

Distribution of Underutilized Fruit in Nepal: Strategies for Conservation and Utilization

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Abstract

Diverse genetic resources-base of fruits in Nepal is contributed by wild, indigenous, and underutilized fruit genetic resources. These wild and underutilized fruits harvested from the forests and farmers' marginal lands can be seen in many local markets even today. Many of these underutilized fruits perform better than exotic species. Fruits such as kafal, lapsi, amla, aiselu etc. harvested from forest are sold in local markets which generate a considerable amount of income to the farmers. Fruits like pummelo, citron are used during special rituals such as for Bhaitika in Tihar and are sold during those festivals. Likewise, bel is used by Newari community during the bel bibah of their daughters. All these fruit germplasms are being maintained in field since other methods have not yet been developed. A National Genetic Resource Centre including underutilized fruit germplasms repository should be established to utilize them. There should be provisions of freeze preservation and cryopreservation, in vitro and field gene banks for conservation. Development of trade related aspect of intellectual property rights system to protect these indigenous and underutilized fruits should be implemented and strengthened by public institution in the country. In situ evaluation of these genotypes using a common protocol could be a worth at initial step whether they are under public or private description.

Keywords: Fruit diversity, conservation, utilization, gene bank, indigenous

Introduction

Nepal lies in South Asia, and is surrounded by China on the north and India on the south, east and west. It is 870 km in length by 130 km in width and its total area is 1,47,181 sq. km. In latitude, it ranges from 26°22' to 30°27' N and in longitude from 80°04' to 88°12' E. The altitude of its terrain ranges from 60 m above mean sea level (msl) in the South-East (Kechna Kal,

Jhapa) to 8,848 m (Mt. Everest) in the North. Nepal experiences three distinct seasons-hot and dry from March to mid-June, wet summer from mid-June to September, and dry and cold season from October to February. The unique agro-ecological zones favored by altitudes, topography and aspect within the country offer an immense opportunity for growing different fruit species. The total cultivated area is around 3 million hectares, of which around

4.79% is covered by fruits. The contribution of the horticulture sector amounts to 15% of Agriculture GDP, of which almost half is constituted by fruits (Atreya and Manandhar, 2016). Owing to its greatly varied geographical and climatic conditions, Nepal accommodates wider biodiversity of fruit species. There are 45 species belonging to 37 genera of wild edible fruits (Kaini, 1994). Seasonal fruits harvested from the forests can be seen in many local markets even today. Southern Terai region is suitable for cultivation of tropical fruits while Mid-hills and High-hills towards north are suitable for sub-tropical to warm and cold temperate fruit and nut species. In Nepal, wild plants of mandarin is found in Mangtewa and Sankhuwasabha, custard apple in Dhankuta in the east while amla (Indian gooseberry) plants in Jaspire, way to Indrawati, wild citron in the Mid-hills of Central region and wild olive plants are found in Dolpa, Humla and Kalikot, the western part of Nepal (Pradhan et al., 2016).

More than 100 indigenous fruit and nut species have been reported in Nepal. Fruits such as kafal (*Myrica esculenta* Buch.-Ham. ex. D. Don), lapsi (Nepalese hog plum, *Choerospondias axillaries* Roxb. B.L. Burt and A.W. Hill), amla (*Emblca officinalis* Gaertn) harvested from forest are sold in the local markets, which generate a considerable amount of income to the vulnerable communities by selling them at a good price. Underutilized fruits have considerable economic values in Nepalese society due to their nutritional, medicinal and cultural values. Some fruits like pummelo (*Citrus maxima* Merr.), citron (*Citrus medica* L.) are used enormously during festival times, e.g., Tihar (festival of lights). Bel (*Wood apple*, *Aegle marmelos* L. Correa) is used by Newari community during Bel Bibah, a special type of marriage of the pre-adolescent Newari girls with bel (Kaini et al., 2016).

