



ALLIED AGRICULTURE

EMERGING TRENDS AND TECHNOLOGY

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Chapter-2

Horticultural Value Chain: Adding Value to Crops

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1.Introduction to Value Addition in Horticultural Crops

Value addition refers to the process of enhancing a product's current form or state to improve its appearance, taste, shelf life, and overall value, ultimately providing consumers with a better return than the farm gate price. Horticultural crops have historically played a vital role in enhancing human quality of life. Records from ancient civilizations indicate that people cultivated fruits in favorable environments and maintained optimal growing conditions by using wickers and constructing huts or boxes to shield crops from adverse weather. This marks the early beginnings of horticultural practices rooted in ancient societies.

In India, rural horticulture encompasses a diverse range of fruit and vegetable crops, including spices, medicinal plants, aromatic crops, and plantation varieties. While most orchards are smaller than 2 acres, the rise of commercial horticulture has led to the establishment of orchards exceeding 100 acres. Thanks to India's extensive agro-climatic diversity, horticultural crops are cultivated across the nation. Since independence, the Indian government has prioritized the establishment of research stations and institutions to promote horticulture. However, despite these efforts, significant losses occur during post-harvest operations, leaving many traditional food crops unavailable to urban markets and industries. There is a pressing need to extend the shelf life of these high-value perishable commodities while simultaneously expanding their market reach. Opportunities abound, as India is the second most populous country, with considerable variations in dietary habits influenced by tradition and culture. Although there has been steady progress in fruit and vegetable production, the productivity of horticultural crops in India remains low, as evidenced by post-harvest losses. The survival of perishable horticultural crops hinges on the implementation of value addition processes to transform them into more efficient and durable products. The base material can be processed in simple or complex ways to enhance its appeal and improve marketability, palatability, digestibility, nutritional quality, and acceptability. The quality of the final product depends not only on the initial grading of the raw materials but also on the care taken throughout the processing stages. An organized processing system can yield greater returns for both farmers and other stakeholders involved, as the trade of processed goods typically commands higher margins compared to raw products.

2. Importance of Value Addition in Horticultural Crops

Once basic food needs are met, humans often seek to enhance certain food items through quality improvement and utility enhancement via processing or recipes. Post-harvest handling methods such as canning, drying, or freezing fruits and vegetables serve to fulfill these objectives, promoting good health through environmental sustainability and providing essential nutrients like vitamins and fiber. The market demand for fresh horticultural products is driven by the desire for high-quality food that maintains its integrity during storage and consumption. While some products are typically consumed fresh, they must still meet high-quality standards to ensure satisfactory eating experiences, even as freshness deteriorates. The growing demand for improved quality leads to consumers' willingness to pay more, resulting in higher returns in the fruit market (Fleming, 2005).

Horticultural crops are highly perishable and can quickly lose quality and decay after harvest. To mitigate this deterioration, it is essential to process and present horticultural crops in a way that preserves their quality until they reach consumers. This can be achieved through the production of both processed and preserved products, as well as fresh offerings. The availability of processed and preserved horticultural crops can facilitate wider trade and reduce the risk of damage due to their increased durability. Additionally, the production of waste products from horticultural crops can limit marketability, leading to direct disposal as waste. As farm productivity increases, production volumes may exceed market demand, resulting in potential spoilage due to market saturation and waste. There are viable technical alternatives for horticultural crops that cannot be marketed directly due to constraints such as storage, packaging, or processing. One solution is to create processed and preserved products with extended shelf life. Ensuring a sufficient supply of horticultural products will promote the trade of processed and preserved items, necessitating post-harvest treatments (such as cooling and cleaning) and processing steps (like packing and labeling). This approach aims to diversify the range of widely traded products, thereby enhancing farmer revenue through various product options and agricultural practices. Another factor driving product diversification is the broad availability of raw materials, which results from effective post-harvest handling practices (such as harvesting ripe or partially ripe sections, washing, and drying). This availability increases the potential for producing processed and preserved products that can be marketed (Meena Vinod Kumar and AS Panwar A Nath, 2018). Strategic diversification into processed and preserved products allows for a broader market reach. The evolution of market demand is expected to align with the availability of horticultural crops, providing farmers with opportunities to easily enter the market with a variety of processed and preserved crops alongside fresh horticultural products. Overall, the proposed and promoted value addition of horticultural crops has primarily focused on farm gate products. However, the broader context of value addition reveals that processed items can be the ultimate goal. It is also emphasized that processed and preserved items can significantly enhance access for rural and underserved communities.

