spoilage and an increase in the market value of horticultural products. The availability of cold-chain infrastructure will also reduce the chances of price instability in the horticultural sector, which will reduce the possibility of "distress sales" by farmers (Das, 2021). The success and sustainability of cold-chain infrastructure can be further supported by partnerships between public and private entities.

3. Addressing Low Productivity Levels: The government should promote the establishment of certified nurseries that produce disease-free planting materials for various crops, including citrus, kiwi, apple, and cardamom, and provide technical assistance for such nurseries to bolster productivity and resilience (Lollen, 2020).

4. Strengthening Integrated Pest Management (IPM):

The improvement of pest management and the implementation of rehabilitation programs for older and declining orchards in the citrus-producing regions of the country require trained professionals and horticultural officers to ensure effective pest control and rehabilitation (Singh, 2018). Constant field visits by trained personnel and expert advice will help in managing both pest problems and orchard rehabilitation.

5. Enhancing Farmers' Access to Markets:

The establishment of rural marketing hubs and farmer-managed collection centres will reduce distress sales and exploitation. Additionally, collective marketing arrangements will improve farmers' bargaining power and ensure more stable income (Morang, 2018). Expanded marketing opportunities for farmers will also be established through digital applications like e-NAM.

6. Enhancing Farmers' Access to Institutional Credit and Subsidies:

By creating simplified loan processes, providing collateral-free loans, and educating farmers about horticulture subsidies, farmers will be able to invest in their orchards more confidently. Mobile banking and door-to-door financial services will also help farmers in remote areas access formal credit (Choudhury, 2017).

7. Promoting Scientific Agricultural Practices through Training and Technology Adoption:

Farmers can produce larger yields of better quality fruits by receiving training in the following areas: 1) high-density planting 2)

drip irrigation 3) fertigation 4) canopy management and 5) protected cultivation. Establishing more demonstration plots and farmer field schools throughout India will further improve the adoption of new farming technologies (Tamang, 2015).

8. Establishing Climate-Resilient Horticultural Models: Developed from climate-resilient horticultural models, these models will provide a range of climate-resistant varieties of crops, rain shelters, and several types of soil conservation measures (e.g., contour bunding and terracing) to help protect orchards against weather-related hazards. In addition, such systems should include an early warning system and climate advisory service to encourage and support adaptive decision-making from farmers (Dutta, 2020).

9. Land Tenure Reforms and Community Orchards: Land tenure arrangements must be clarified and community orchards must be created to facilitate development of orchards on a larger scale. Community based and cooperative managed orchards have been successful in establishing horticultural development in tribal areas where individual land parcels are highly fragmented (Mibang, 2018). Therefore, cooperative managed orchards can play an important role in promoting horticultural development in areas of fragmented landholdings.

10. Promoting Value Addition and Local Processing Units: Establishing local processing units to create value-added products can provide farmers greater income opportunities and create less waste for their products. Business Development Programs that support rural youth and women entrepreneurs will further strengthen local agro-processing businesses (Goswami, 2019).

11. Strengthening Extension Services and Farmer Training Programmes: Increasing the number of extension personnel, the number of mobile extension units, and the number of training camps for farmers involved in 'scientific horticulture,' will improve the awareness of scientific horticultural techniques. Collaborating with Krishi Vigyan Kendras ICAR-Indian Council of Agricultural Research, Non-Government Organisations and others to provide improved outreach and training programs for farmers will help to achieve this goal (Taba, 2019).

12. Promoting Farmer Producer Organisations and Cooperative Marketing: Farmer Producer Organizations and cooperative marketing organisations enable farmers to pool resources, access larger markets, and receive better prices for their products. Farmer Producer Organisations and cooperative marketing also decrease the costs of transportation, storage, and packaging therefore increasing farmer profitability (Basar, 2021).

13. Agricultural Careers for Young People in Rural Areas: Programmes that develop skills and provide support for entrepreneurs can attract more young people to work in horticulture. By using modern technologies such as greenhouses, food processing, logistics, and packaging, young people will be encouraged to get involved with businesses that grow, process, and market horticultural products (Pertin, 2017).

14. Offer Input at a Reduced Cost: Subsidised input is the provision of required inputs to raise crops at a lower than market price. Providing subsidies for inputs, such as fertilisers, tools, and drip irrigation systems, will significantly reduce production costs. Establishing local supply chains to provide farmers access to the necessary inputs will lessen financial burdens associated with obtaining input and increase access to input (Nani, 2018).

15. Modernised Packing, Grading, and Transport Systems: Investing in modernised packing and uniform grading practices, and using refrigerated transport systems, will help improve the competitiveness of horticultural products produced in Arunachal Pradesh when compared to national and international markets. Modernised pack facilities will reduce damage to horticultural products, and the implementation of refrigeration systems on transportation vehicles will improve the quality of perishable outputs (Lollen, 2020).

VII. LIMITATIONS OF THE RESEARCH

There are a number of limitations that researchers have found to account for developing this sector:

- (1) There is limited available primary data from remote districts.
- (2) Due to lack of documentation there are some inconsistencies in the secondary records of some crops.
- (3) District level statistics do not provide us with a complete view of production for the years 2020-2025.
- (4) There are geographical limits on farm-level comparisons; and (5) secondary sources may not describe production as affected by seasonal differences.

VIII. CONCLUSION

Arunachal Pradesh has become a leading State in terms of Sustainable Rural Development within the field of Horticulture due to the extensive agri climatology and resources of the State as well as the traditional knowledge of the people on farming. The development of fruit crops Kiwis, oranges, apples, and spice crops large cardamom, ginger and turmeric has had a positive impact on the livelihood of Tribal communities across the state. The

development of Horticulture has been met with numerous challenges including poor infrastructure & connectivity, lack of proper infrastructure for post-harvest handling, pest infestation, low market access, and low technical assistance. To overcome these barriers and resolve these constraints, it is vital that the State of Arunachal Pradesh establishes more supportive infrastructure, allowed for the use of science to improve productivity, offered value-added services and established strong supportive institutions. Through a cooperative/coordination between Farmers, Government, and Cooperatives working together, there is potential for Horticulture to play an important role in creating an environment of Economic Growth and Livelihood Security within Arunachal Pradesh.

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