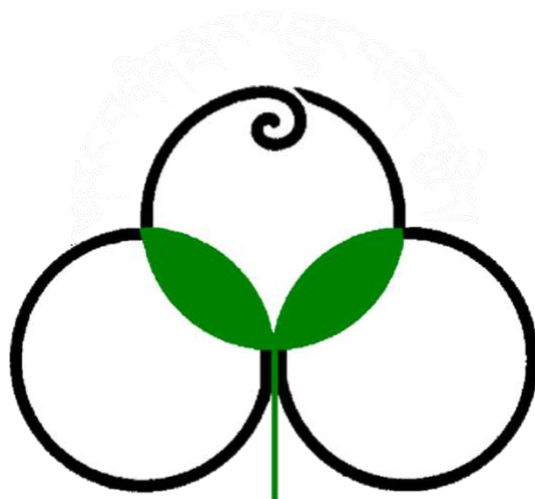


**STRATEGY FOR THE NATIONAL FRUITS AND NUTS
RESEARCH AND DEVELOPMENT**



**Department of Agriculture
Ministry of Agriculture and Livestock
Royal Government of Bhutan**

2023

Authors:

1. Mr. Sangay Dendup, National Fruits and Nuts Program Coordinator (Lead)
2. Mrs. Pema Yangdon, Sr. Horticulture Officer, ARDC-Wengkhar
3. Ms. Ugyen Wangmo, Horticulture Officer, NCOA-Yusipang
4. Ms. Sangay Choden, Horticulture Officer, NSC, DoA
5. Mr. Sangay Dorji, Sr. Horticulture Officer, ARDC-Samtenling

Coordination & Lead:

Mr. Sangay Dendup
Agriculture Production Division
Department of Agriculture

Published by:

Department of Agriculture
Ministry of Agriculture & Livestock
Tel# 02-322228/331316/336462/336186(F)

1. Background

Horticulture industry in Bhutan is undergoing continuous change like anywhere else in the world. This is due to the growing demand of consumers for safe and healthy foods, increased urbanization of societies, the growth in scale and influence of markets, the commercialization of farming system, changes in the availability of labor and priority setting by the government. Horticulture commercialization and enterprise development is one of the important initiatives of the Ministry of Agriculture and Forests in the 13th FY plan period. The commodity-based development approach of the Department is in-line with the objectives and the priorities of the Ministry of Agriculture and Forests. It is also in-line with the Ministry's National Food and Nutrition Security Policy and Department of Agriculture's Horticulture development plan for income generation and poverty alleviation. The strategy is expected to contribute to the overall development of horticulture in terms of commercialization, enhancement of production and quality, generation of income, enhancement of nutritional status of the rural people and alleviation of the unemployment challenges.

The impact oriented and market-based commodity development approach strategy for fruits and nuts is expected to contribute to the overall development of horticulture sector in the country. The strategy will focus on commercializing the potential fruit crops based on potentiality across different agro-ecological zones through two pronged approaches. In the areas with good accessibility to road and market coupled with potential for future expansion, commercialization will be pursued while in the outlying areas, crop diversification will be pursued to ensure food and nutrition security in the country.

2. Broad Objectives

The strategy paper is developed as a living document to pursue vibrant fruits and nuts development initiatives in the country with the following objectives:

- To enhance food and nutritional security through sustainable production of fruits and nuts.
- To encourage and promote market-based production of fruits and nuts.
- To capitalize production of priority commodities in potential production areas.
- To analyse present and future opportunities for fruit and nuts development.
- To improve implementation of plans and programs for vibrant fruits and nuts industry.
- To prepare investment plans and mobilize resources.
- To enhance income generation of the fruit growers
- To create employment opportunities to mitigate rural-urban migration.
- To promote sustainable land use system for a healthy environment

- To encourage horticulture commercialization and enterprise development.
- To produce adequate quantity of local fruits for import substitution

3. Current Scenario

Among more than 26 different fruits and nuts grown across different agro-ecological zones of the country, apple in temperate region and arecanut in sub-tropical region have gained considerable commercial importance apart from citrus. Other fruits constituting a wide assortment of stone fruits, walnuts, kiwi, persimmon, avocado, pears, apricots, peaches, plums etc. are grown on limited scale and have not gained commercial significance. This is because of the lack of committed funds for commercialization of potential fruit crops in the country.