Several economically beneficial reasons exist for on-farm product diversification and value enhancement, including the promotion of value addition that leads to a better realization of crop costs, increased economic margins, and improved profitability for horticultural farmers. Additionally, upgrading packaging and enhancing product appeal can boost the potential for external sales of exotic goods, increase market competition, and strengthen the position of indigenous products. This diversification also facilitates the enhancement of farmers' commodities in international trade, ultimately leading to the creation of unique and superior value-added horticultural products that can establish a farmer's brand.

3. Challenges and Opportunities in Value Addition

Horticulture could be defined as the science and art of growing fruits, vegetables, flowers, and ornamental plants. In Ethiopia, horticulture is an age-old sector that is attracting an increasing attention as a dependable source of income and job opportunities. In recent years, there has been a growing interest in improving farmers' income and productivity in this sector by various stakeholders. The Government of Ethiopia is giving a special focus to horticulture to increase its contribution to economic development. As a result, the horticulture sector is growing rapidly from time to time. In Ethiopia, the export of horticultural crops is becoming an essential alternative to traditional export crops to generate foreign exchange, which is necessary for sustainable economic development. Horticulture has attracted diverse groups of actors within and outside the government, including donors and the private sector. Like any other agribusiness enterprise, the opportunity for market development and profit optimization in horticultural production greatly depends on production, harvesting, preservation, storage, transportation, distribution, and market system preferred by farmers and other stakeholders. All these factors in turn required the use of well designed and well-built facilities and sound infrastructure supported with proper management. Improvement of technologies to enhance the production and postharvest handling system of horticultural crops thus become major concerns of all stakeholders and the government in general. However, despite its potential to the national economy; the technological base of this sector is very weak and it is characterized by traditional strategies and practices in area coverage, productivity, handling, packaging, storage, transportation, processing, and value addition. The implementation of postharvest technologies will contribute significantly to a:

1. Reduction of spoilage loss and production of marketable and better-quality products to meet the need of the consumers,
2. To improve the overall marketing system of farmers by enabling them to easily supply their product to urban consumer centers as well as export to foreign countries (Ketema Ashinie, 2019).

4. Technological Innovations for Value Addition

Horticulture encompasses the cultivation of fruits, vegetables, and other products of botanical origin. It plays a crucial role in providing employment and revenue opportunities for all countries. The sector is undergoing radical changes due to new and transforming advances in skill, science, technology and management. Horticultural crops are specifically sensitive to handling and have brief shelf life at room temperature as compared to field crops like cereals or legumes. Therefore, post-harvest losses are a

problem faced by growers and exporters. The value addition of horticultural crops is favored by zones in warmer climates and is a prospective avenue for the exports of such concentrated or processed commodities. The technological cutting edge approaches can provide the roadmap to enhance the value addition of horticulture crops as well as diminishing the post-harvest losses. These revolutionary approaches have been broadly classified as a following methods.

The operation of agriculture at field scales with alterations in response to intra-field variations is defined as precision agriculture. The advances in remote sensors and geographical information systems have facilitated the production development in the direction of horticultural crops. Another decisive factor is the use of film or “smart” packaging of flavonoids produced in fruits and vegetables. The incorporation of flavonoids can adjust the rate of ripening or decrease the incidence of spoilage. At room environment temperatures, thermos-stabilizing packages have been designed to reduce the irreparable damage of heat-sensitive fresh products. The rising demand for minimally or non-preserved fresh-cut products enhances the investigation and development of high degrees of food packaging. Another tactic to encourage the utilization of fresh-cut, minimally processed and highly appealing products is the application of controlled atmosphere and modified atmosphere substances. Energy consumption and waste generation have been reduced considerably in state-of-the-art production activities by using advanced processing technologies such as high pressure processes and membrane filtration methods. Broad spectrum of critical issues concerning horticultural products from field to decide may be addressed by creating and sharing information. By using the monitoring and recording methods, information technology can be employed to create proposals for improvements across the horticultural industry, through the supply chain and markets.