Several indigenous fruit plants and their wild relatives such as mayal or mel (*Pyrus pashia* Linnaeus), jyaamir (Rough lemon, *Citrus jambhiri* Lush.) and local olive have

been used as rootstocks for grafting scions of high-yielding varieties. Similarly, the local peach, pear, plum, citron, nibuwa (Hill lemon), pummelo, carrambolla (star fruit), wild siudi fruit, kalijamuno, chutro, etc. are harvested from either own farm or from forest area and sold in the local markets. These fruit species and their wild relatives can be used in breeding programs to improve fruit varieties to suit the local environment (Regmi and Shrestha, 2005). But documentation, characterization, conservation and evaluation of indigenous fruit species are still lacking.

Materials and methods

This study was carried out by using secondary data from previous publications. Survey was carried out also used to update and cross validate the inventory lists available in the published annual report, journal articles and books. Literature on Conservation and Utilization of Agricultural Plant Genetic Resources in Nepal (CUAPGR) has also been reviewed and updated the findings of Thapa et al (2017), Shrestha et al (2017) and Karki et al (2017).

Results and discussion

Underutilized fruit genetic resources:

Nepal is rich in wild and local fruit germplasms. It is also an original place of many species of fruits. Many of the indigenous fruit species are performing as good as or better than exotic varieties, e.g., 'pharping' (asian sand pear), junar (sweet orange), Dhankuta local mandarin, 'kagati' (acid lime) are superior compared to exotic varieties. The homestead gardens scattered all over the country and the palace gardens of Ranas and elites around the Kathmandu valley are the good sources of variability for fruit germplasms. Moreover, many private farms and nurseries have introduced and maintained exotic fruit varieties in their personal interest. Besides the traditional and exotic cultivars, there are some fruits which are traditionally grown and available in wildly

form in Nepal, e.g., amla (*Emblca officinalis*), pahelo, kalo and rato ainselu (*Rhubus ellipticus*, *R. foliolosus* and *R. acuminatus*, respectively), bel (*Aegle marmelos*), bhogate (*Citrus grandis*), bimiro (*Citrus medica*), chaksi (*Citrus limettoides*), chiuri (*Basia buttyacea*), chanle katus (*Castanopsis indica*), imali (*Tamarindus indica*), jamun (*Syzygium cumini*), wild apple (*Malus baccata*), jyamir (*Citrus jambhiri*), kafal (*Myrica esculanta*), kimbu (*Morus indica*), lapsi (Nepalese Hug Plum; *Choerospondias axillaris*), edimayal or sano mayal (*Pyrus pashia*), nemaro (*Ficus carica*), tindu (*Diospyrus malbarica*), wild species of olive (*Olea ferruginea* and *O. glandulifera*), theki phal (wild kiwifruit, *Actinidia callosa*), etc. (Thapa et al., 2017). There is an ample scope of utilization of existing wild relatives and underutilized fruits through

evaluation and selection breeding for livelihood improvement of farmers in Nepal.

Distribution of local, indigenous, wild relatives and underutilized fruits:

There are many temperate, sub-tropical and tropical wild fruit relatives having more than one species are *Annona*, *Citrus grandis* (L.) Osbeck, *Mangifera*, *Musa*, *Aegle* and *Rhus* (satibayar) as reported by Gautam (2013). Recently, Upreti et al (2012) made an inventory of wild edible fruit crops of Nepal from Makawanpur, Tanahun, Dang, Bardia and Kailali districts, and recorded 44 wild fruit species. These wild fruits are neither conserved nor studied systematically. Some wild relatives of kiwifruits are found in Nepal which is source of rootstock for imported kiwi sapling production and their role in abiotic and biotic stress tolerance has yet to be studied.