With improved market infrastructure, reliable transportation and improved storage system in place, there is a huge potential of commercializing potential fruit and nut crops in the country.

3.1 Fruits and nuts Export

Out of 18 fruits and nuts traded, apple in the warm temperate region and arecanut and citrus in the sub-tropical region are the main commercial fruit crops with 80% of produce marketed outside the country. However, there is potential of expanding the export list of the horticultural crops in future. While commercialization is focused on market-oriented commodities, other fruits and nuts will be encouraged as backyard orchard for income diversification and food and nutrition security of the rural populace.

3.2 Choice of Commodities

Currently, the choice to grow a particular fruit crop is dependent on many factors. Topping the list is the potentiality of the area, societal expectation/preference of the farmers, accessibility to road and market, scope for product diversification and availability of the area for future expansion.

3.3 Constraints/challenges

Bhutan shares its border with the two most populous countries in the world. They are far ahead of us in terms of area, volume of production and scale of market reach. Therefore, we need to select the horticultural crops for commercialization intelligently. A careful selection of location specific varieties/cultivars and adoption of sustainable production system (Organic/BhutanGAP) is very important to provide us comparative advantage in terms of season and economies of production, capturing niche market and fetching premium market

prices. The science attached to horticulture should respond to many of challenges through research and innovation that seek to gain more efficient methods of crop production, refined post-harvest storage and handling methods, newer and higher value cultivars, demonstration of health benefits, and newer methods of knowledge dissemination.

3.3.1 Production constraints

- Soil and topography
- Low volume of production
- Inadequate quality planting materials
- Unfavourable climatic conditions
- Low access to credit facilities
- Lack of formal linkages with international and regional institute
- No package support for enterprise development
- Poor orchard management
- Absentee owners

3.3.2 Market constraints

- Seasonality
- Low volume and quality
- Scattered production sites
- Inadequate market information
- Limited export market
- Lack of cold chain facilities
- Processing and value addition

3.3.3 Poor coordination

The policy/plans that is formulated at the National commodity level is not always translated into implementation at the local level. Due to differing priorities at the local level, most of the planned activities for production of fruits and nuts receives less attention.

3.3.4 Low investment

There are no donors and projects dedicated purely for fruits and nuts development in the country. The resource allocation from RGoB is very minimal limiting the scope of taking the sector forward. Investment in fruit production is a long term venture providing economic return

only after five to six years, therefore, the sector receives limited policy supports unlike quick crop sectors like vegetables and cereals. Fruit growing is a long-term endeavor, as orchards go through an early unproductive phase lasting for few years, before they begin the positive part of their economic cycle. Therefore, availing appropriate credit facilities and subsidies for tree crop development (no grace period allowed for loan repayment) are some of the challenges faced by this sector.

3.3.5 Lack of crop specific experts

Fruits and nuts is an aggregate of 26 different commodities ranging from sub-tropical to warm temperate region. However, there are no fruit experts in the country to provide specialized advises on crop research and development.

3.3.6 Climate Challenges

Constraints for fruit production under natural environment will worsen when the climate change will occur, leading to multiple stresses. Such condition will lead to increased plant organ respiration and reduce plant water use efficiency with detrimental consequences on biomass production (yield) and product quality.

The climate change is expected to bring 'extreme' weather conditions such as unpredictable events leading to flooding, draught, incidences of pests and diseases and other calamities. These elements must be thought of when coming up with innovations in the fruit research and development sector in the future.