5. Value Addition Techniques for Specific Horticultural Crops

Value addition techniques in horticulture enhance the quality and marketability of raw products, creating higher value for producers. These techniques vary based on the crop and its characteristics. For fruits like mangoes, apples, and berries, common value-addition methods include processing into jams, juices, dried fruits, and fruit pulps. These products have longer shelf lives and appeal to a broader market. For vegetables such as tomatoes and peppers, techniques like freezing, pickling, or making sauces and salsas add value. These processes help preserve the produce and cater to both local and international markets. In the case of spices like turmeric, ginger, and garlic, drying, grinding, and packaging as powders or pastes increase their shelf life and commercial appeal. Additionally, creating spice blends or essential oils offers niche market opportunities. For flowers and ornamental plants, value addition can include the creation of dried flower arrangements, essential oils, or cosmetics. Similarly, for crops like potatoes, value-added products like chips, fries, or flour contribute to higher profits. By adopting these techniques, horticultural producers can diversify their income streams, reduce waste, and improve sustainability, ensuring that crops reach consumers in various forms, all while contributing to local economies.

5.1. Fruits

Value addition in fruits involves transforming raw fruits into products with higher commercial value, extending shelf life, and offering new market opportunities. Common methods include:

Processing into Juices and Pulp: Fruits like oranges, mangoes, and apples are processed into fresh juices, concentrates, or pulp, offering a convenient and long-lasting product for consumers.

Drying and Dehydration: Drying fruits such as apricots, raisins, or bananas helps preserve them, allowing them to be sold as snacks or ingredients for other food products.

Making Jams, Jellies, and Marmalades: These are popular value-added products made from fruits like strawberries, guavas, and citrus, which increase shelf life and appeal to consumers.

Canning: Fruits can be canned in syrup, such as peaches or pineapples, providing convenience for consumers and extending the product's availability.

Frozen Fruits: Freezing fruits like berries, mangoes, and peaches allows for year-round availability and use in smoothies, desserts, or baked goods.

Fruit-based Snacks: Fruit chips, dried fruit bars, and fruit leathers are increasingly popular as healthy snack options.

5.2. Vegetables

Value addition in vegetables involves processing or transforming raw vegetables into products with higher value, extended shelf life, and increased consumer appeal. Common value addition methods include:

Freezing: Vegetables like peas, carrots, and beans are frozen to preserve their freshness, nutritional value, and taste, making them available year-round.

Canning: Vegetables such as tomatoes, corn, and beans can be canned in brine, sauces, or as standalone products, allowing them to be stored for long periods.

Pickling: Vegetables like cucumbers, onions, and cabbage are pickled to create popular products such as pickles, which are in high demand globally.

Dehydration: Vegetables such as tomatoes, mushrooms, and spinach can be dehydrated to make powders or dried flakes, which are easy to store and use in various dishes.

Processing into Sauces and Pastes: Tomatoes, peppers, and carrots can be processed into sauces, pastes, or soups, adding convenience and versatility for consumers.

Vegetable Chips and Snacks: Vegetables like sweet potatoes, zucchini, and kale can be turned into chips or snacks, catering to the growing demand for healthier alternatives.

Frozen Ready Meals: Combining vegetables with grains, meat, or sauces to create frozen ready-to-eat meals increases market appeal and adds convenience for busy consumers.

5.3. Herbs and Spices

Value addition in herbs and spices involves transforming raw products into forms that enhance their appeal, shelf life, and market value. Key techniques include:

Drying: Fresh herbs like basil, thyme, and rosemary are dried to preserve their flavor and extend shelf life. Dried herbs can be sold in bulk or packaged as ready-to-use products for consumers.

Grinding and Powdering: Spices like turmeric, cumin, and chili are ground into powders, making them easy to use in cooking. Ground spices are more convenient and often fetch higher prices than whole spices.

Oil Extraction: Essential oils from herbs like mint, lavender, and eucalyptus are extracted for use in aromatherapy, cosmetics, and as flavoring agents. These oils can be sold in bulk or as part of specialized products.