Table 1a: Distribution of underutilized temperate fruits

S.N.	Local Name	Common Name	Scientific Name	Distribution
1.	Ainselu	Himalayan raspberry	<i>Rhubus ellipticus</i> Sm.(pahenlo ainselu) <i>R. foliolosus</i> D. Don.(kalo ainselu) <i>R. acuminatus</i> Sm. (rato ainselu)	Mid-hill region between 700—2,000 masl
2.	Alubakhara	Plum	<i>Prunus salicina</i> Lindl.	Mid- to High-hills
3.	Bhuin ainselu	Strawberry	<i>Duchesnea indica</i> Syn. <i>Fragaria indica</i>	Throughout High-hills
4.	Dale chuk	Seabuckthorn	<i>Hippophae salicifolia</i> D. Don	High-hills of Mustang and Dolpa
5.	Dhalne katus	Wild chestnut	<i>Castanopsis indica</i>	Throughout Mid-hills
6.	Jaitoon	Olive	<i>Olea ferruginea</i> Royle <i>O. cuspidate</i> Wall. ex. G. Don <i>O. glandulifera</i> Wall. ex. G. Don	High-hills of Mid- and Far-western regions
7.	Jangali aru	Peach	<i>Prunus prostrata</i> Labill. Hook. f.	Above 3000 m in Western region
8.	Jangali aru	Peach	<i>P. jaquimontii</i> Hook. f.	Cold dry region of Mustang and Dolpa
9.	Jangali naspati	Pear	<i>Pyrus serotina</i> Rend.	Mid-hill region between 700-2000 masl
10.	Jangali syau	Apple	<i>Malus baccata</i> (L.) Borkh. <i>M. pumila</i> Miller. <i>M. sikkimensis</i> (Wenz.) Koehne	Western High-hills to Eastern High-hills

11.	Kafal	Bay-berry	<i>Myrica esculenta</i>	Hilly regions
12.	Khanayo	Ficus	<i>Ficus semicordata</i>	Low to Mid-hills
13.	Khurpani	Apricot	<i>P. armeniaca</i> L.	High-hills
14.	Lapsi	Hog plum	<i>Choerospondias axillaris</i> Roxb.	Mid- to High-hills
15.	Nemaro	Common fig	<i>Ficus carica</i> L.	Throughout Mid-hills
16.	Paiyun	Nepalese cherry tree	<i>P. cerasoides</i> D. Don. <i>P. cornuta</i> (Wall. ex Royle) Steud. <i>P. nepalensis</i> (Ser.) Steud.	Mid to high hills
17.	Patle katus		<i>Castanopsis hystrix</i> Miq	Throughout Mid-hills
18.	Sano mayal or wild pear	Pear	<i>Pyrus pashia</i>	Mid-hill region between 700—2,000 masl
19.	Theki phal	Kiwifruit	<i>Actinidia callosa</i> Lindl.	Sub-Himalayan tract from Kathmandu eastward

Source: Thapa et al., 2017; Kaini, 1999

Table 1b: Distribution of underutilized sub-tropical fruits

S.N.	Local Name	Common Name	Scientific Name	Distribution
1.	Amla	Indian Gooseberry	<i>Emblica officinalis</i> Gaertn.	Terai to Low-hills
2.	Anar	Pomegranate	<i>Punica granatum</i>	In a vast tract of hill slopes
3.	Bhogate	Pummelo	<i>Citrus grandis</i> Osbeck	Low to Mid-hills
4.	Bimiro	Citron	<i>C. medica</i>	Eastern Mid-hills
5.	Chaksi	Sweet lime	<i>C. limettioides</i>	Mid-hills
6.	Chiuri	Butter tree	<i>Bassia butyracea</i> Roxb.	Mid-hills
7.	Chutro	Barberry	<i>Berberi saristata</i> Roxb. ex. DC.	Rarely used as fresh fruit
8.	Kali Jyamir	Rough lemon	<i>C. junos</i> Tanaka	Eastern Mid-hills
9.	Kathe Jyamir	Rough lemon	<i>C. jambhiri</i>	Eastern Mid-hills
10.	Kimbu	Mulberry black	<i>Morus alba</i> L. <i>M. nigra</i> L. <i>M. rubra</i> L.	Throughout Mid-hills
11.	Nibuwa	Lemon	<i>Citrus lemon</i> Burm	Low to High-hills
12.	Sankhatro	Grape fruit	<i>C. paradise</i>	Low to High-hills
13.	Sati bayar	Nepali sumac	<i>Rhus parviflora</i> Roxb.	Terai to Low-hills