3.4 Opportunities

- Conducive policies and strategies in place
- Availability of annual fruit crops
- New market opportunities
- Greater public awareness
- Availability of vast fallow land
- Demand for organic fruits
- Availability of under-utilized dry lands
- Scope for carbon sequestration

4. Way-forward for Fruits and Nuts Development in Bhutan

4.1 Prioritization of commodities in the 13th Plan.

Twenty six different fruit crops are grown across Bhutan's agro- ecological zones. Among 26 different fruit crops, the Department of Agriculture has prioritized to focus on 10 commodities for commercialization and fruit enterprise development in the 13th plan- 5 fruit crops in the temperate region and 5 in the sub-tropical region. While we focus on commercialization of the selected fruit crops, other potential fruit crops will be encouraged for crop diversification to enhance food and nutrition security. The prioritization is based on the potentiality of the area in terms of elevation, access to road and market, societal choice/preferences of the farmers and availability of adequate area for future expansion. We have also considered the comparative advantages like season and economies of production under our farming system.

In the temperate region, we will focus on apple, persimmon, walnut, kiwi and pear while in the sub-tropical region, our focus will be on arecanut, mango, banana, passion fruit and avocado.

4.2 Prioritization for Dzongkhags

In close consultation with the Dzongkhags, the Department has prioritized fruit crops for commercial production in all the Dzongkhags in the 12th plan. Following are different crops identified and prioritized to enhance income of the rural farmers through commercialization and enterprise development:

Dzongkhag	Prioritized commodity
Haa	Apple
Paro	Apple, walnut, pear, persimmon
Thimphu	Apple, walnut, pear, persimmon
Wangdue	Walnut, pear, persimmon, avocado, mango
Punakha	Persimmon, pear, avocado, walnut
Gasa	Pear, walnut and persimmon
Trongsa	Walnut, Pear, Avocado, mango
Zhemgang	Walnut, Pear, Avocado
Bumthang	Pear, Apple
Mongar	Avocado, persimmon, mango, pear, passionfruit

T/gang	Pear, passion fruit, avocado, persimmon
T/Yangtse	Pear, passion fruit, persimmon
Lhuntse	Pear, passion fruit, persimmon
Chukha	Arecanut, avocado, mango, banana, kiwi
Dagana	Pear, persimmon, passionfruit, banana
Tsirang	Banana, passionfruit, mango, kiwi
Sarpang	Arecanut, mango, banana
S/Jongkhar	Arecanut, passion fruit, mango
P/Gatshel	Passionfruit, walnut, pear, mango
Samtse	Arecanut, banana, mango

4.3 Improving supply and distribution system of quality planting materials to upscale production

The National Seed Centre under the Department of Agriculture is leading agency with both social and commercial mandates. The Centre supported by the registered private nursery growers is responsible for production and supply of quality planting materials on commercial scale. Therefore, the National Seed Centre (NSC) under the Department of Agriculture will spearhead the multiplication and production of adequate quality planting materials for successful implementation of fruit commercialization program in the country. While ARDCs maintain the mother block of released varieties as Gene Bank, NSC will take over the germplasms of the released varieties for multiplication and distribution to the growers.

4.4 Strengthening seed sector for sustainable supply of quality planting materials

Non-availability of adequate quality planting material is one of the biggest challenges for development of fruit sector. There is an increasing demand for fruit seedlings in the country and pressure is expected to increase in the 12th plan. Therefore, we need to strengthen the production capacity of the National Seed Centre and encourage establishment of more private fruit nursery growers to meet the increasing demand. Considering a need for a clear and sustainable mechanism for production and supply of quality planting materials in the country, the sector will focus on establishing more private fruit nursery growers. Such initiative will not only contribute towards sustainable supply of fruit seedlings but also alleviate the unemployment challenges.

4.5 Supporting access to customized credit facilities and available subsidies

The nature of sector being a long term investment venture with expected returns only after 5 years or more from the establishment period, it is critical to have a grace period tailor made for fruit sector. A grafted seedling would usually take 3-5 years before it starts bearing fruits and the non-grafted seedlings would take minimum of 7 years. Till date, there have not been credit facilities taking this aspect into account and no grace period to benefit those clients who wants to venture into the fruit production. For successful implementation of fruit commercialization program, credit facilities with grace period of at least three years will be made available in close coordination with the relevant financial institutes. In addition, we will also look into providing subsidies in terms of inputs, land development and infrastructures like electric fencing and irrigation to bring down the upfront cost of establishing an orchard.