Blending: Combining multiple spices to create blends, such as curry powder or garam masala, adds value by offering ready-to-use mixes for consumers. Herb blends like Italian seasoning or mixed herbs are also popular.

Pickling: Herbs like dill can be used in pickling vegetables, creating an added-value product that appeals to consumers who enjoy tangy, preserved food items.

Packaging: Attractive packaging, such as jars, sachets, or gift sets, enhances the perceived value of herbs and spices, allowing for premium pricing.

5.4. Nuts and Seeds

Value addition in nuts and seeds involves processing and transforming them into higher-value products, improving their marketability, shelf life, and consumer appeal. Key techniques include:

Roasting: Nuts like almonds, cashews, and peanuts, as well as seeds like sunflower and pumpkin, are often roasted to enhance flavor and texture. Roasted nuts and seeds are popular as snacks or ingredients in various food products.

Grinding into Butters: Nuts like peanuts, almonds, and cashews are ground into nut butters, such as peanut butter or almond butter, which are widely consumed and have a higher market value than raw nuts.

Oil Extraction: Oils are extracted from nuts like walnuts, almonds, and hazelnuts or seeds like flax and sesame. These oils are used in cooking, cosmetics, and pharmaceuticals, providing higher value than raw nuts or seeds.

Flour Production: Grinding nuts and seeds into flours (e.g., almond flour, sunflower seed flour) is an increasingly popular gluten-free alternative in baking and cooking.

Snack Mixes and Granola: Combining roasted nuts, seeds, and dried fruits into snack mixes or granola increases their value as a healthy snack option.

Packaging and Branding: High-quality packaging and branding, such as resealable bags or gift sets, add perceived value and attract premium prices for nuts and seeds.

6. Value Addition through Processing and Preservation

The need for consumption of hygienically safe and nutrient rich foods has opened new vistas for the value addition of horticultural crops. The focus is to enhance the values of horticultural crops rather than simply increasing the volume of production. Several methodologies are already in vogue to add value to the products. Value addition through processing and preservation is an age old practice and includes canning and bottling, freezing, dehydration, and fermentation. These methodologies not only enrich the crops but also ensure safety of these products. The prime focus now is on innovative processing techniques based on consumer preference of including more fruit and vegetable in diet as they supply certain requisite vitamins, minerals, and fibers to maintain a healthy life. Quality standards and regulations have been prescribed for various horticultural products and products of daily uses. A major challenge is to manufacture value-added products that can be safely produced, attract its consumer and fetch more agriculture producers. Value added products of horticultural produces are characterized by higher margin and because of consumer appeal. Post-harvest technology and processing have the potential to bring about both direct and indirect economic benefits, particularly in terms of reduction of post-harvest losses, improving the incomes of small holder growers and generating employment opportunities. Processing in general entails higher degree of conversion of fresh produce into semi-processed and processed goods and forms, thereby enhancing their shelf life and often altering the basic form and nature of the product. As the produce becomes less perishable, more structured marketing strategy can be devised and implemented – better remunerative returns

obtained. Here are few case examples to demonstrate how processing as value addition exercise has been effectively integrated into the marketing strategy of perishable horticultural products and in the process helped in creating a better niche for horticultural products in the domestic markets. Extensive research and development work on post-harvest technology of horticultural produces has resulted in discovering new preservation methods and their technological solutions. Many of these technologies are tailor made for the specific requirement of small and medium industry, which typically process and generate products and byproducts related to the horticulture industry. The preservation and extraction techniques have been made much more affordable, adaptable and user friendly.

7. Market Trends and Consumer Preferences

In recent decades, horticultural crops have gained momentum in the race of being produced commercially and occupy the biggest space in world agriculture. Commercialization of horticulture has become a key component of the development strategies in many developing countries and an even more important food security strategy. The major share of the market value of horticultural crops in developed countries is due to the substantial processing. Several processed products are produced from vegetables, fruits, spices, and different ornamental crops of horticultural origin. Value addition opportunities in this sector are absolutely enormous, whether for domestic markets, export, or off-season markets. However, the planned initiatives for commercializing different horticultural products largely ignore the supply chains to add perceptible value with quality part and make competitiveness in the market. That market would spoil with import of enormous products (K. Ngugi et al., 2008). For example, processed products particularly in the form of dried or frozen held the consideration as well as the class, but fruit sauces, ready-to-eat curries, and gravies possessed quality and safe part disregarded. However, market trends and consumer preferences have been changing at a very fast rate.