Source: Thapa et al., 2017; Kaini, 1999

Table 1c: Distribution of underutilized tropical fruits

S.N.	Local Name	Common Name	Scientific Name	Distribution
1.	Aule Bayar	Indian Plum	<i>Zygyphus mauritiana</i> Lam	Terai to Mid-hills
2.	Badhar	Monkey jack	<i>Artocarpus lakoocha</i>	Low to Mid-hills
3.	Bel	Wood apple	<i>Aegle marmelos</i> L. Correa	Terai to Low-hills
4.	Bhalayo	Marking Nut tree	<i>Cotinus coggyria</i> Scop	Terai to Low-hills
5.	Gulab-jamun	Rose apple	<i>Syzygium jambos</i>	Terai to Low-hills
6.	Imali	Tamarind	<i>Tamarindus indica</i> L.	Terai to Low-hills
7.	Jamun		<i>Syzygium cumini</i> L. Swingle	Terai to Low-hills
8.	Jamun	Black plum	<i>Eugenia jambolana</i>	Terari region
9.	Jangali aanp	Mango	<i>Mangifera sylvatica</i> Roxb.ex. Roxb	Central inner terai region
10.	Jangali kera	Wild banana	<i>Musa acuminata</i> Colla.	Terai region
11.	Katahar	Jack fruit	<i>Artrocrappus heterophyllus</i>	Terai to Low-hills
12.	Ram phal or sarifa	Sugar apple or Custard apple	<i>Annona squamosal</i>	Terai to Low-hills
13.	Tindu		<i>Diospyros malabarica</i> (Desr.) Kostel.	Foot hills

Source: Thapa et al., 2017; Kaini, 1999

Utilization of underutilized fruits for livelihood improvement:

In the context of predominant subsistence agriculture in the country, very limited fruit trees are generally maintained at home gardens. Utilization of intra-species diversity is relatively higher than that of inter-species diversity. However, utilization of inter-specific diversity is experienced in big home gardens maintained by well-off families of Terai where diversity of mango is very prominent. Despite long history of introduction and evaluation of genotypes in different agro-ecological regions, all the elite genotypes were not fully adopted by the farmers. The pace of commercialization of fruit farming is very slow because of long gestation period and high initial investment. Demand of diverse genotypes generates from the commercial growers for niche markets or supplies the commodity in extended period of time. In poor presence of commercial ventures, demand of diversified fruit varieties is very weak. Moreover,

public institutions are not offering options to the users for the utilization of elite genotypes at larger scale. In this scenario, utilization of fruit genotypes primarily depends on supply side. Saplings whatsoever produced in the public farms are distributed to the farmers through public sector extension services. Farmer to farmer exchange system is still prevalent, but seedlings or seed are the main source of propagation. Hence, utilization of elite local genotypes is still poor.

Collection and consumption of wild fruits is common in agrarian setting (Table 2), but trading of wild species is coming up in many places. For example, trading of bay berry on the Dadeldhura–Dhangadhi Highway is estimated to be Rs. 400 thousand per annum. A wine industry named Tashi and Rizal, established in the eastern hills is utilizing wild fruits (Himalayan raspberry and barberry) for wine making (Thapa et al., 2017).