4.6 Commercializing fruit production for income generation

The yearly import status of fruits and nuts clearly indicates the urgency and the need to commercialize fruit crops not only for import substitution but also for air freight markets to generate revenue. There is prospect of transforming farming systems and rural livelihoods of smallholder farmers through commercialization of potential fruit crops. The move for commercialization will ensure realization of social benefits through enhancing food and nutrition security, improvement of rural livelihood, poverty reduction and creation of employment opportunities apart from obvious economic and environmental benefits.

Incentivizing private sector investment will play pivotal role in successful implementation of fruit commercialization programs. Some of the drivers leading to increased investments by the private sector is creating niche market for the produces and commitment for subsidies by the government through policy interventions.

4.7 Promoting enterprise development in fruit industry for livelihood improvement

Fruit industry provides high quality food and nutrition to the population, generate cash income for the growers and creates employment opportunities for the youth. Recently, the university graduates and unemployed youths started venturing in to fruit enterprises like processing, fruit nurseries and commercial fruit farming as a viable career option. The enterprises make significant contribution to the socio-economic life of the country by way of supporting people to earn money, make contribution to family incomes, and supply basic goods and services for local consumption. The sector will encourage both private and government investments for

development of more enterprises to create employment opportunities and also to contribute towards economic well-being of the country.

4.8 Producing fruit crops for diversification

Crop diversification is an important stress-relieving option for economic growth of the farming community. Diversification and inclusion of new varieties can be one of the important technologies in increasing the farmers' income to a certain extent. The aim of crop diversification is to increase crop portfolio to ensure that farmers are not over dependent on a single crop to generate their income. When farmers go for single crop type they are exposed to high risks in the event of unforeseen climate events that could severely impact their production, such as emergence of pests and the sudden onset of frost or drought.

Crop diversification is also necessary to stabilize production and price, and for continuous supply of horticultural produces. Commodities like peach, plum, chestnut, cherry and strawberry for temperate region and litchi, pineapple, pomegranate and dragon fruits for sub-tropical region will be supported for crop diversification..

4.9 Encouraging high density fruit cultivation for increased return from per unit area

With less scope for area expansion, there is need to gear towards high density fruit cultivation to make the best use of vertical and horizontal space per unit time. This will help to harness maximum possible return per unit of input and resources. The high yielding dwarf variety fruits will be promoted as high density orchards with improved management practices. The ARDCs under the Department of Agriculture will play pivotal role in dissemination of the high density fruit orchard development technologies.

4.10 Showcasing technologies through establishment of demo-orchards

Through our ARDCs, different demonstration orchards with efficient water management technologies, soil and nutrient management and integrated pest and disease management will be established at strategic locations to show case the improved methods of fruit production. Scientific canopy management, multi-tier cropping system, proper fruit training and development of high density fruit orchards will be encouraged through establishment of demo-orchards in potential Dzongkhags.

4.11 Improving land races through top working

There are different local fruit trees grown across the country by the farmers in their backyard orchards for nutrition and religious offerings. These trees can be improved in terms of quality as well as yield through top-working with the improved varieties. The sector will take initiatives of improving local races through top working with the improved and high yielding varieties. The identified potential local fruit crops for improvement are hard shell walnut, local pear, persimmon, plum and peach. The top- working will be carried out across the country in collaboration with different technical agencies under DOA. In the east, ARDC-Wengkhar will lead the implementation of top-working initiatives while in the west, ARDC-Yusipang and Bajo will take the lead. In the southern region, ARDC-Bhur's role will come into play.