In recent years, consumer attention has shifted towards health and wellness food. Demand for consumption of organic, local, healthy, and sustainably produced nutritious food is on the rise. Industry is making rapid advancement and expects its products to be innovative. To make a marketing strategy in suitable customers, those demands are directed from the consumer side should be considered. Including many new attempts like biotechnological advancements, the rising consciousness of conventional medicine's revanchism and acceptance for healthier equilibriums, contemporary nutrition adaptations, and constant developments in vitamin and mineral bases, demands from customers are constantly changing (Rahman et al., 2021). Food processors can retain advantages in the market if they remain up-to-date regarding changes in consumer behavior patterns. Analysis of research discoveries helps guidances suitable marketing strategies which must be in consistence with those evolving developments. This review aims to provide in-depth information with an analysis of current and future market trends, which are coming from consumer preferences. This work represents an important step in a satisfying segment of this scope, and its findings should be of use to all those interested in this area.

8. Economic and Social Impact of Value Addition in Horticultural Crops

There are strong economic and social reasons for the value addition of horticultural crops. Fresh horticultural crops are often perishable and their value deteriorates rapidly. Value addition in terms of

better quality, special processing and packaging can preserve these products for long periods, result in farmers and local communities earning much more. Most of these crops are grown by small scale farmers, and improved quality crops would fetch them higher prices, thereby raising their incomes. Processing of horticultural crops can be of two types, namely non-alcoholic and alcoholic. It has been noted that non-alcoholic processing can lead to higher economic benefits to the growers as compared to the alcoholic method.

Value addition is an excellent way of creating jobs in rural areas where there is no other alternative of employment. Each horticultural crop treatment involves many operations such as drying, cleaning, waxing, size sorting, and packaging which are labor intensive. Most of these can be done manually and thus a considerable amount of work can be generated on a daily basis even in small scale units. This sector has arrived at a point in its evolution that has gained widespread recognition for its potential in the creation of enterprises and the stimulation of local economies. Particularly in developing countries, it plays a critical role by improving food security and reducing poverty. In addition, it contributes significantly to the balance of payments by generation of foreign trade earnings. Horticulture plays a vital role in providing health and nutrition, and has been recognized as a high potential for employment due to higher crop intensity and more employment per unit area as compared to grain crops. As a matter of policy, therefore, efforts are constantly being made to increase its production and productivity and promote efficiency in its post-harvest handling, processing and marketing.

9. Policy Frameworks and Government Initiatives

Creating an enabling environment for small- and medium-sized producers and businesses to engage in value addition practices is crucial. This includes improving farmers' access to technical know-how, disseminating knowledge about product standards and regulations, and supporting the provision of appropriate post-harvest technology, information infrastructure, and partnerships between private sector and local authorities. Given the high cost and risk associated with the development and marketing of innovative products, state support in the form of subsidies, grants, and training is needed. Legal regulations also give producers the basis for claiming compensation in the case of unfair behavior of trading partners (Davis, 2006). Market standards and regulations, particularly technical standards on quality, hygiene and safety, are of critical importance (Sausman et al., 2015). Once a bottleneck is associated with cross-cutting issues such as water quality, just energy needs, so support to address such issues along the value chain or in a cluster can benefit a range of value chain participants. An enabling environment should include all major commercial policy rules to favor the continuous expansion of value addition practices; for instance, trade liberalization and market deregulation. These principles safeguard smallholders' access to lucrative opportunities in high-value product markets, secure safeguards against powerful agents in industrial agglomeration, and mainstream allowance of a comprehensive evolution in support to agriculture and rural development from direct government intervention on markets. A sustainable market and fair trading environment that benefits small-scale growers as well as SMEs (small and medium enterprises) must avoid a permanent ban on agro-

processing imports but ensure they meet the same safety and quality standards expected of domestically produced goods.