Table 2. Potential use of underutilized fruits

S.N.	Nepali Name	English Name	Scientific Name	Uses	Fruiting Time
1.	Ainselu (Pahenlo)	Yellow raspberry	<i>Rhubus ellipticus</i> Smith.	Fresh, wine	May—Jun
2.	Ainselu (Kalo)	Black raspberry	<i>R. foliolosus</i> . Don	Fresh, wine, candy	May—Jun
3.	Ainselu (Nilo)	Blue raspberry	<i>Vaccinium uliginosum</i> Linn.	Fresh, puree, juice	May—Jun
4.	Ainselu (Rato)	Ceylone raspberry	<i>R. acuminatus</i> Smith.	Fresh, sarbat/juice	May—Jun
5.	Amba	Guava	<i>Psiudium guajava</i>	Jam/jelly, juice, candies	Aug—Sep
6.	Amla	Indian gooseberry	<i>Emblca officinalis</i> Gaerth.	Fresh, Murabba, sauces, pickles, hair-oil, Chyawanprash	Dec—Mar
7.	Aaru	Peach	<i>Prunus persica</i>	Fresh, dried	Sep—Oct
8.	Bel	Wood apple or Bengal quince	<i>Aegle marmelos</i> (L.) Correa	Fresh, sarbat, laxative, squash, richest source of riboflavin	May—Jun
9.	Bayar	Chinese date or Indian plum	<i>Zigyphus mauritiana</i> Lamk. <i>Z. incurva</i> Roxb. <i>Z. jujube</i>	Fresh	Dec—Jan
10.	Bhogate	Pummelo	<i>Citrus grandis</i> (Linn.) Osbeck.	Fresh	Sep—Oct
11.	Bimiro	Citron	<i>C. medica</i> Linn.	Fresh	Sep—Dec
12.	Chaksi	Sweet lime	<i>C. limetoides</i> Tanaka	Fresh, juice, fragrance	Oct—Dec
13.	Chiuri	Butter tree	<i>Bassia butyracea</i> or <i>Aesandra butyracea</i> Roxb.	Vegetable fat	Jun—Aug
14.	Chutro	Nepalese barberry	<i>Berberis aristata</i> Roxb. ex. DC.	Wine	May—Jun
15.	Dakha Dana	Black Currant	<i>Ribis nigrum</i> L.	Jam, jelly, cider	May—Jun
16.	Dale Chuk	Seabuckthorn	<i>Hippophae salicifolia</i> D.Don	Concentrate (chuk), squash, jam, cough syrup, wine	Jul—Sep
17.	Haluwabed	Persimmon	<i>Diospyros virginiana</i>	Fresh, dried-products	Oct—Nov

S.N.	Nepali Name	English Name	Scientific Name	Uses	Fruiting Time
18.	Imali	Tamarind	<i>Tamarindus indica</i> L.	Souring agent, ingredient	Apr—Jun
19.	Jamun (Kalo)	Black plum/ Java plum / Jambol	<i>Eugenia jambolana</i> Lamk. <i>Syzygium cumunii</i> L. Skeels	Fresh, jam/jelly, squash, pickles, juice/wine	Jun—Aug
20.	Kafal	Bay berry/Box myrtle	<i>Myrica esculenta</i> Buch.-Ham.ex D.Don.	Fresh, sarbat, tanning/dyeing	May—Jun
21.	Kali jyamir or Kathe jyamir	Rough lemon	<i>Citrus junos</i> Tanaka	Juice, chuk (concentrate)	May—Jun
22.	Katush	Nepali Chestnut	<i>Castanopsis indica</i>	Dry-nuts	Aug—Nov
23.	Kera (jangali)	Wild banana	<i>Musa acuminata</i> Colla.	Rarely used as fresh fruit	
24.	Khanayo	Ficus	<i>Ficus semicordata</i> BuchHam(F. <i>cunia</i> Ham.)	Fresh	
25.	Khurpani	Apricot	<i>Prunus armeniaca</i> Linn.	Fresh, dried, jam	Jul—Aug
26.	Kimbu	Mulberry black	<i>Morus alba</i>	Pies, tarts, wines	Apr—Jun
27.	Kusum	Ceylon oak	<i>Schleichera oleosa</i> (Lour.) Merr.	Oil extraction	
28.	Lapsi	Nepalese hog plum	<i>Choerospondias axillaris</i> Roxb.	Pickles, candy, dry-powder, fruit leather	Sep—Dec
29.	Mayal	Wild pear	<i>Pyrus pashia</i>	Alcohol beverage	Nov—Dec
30.	Nimaro or Anjir	Common fig	<i>Ficus carica</i> Linn.	Dried fruit	
31.	Ram phal or Sarifa	Sugar apple/ Custard apple	<i>Annona squamosa</i> Linn. <i>Annona reticulate</i>	Fresh	Aug—Sep
32.	Rukh katahar	Jackfruit	<i>Artocarpus heterophyllus</i>	Fresh, pulp used as dessert	Dec—Jul
33.	Sankhatro	Grapefruit	<i>Citrus paradisica</i> Macf.	Processed products	
34.	Sati bayar	Nepalese sumac	<i>Rhus parviflora</i> Roxb.	Dry	Dec—Apr