4.12 Rehabilitating and rejuvenating fruit trees to enhance production

Most of the orchards in apple growing areas are old and declining. With increasing age of any fruit trees, the economic life will decrease. There is need to support the replanting of old apple orchards especially in the remote Gewogs of apple growing areas.

To achieve this objective, fruits and nuts programme will provide supports in terms of inputs like seeds and seedlings and provide technical supports. The sector will also encourage rejuvenation of the old fruit trees. Similar activities will be implemented in other fruit crops.

4.13 Promoting improved trellising systems

Kiwi and passion fruit production is gaining commercial importance with growing number of agro- industries and small scale processing units. Up-scaling production of passionfruit and kiwi in the potential Dzongkhags will contribute not only towards improving the rural livelihood but also towards meeting the raw material requirement of the agro-processing industries. Considering economic importance of the above two crops, the improved methods of trellising will be encouraged in potential Dzongkhags.

4.14 Promotion of protected cultivation of fruits

With technology advancement in agriculture, various types of protected cultivation practices suitable for a specific type of agro- climatic zone has emerged. Protected cultivation is a specialized form of agriculture. The purpose of protected cultivation is to grow crops by altering the natural environment of the crop so that the harvest period can be extended. It increases the yield, improve the quality and stability of production and make commodities available when there is no outdoor production. Various kinds of fruits, such as strawberry,

grape, peach, nectarine, flat peach, apricot, cherry, plum and citrus have proved to be successful for protected cultivation in other countries. With such technologies proven elsewhere, the sector will also encourage and promote protected cultivation in Bhutan.

4.15 Encouraging water management activities to enhance production

Irrigation play a very important role in production of quality fruit crops. Currently, most of the orchards in Bhutan are rain-fed. We need to encourage technologies of efficient water management and smart irrigation systems where ever possible to improve quality as well production. Use of sprinklers, drip irrigations and smart irrigation systems in orchards will be promoted and implemented by the sector.

4.16 Integrated pests and disease management

The commercialization of fruit production if not monitored properly can result in the use of chemical pesticide leading to environmental impacts. However, necessary attention will be given to the adoption of environment- friendly measures like IPM and Integrated Disease Management to ensure that the development does not take place at the cost of the health of the environment. Technologies like disease forecasting mechanisms will be made available. Concerted effort will be put in place to create awareness and educate the growers on integrated pests and diseases management. NPPC will take lead role in conducting awareness campaigns in close association with other relevant agencies.

4.17 Integrated Plant Nutrient Management

Integrated nutrient management is a tool which can offer good options and economic choices to supply plants with sufficient amounts of macro and micronutrients. It can reduce the doses of chemical fertilizers, creates favorable soil conditions, eliminates environmental constraints and safeguards soil nutrient balance in the long run to an optimum level for sustaining the desired crop productivity. Therefore, the sector will focus on integrated nutrient management in crop production instead of relying solely on chemical inputs.

4.18 Supporting processing and value addition

The Department will support and encourage processing and value addition of fruits through supporting enterprise development and providing necessary technical supports. The National Postharvest Centre under the Department will conduct research on processing and value addition of fruits and develop technologies. The product development technologies will be

handed over to the interested groups and individuals for commercialization. The sector will promote small to medium scale processing units either at village level/Gewog level in major commercial fruit growing areas.

4.19 Storage facilities to reduce post-harvest losses

At present, we have very limited storage facilities for horticultural produces. The improved methods of grading, packaging and transportation is another challenge faced by the farmers. Losses due to postharvest in Bhutan is one of the highest in the region. There is need to put in place the facilities of storage system at strategic locations to store fruits during peak production season. The sector will continue the promotion of zero energy cool chambers and improved storage facilities will be established in major fruit growing areas.

4.20 Implementing contract farming system

In an age of market liberalization, there is a danger of small-scale farmers not being able to fully participate in the market economy. In many countries such farmers could become marginalized as larger farms become increasingly necessary for a profitable operation. A consequence of this will be a continuation of the drift of populations to urban areas that is being witnessed almost everywhere. However, contract farming provide opportunity for the small farmers to farm in a commercial manner committing to provide specific commodities in quantity and at quality standards determined by the purchaser and a commitment on the part of the purchaser to support farmer's production and to purchase the commodity. Such arrangements should be promoted through linking the producers with agro-processing industries like Bhutan Agro-industries Ltd.