10. Case Studies and Best Practices

In many parts of the world the value-added component accounts for a significant share of the value of horticultural crops. Nevertheless for some of the poorest regions the possibility to increase income deriving from production and trade of horticultural crops with sustainable practices has been understudied and often underestimated. This section aims to fill this gap focusing on some best practices adopted in this sector. These antigens include small agro-processors in emerging market economies, smallholder farmers eking out a living on the fringes of global value chains, and consumers who face too few options to access the food they desire. The article uses Granovetter's concept of "the strength of weak ties" to examine challenges and opportunities these agents face in identifying and exploiting potential development alliances (Westlake, 2016).

Nature's Way, Fiji: The case of beeswax production in Lomaiviti Island (Fiji) Each case study is analysed according to a common framework (challenge, strategy, and results). Despite regional differences between the case studies, some general conclusions can be drawn. Most of the poor regions, where the impact of an increase in agricultural productivity would be the highest, have so far been the least affected by sustainable horticultural practices. Many of the examples in the literature that suggest "recipes for success" come from richer and more dynamic regions. Some of those strategies are not easily replicable in the medium term by districts where factors such as poor infrastructure, scant access to institutional assets, institutional underdevelopment, lack of skills, and widespread social and ethnic conflicts hinder the establishment of links between different chain agents (Padel et al., 2018).

11. Future Directions and Emerging Trends

Agriculture continues to be an important economic sector and the largest source of livelihood for a majority of India's population. Horticulture is considered one of the most rewarding ventures in view of its full of opportunity, potential for diversification, and possibility of enhancing the income many folds. India is a versatile producer of horticultural crops, both tropical and temperate. Owing to the wide range of diversity in climate, soil, and topography, a wide range of plants are available. India has a well-developed infrastructure for the processing of fruits and vegetables. Processed fruits and vegetables market has seen an interesting, but uneven, growth pattern. In between, trends in technology have also undergone significant changes. Since the economy opened up, globalization has led to many changes in food consumer behavior and food technologies (Meena Vinod Kumar and AS Panwar A Nath, 2018).

A new food culture is evolving due to an increase in disposable income, change in the traditional concept of the family secondary to increase in the number of working women and a significant increase in the number of fast food chains. More and more of these people are looking for ready to eat junk foods. This segment of the market is showing tremendous growth and changes in the behavior of the food processing industry. Traditional horticultural crops quantity and in the character available are no

longer able to fulfill the future market needs. Main future directions and emerging trends in this sector are globalization of markets will not only increase the level of competitiveness on the market, but it will also impose the necessity of structural changes and the development of economies of scale. Accessibility to wider market in product offerings and government restriction decrease for the export. Broadly, the future consumer preferences are expected to show a shift towards 'health and sustainability'. This shift might alter focus on the development of traditional field crops and the current use of natural space. Value addition potentials are high on broadleaf and spices crops. Vegetable and vegetable products can improve on profits generated by the arable agriculture. Will strengthen the tightness of the ancillary industries, and ensure more sustainable agricultural systems. Once this background was set is clear the importance of innovation, research, and development in order to stay competitive on market and realize the full potential of horticultural crops. Any innovations on the production and processing techniques are expected to have a marked effect on the value-adding prospects of horticultural crops and that the irrigated area will be more suitable to realize this potential. India faced with the twin challenges of growth in urban population and economic growth. These will likely lead to a substantial increase in the demand for water. In this context, the simulations analysis the implications of alternative scenarios of future climate change for the crop supplies, demand for irrigation water and the prospects for food self-sufficiency. Niche markets and specialty kind of products might represent future interesting market opportunities and that a strategy into this direction could be more profitable and efficient to both commercial growers and government. This set of results can be of interest for policy makers to reflect on early adaptation strategies. It is technically possible to cope with forthcoming trends and challenges only by a very proactive and informed attitude. Prospective results can provide useful information to various stakeholders on how to modify the production systems citing on possible socio-economic policy actions. This discussion is enriched with promising avenues for future research. These overall, it is clear that the value-added potentiality of horticultural crops is a dynamic and evolving landscape and not a static one.

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