Source: Thapa et al. 2017; Upreti et al. 2012; Shakya, D.B. 2002

Existing conservation practices:

Nepal Agricultural Research Council (NARC) is the main institution involved for conservation of underutilized and wild fruits and managing agro-biodiversity through commodity programs and National Agriculture Genetic Resources Center (NAGRC). However, large numbers of germplasms are conserved in government farms under DOA and private farms. National botanical gardens, public and private farms, field gene-banks and horticultural research and development centers have conserved many underutilized fruit crops. The underutilized fruits are conserved in three different ways in Nepal are as follows.

On-farm conservation: It is a dynamic conservation of traditional and locally adopted varieties and landraces in farming community (Joshi et al., 2013). The continuous cultivation and management of a diverse set of populations by farmers in the agro-ecosystems is the technique of on-farm conservation.

In situ conservation: It is the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings (Collins and Hawthorn, 1999; FAO 2009). Growing fruit trees in home gardens has been practiced in Nepal since time immemorial. Most of the fruits are grown in the backyard or in the homestead garden for their specific usage. Public and community orchards in temple compound, in Guthi (trust) land and areas designated for pilgrimages also harbor local fruits. *Chepangs* (one of the most backward indigenous groups of people) are known for their immense knowledge on forestry products, and collection and preparation methods. They have special relationship with the chiuri trees as they have custom of giving a chiuri tree as dowry to their daughters during marriage. Hence, it is regarded as a private resource. Chiuri is a source of livelihood to this community (Karki et al., 2017). It is conserved by *Chepang* community in Chitwan, Dhading, Gorkha, Makawanpur and Tanahun districts.

People conserve minor and underutilized fruit trees in their grassland and terraces as well. People grow various fruit species in their home gardens, hedges and curtilages. Indigenous fruits like amla, badahar, bel, kafal, katus (local chestnut), and lapsi are selectively allowed to grow in the public and community forests, along the river banks and in the farmer's grasslands. It is also grown in private home gardens, hedges and bunds of upland fields for fodder, fire wood, medicinal use and timber. Wild fruit trees are also protected inside botanical gardens, national parks, community forests and protected areas. *Chepang* communities conserve chiuri (Aryal et al. 2009). Cultivated underutilized fruit species are conserved in homestead gardens, in community and public places around temples as well as in private orchards.

Ex situ conservation: All the fruit germplasms are being maintained in field since other methods have not yet been developed. Due to unethical use and absence of appropriate conservation mechanisms, genetic erosion of natural resources is occurring at an alarming rate. Therefore, NARC and the farms under the DOA has been starting collection and maintenance of these germplasms. NARC has started to maintain germplasms of the APGRs including underutilized and endangered fruit species at its each station and centers since 2016 AD. Such type of field gene banks will help to preserve for future utilization in fruit breeding.