4.21 Enhancing competence of farmers, researchers and extension officers

For successful implementation of any development activities, it is imperative for the people involved to possess adequate knowledge, skills and abilities. Therefore, it is essential for the sector to provide need-based competency development opportunities to enhance service delivery in the world of changing working environment and technologies.

5. Way Forward and research priorities for fruits and nuts program

Fruit research system in Bhutan is more of adaptive in nature. Many fruit varieties are being released for cultivation both on commercial scale and in backyard orchards based on the suitability to diverse agro-ecological conditions. The diverse agro-ecological scenario offers

Bhutan an opportunity to produce different varieties of fruit crops. However, with globalization and changing world climate, the research on fruits should focus on characterization and conservation of climate resilient indigenous fruit crops, genetic resources and their utilization; sustainable plant protection; efficient use of primary resources; enabling technologies like robotics, precision horticulture and protected cultivation systems. These research areas need continuous activity to generate fully effective results that can be implemented for robust development of fruit industry.

5.1 Characterization and conservation of climate resilient indigenous fruit crops

With rapid climate change in action, it is important for a country like Bhutan to identify and conserve local germplasms/local races. These fruit varieties has gradually developed resilience to climate change and would ensure diversity of crops in the face of changing world climate. Therefore, the sector will look into characterization and conservation of indigenous fruit germplasms.

5.2 Research on robotization and precision horticulture

Horticultural production systems are intensive and need to make number of management choices that impact the profitability of the operation. Therefore, robotization and precision farming is an important research component in horticulture to enhance decision making processes with reduced manpower.

5.2 Integrated nutrient management

Research on integrated nutrient management should focus on i) identifying the causes of soil sickness and developing innovative solutions for soil nutrient management, ii) reduce the need for chemical fumigants and fungicides to enhance sustainable production system. The adoption of rational, innovative and sustainable cultivation technologies is required to enhance the soil's ability to sustain plant growth and health by triggering beneficial functioning of the natural microbiome.

5.3 Postharvest research for product diversification

National Post Harvest centre will conduct research on new product development for product diversification. This will contribute towards minimizing postharvest losses in fruits. The centre will also work in close collaboration with ARDCs and Dzongkhags to scale-up and commercialize enterprise development in the country for import substitution.

5.4 Germplasm maintenance

All the research and development centres will maintain the germplasms of non-released fruit varieties and foundation block germplasms of released varieties.

5.5 Genetic resources and their utilization

Utilization of appropriate plant material is key for successful and sustainable fruit production. The sector will take full advantage of doing research on unexploited genetic resources that may provide potential solution to increased environmental, economic and social sustainability issues.

5.8 Sustainable plant protection

Public concern over the effects of pesticide utilization on human health and the environment has led to continuous changes in pest and disease management. This has resulted in the development of Integrated Pest Management.

A synergistic integration of IPM and research on Innovative IPM practices with lower environmental impact, reduced chemical residues and enhanced sustainability must be pursued to promote chemical free fruit cultivation.

5.9 Protected cultivation

Although field production systems are still the most important part of the fruit production system, greenhouse production is gaining importance elsewhere in the world. Research also need to focus on innovative systems for crop production, energy management and real-time dynamic responses of plants in greenhouses to enhance crop production.

6. National Fruits and Nuts Governance

The Department will appoint a National Fruits and Nuts Coordinator placed in ARDC who will conduct research on fruits and nuts. A coordinator will be represented by a Focal Officer in the Department who will mobilize resources, plan, coordinate and facilitate the overall research and development activities of the national fruits and nuts program.

While ARDC-Wengkharr will lead the national research and development programs of fruits and nuts in the country, ARDC-Samtenling will lead the research and development initiatives of sub-tropical fruits and nuts.