Conservation of underutilized fruits for livelihood improvement:

Genetic resources of fruits of many species are found conserved in many private orchards, home gardens and public areas in Nepal (Subedi et al., 2005), e.g., parks, public gardens, temple areas and schools. They are good examples of in situ and on-farm conservation but record of such resources and systematic studies for future utilization of such vast number of resources are lacking and proper attention need to be given by all research and development actors.

Home gardens and orchards of old Rana palace

and custodian farmers are also reservoirs of fruit tree biodiversity (Kumar and Nair 2006; Pudasaini et al., 2013). Sthapit et al. (2015) reported that both the term and concept of 'custodian farmer' are relatively new in the field of in situ and on-farm conservation of fruit tree biodiversity. Custodian farmers are defined as those farmers who actively maintain, adapt and disseminate agricultural biodiversity and related knowledge over time and space at farm and community-levels, and are recognized by their community members for their efforts (Sthapit et al., 2013). The important role that custodian farmers play in conservation, innovation and development is often underestimated, undervalued and unrecognized. Another low-cost, efficient strategy to strengthen community biodiversity management is to work with custodian farmers (Sthapit et al., 2013) to identify elite materials, which are the best trees (plus trees) available in the community, to characterize and evaluate them and to further multiply them for community benefits. In the last five years, 95 elite varieties of *Mangifera*, 32 of *Citrus*, 5 of *Garcinia* and 2 of *Nephelium* were identified; characterized and documented using farmer fruit tree catalogues from South East Asian countries. Of these, a total of 75 farmer varieties of *Mangifera*, 16 of *Citrus*, 5 varieties of *Garcinia*, and 2 of *Nephelium* were registered by the respective competent authority of the government (Sthapit et al., 2016). These elite farmer materials are potentially valuable natural assets developed by farmer innovation that help for better income and livelihoods of farmers. It is a challenge to bring these issues in mainstream of development and recognize the contribution by custodian farmers, which is exacerbated by their lack of links to mainstream research and development institutes or networks. Surprisingly, there has been no attempt by national plant genetic resources programs or conservation agencies to systematically identify or locate custodians of fruit tree diversity, but there is greater scope for way forward.

Strategies for conservation and utilization of underutilized fruits

Different strategic plans have been developed for the overall development of fruit sub-sector in Nepal (FDD, 2017; Shrestha et al., 2017). The plans, policies and projects developed and implemented so far are mentioned below:

- In 1950 AD, 13 horticulture farms/stations were established in different agro-ecological zones of Nepal with technical co-operation of the Indian Cooperative Mission (ICM).
- Celebration of the "Agriculture Year, 1975" brought a paradigm shift in horticulture sapling production. Private nurseries were established all over the country to produce fruit saplings locally. However, to regulate the quality standards of saplings, nursery act and regulations are still lacking, and fruit saplings are produced and marketed on ad-hoc basis.
- Japan International Cooperation Agency (JICA) supported Horticulture Development Project (HDP, 1985) was commenced with its project office at Horticulture Center, Kirtipur. This project promoted pear, persimmon and chest nut in Kathmandu, Bhaktapur and Lalitpur and sweet orange in Sindhuli and Ramechhap districts.
- "One village one product" campaign started from 2007 onwards for the promotion of the fruits like hog plum, wood apple, kiwifruit, etc.
- Agriculture Perspective Plan (1995-2015)
- National Agricultural Policy (2005)
- Agriculture Development Strategy (2015-2035)
- Prime Minister Agriculture Modernization Project (2016-2026)
- Fruit Development Project (2017)
- Fruit Year (2018)
- Fruit Decade (2016/017-2025/2026)

Government of Nepal has initiated a number of programs/projects with the external support from the bilateral and multilateral donors to strengthen fruit research and development in the country. These programs/projects have supported in the development of fruit subsector towards farm station establishment and strengthening, fruit germplasm introduction, maintenance, characterization, evaluation and utilization of fruits both in the past and present.

NARC is mandated for all research activities including horticulture and the Department of Agriculture (DoA) for all extension and development activities. There are many horticultural stations under the DoA and horticulture research stations under the NARC located in different agro-ecological regions of Nepal which are mandated to carry out both research and development activities.

Opportunities:

Comparative advantage: With minimum expenditure, farmers from nearby natural forests are picking raspberry, bayberry etc. and earning some money by selling these fruits in their locality.

Employment opportunity: Drain of man power to the overseas is due to unemployment problems in the country. At present situation, more than 3,000,000 youths (youngsters) have been deployed in the overseas in search of job. In this context, production, processing and marketing of many such underutilized fruits create employment opportunity to the rural and urban youths.

National and international markets: Being organic, safe and hygienic product markets of these products are likely to be in increasing trend, both in the national and international markets.

Environmental protection: Cultivation and conservation of these fruits will strengthen environmental protection.

Challenges:

Despite of greater scope and potentiality, there

are various constraints for the production, processing and marketing of underutilized fruit crops. Some of the problems and limitations are:

- Lack of reliable statistical data for underutilized fruits;
- Ignorance among people about nutritional and economical value of these fruits;
- Long gestation period for the commercial production of most of these fruits;
- Many of these fruits have specific climatic requirements;
- Technology regarding propagation and production of most of these fruits has not been yet developed;
- The pocket areas of underutilized fruits are scattered by which investment cost involves high for collection, processing and marketing at commercial scale;
- Absence of separate policy and programs for commercialization and wide propagation of under-utilized fruits of economic significance;
- Due to the risk associated with development aspects, public as well as private sectors have not shown much interest in the promotion of these fruits.

Way forward

The trend of fruit consumption is growing day by day with the increasing in urban population. As the people, either in rural or urban areas, are getting health conscious, fruits with more nutritious and therapeutic values could be promoted as fresh and processed products and complementary or substitute for the underutilized fruit crops.

Most of the varieties of major fruit crops growing in Nepal are exotic germplasms, and hardly a few of these fruits are of local or wild origin. Therefore, it is necessary to evaluate, select and identify wild fruit trees/shrubs varietal improvement. DoA and NARC should take initiation to study in details on these under-utilized fruit species.

These germplasms should be utilized in fruit industry by domestication of elite lines or using as rootstocks. For this, characterization, evaluation and utilization should be the priority program of public research institutions. Even the same fruit is known by different names in different regions. Many indigenous and wild grown fruits are yet to be named, characterized and tested. Trade related aspect of intellectual property rights (TRIPs) should be developed and implemented to protect indigenous and underutilized fruits.

Thus, in view of developing the prospective of underutilized fruit crops, the following steps should be taken:

- Collection, evaluation, characterization, registration and documentation of indigenous fruit germplasms;
- Both production and productivity of desired fruits to be increased through area expansion and better management practices;
- Development of suitable technology for propagation and application through training and exposure visit programs;
- Preparation of project profiles of underutilized fruit crops for future development;
- Genetic selection of pest-resistant and high-yielding trees, shrubs and bushes;
- Decrease in post-harvest loss through improved post-harvest handling including packaging, transportation and storage;
- Find out ways of adding value to the local edible wild fruit crops by means of processing and packaging to produce quality products;
- Provision of technical support and training related to special need of specific underutilized fruits;
- Standardization of production technologies, and new product development to meet the needs of both national and international markets;
- Formulation of policy to support local, regional and international market promotion programs;
- Establishment of botanical gardens in tropical, subtropical and temperate regions for the conservation of underutilized fruits;
- Provision of research and yield trials at different NARC- and DoA-owned farms/ centers;
- NARC should involve in improvement, utilization and conservation of wild fruits like Chiuri, Kafal and other similar fruiting trees in a coordinated way with the department of forestry;
- Access to finance and mortgaging for local and custodian farmers.

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