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Production and Regulation of Planting Materials of Horticultural Crops in Nepal

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Abstract

Availability of quality planting materials on time is the most important starting point for a successful horticultural enterprise. In Nepal, horticulture resource centers under federal and provincial governments; horticulture research stations, commodity research programs and the provincial research directorates under Nepal Agricultural Research Council work on horticultural research, variety development and maintenance, adaptation trials, and planting materials production in different ecological zones. These provide about 20% of the basic planting source materials such as seeds, seedlings, saplings, tubers, and propagules for multiplication to private nurseries, seed producer groups, cooperatives, and companies. Private sectors fulfill about 80% of the total demand for horticultural planting materials. Nepal has been importing hybrid seeds of flowers and vegetables for decades. Recently, there is an increasing trend of import of hybrid seeds of flowers and vegetables, grafted saplings of apple (high density), and walnut, which must be regulated to prevent the import of disease, pests, or other unforeseen risks. The government gives top priority to capacity building of government resource centers and private nurseries to produce seeds and saplings of standard quality to meet the demanded quantity for sustainable and holistic development of the horticulture sector. Varietal characterization, development of superior varieties, maintenance of genetically pure mother stocks of each variety for production of quality planting materials, certification of nurseries, and planting materials are other important areas to focus. Horticulture Nursery Policy, Act and Regulation Guideline are being formulated to monitor, regulate, and ensure the quality for both internal production and import/export if required.

Keywords: Flower, fruit, sapling, seed, vegetable

Introduction

Horticulture crops include flowers, fruits, ornamentals, plantation crops (coffee, tea, and rubber), and vegetables including roots,

tubers (potato as well), and spices. Most of these are high-value crops. Nepal exports tea, coffee, large cardamom, ginger, etc. to different countries. Different agro-ecological zones of Nepal are suitable for growing varied

horticultural crop species ranging from tropical to temperate fruits, flowers, and vegetables. The increased public awareness on the requirement of a balanced diet for good health has drastically increased the demand for fruits, spices, and vegetables for daily consumption. It is necessary to further increase the production and quality of horticultural products that are the major sources of essential nutrients (vitamins and minerals) to improve the immune system. Increased demand of these further increases the demands for quality planting materials and improved varieties with higher yield potentials.

The National Centre for Fruit Development (NCFD) under the Department of Agriculture (DoA), the Ministry of Agriculture and Livestock Development (MoALD) is the federal institution that is responsible for the overall development of fruits (Pomology) and flowers (Floriculture). There are five horticultural development centers under NCFD. They produce, maintain, and conserve quality fruit saplings of different fruit crops. Similarly, the National Centre for Potato, Vegetable and Spice Crops Development is the focal institute responsible for the overall development of the vegetable sector in the country. National Horticulture Research Center supported by various commodity research programs under Nepal Agricultural Research Council (NARC) research on horticultural commodities and technology development.

Nepal is rich in plant genetic materials. There are approximately 30 indigenous species of *Rhododendron* in Nepal (Jha et al., 1996) and 36 *Ficus* species are indigenous to Nepal (Kunwar and Bussmann, 2006). Lily of Nepal (*Lilium nepalense*) has been commercially available in foreign countries (Schnelle, 2012). Moreover, there are 107 indigenous fruit and nut species in Nepal (Joshi et al., 2007). In this way, Nepal has many endemic horticultural plant species that are yet to be identified, characterized, and hence explored for commercial production.

Although good quality seeds and saplings can be produced within the country, the horticulture sector is facing a shortage of quality source material as most of the private nurseries are unorganized; lack technology and knowledge to maintain genetically pure mother stocks and the government institutions are unable to provide enough standard quality planting material to the farmers all over the country.

Materials and Methods

Primary data of different planting materials were obtained from the farm records of government horticultural resource centers. A list of imported planting materials was generated by compiling the records obtained from the Plant Quarantine and Pesticide Management Center (PQPMC) and Seed Quality Control Center (SQCC). The records of the planting materials produced by the private sectors were collected from written applications registered at NCFD and the data submitted to the online balance sheet software. The data on the import and export of planting materials especially related to floriculture was received from records maintained by the Floriculture Association of Nepal (FAN), the Trade and Export Promotion Center (TEPC). The data were analyzed using Excel.

Results

Planting materials of fruit and plantation crops produced by the government resource centers:

The data on fruit cultivation in Nepal over the last ten years shows that the total cultivation area under fruit crops has increased from 1,03,651 ha to 1,64,623 ha (Figure 1a) indicating that the demand for total planting materials is increasing each year. An increase in total area and productive area (Figure 1a) has resulted in increased fruit production from 6,86,213 t to 11,77,640 t in 2018/19 (Figure 1b). However, the average productivity has remained almost

constant or has slightly decreased from 9.98 t/ha to 9.81 t/ha (Figure 1c) during the last ten years which is due to unavailability of quality planting materials and lack of or insufficient appropriate technology and orchard management.

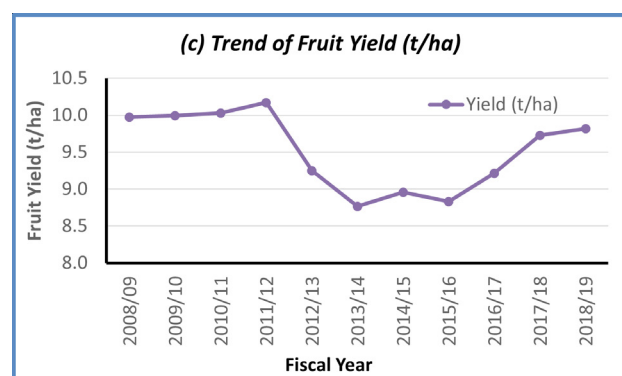
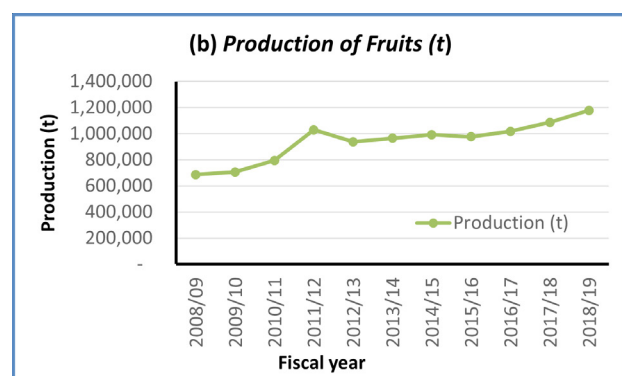
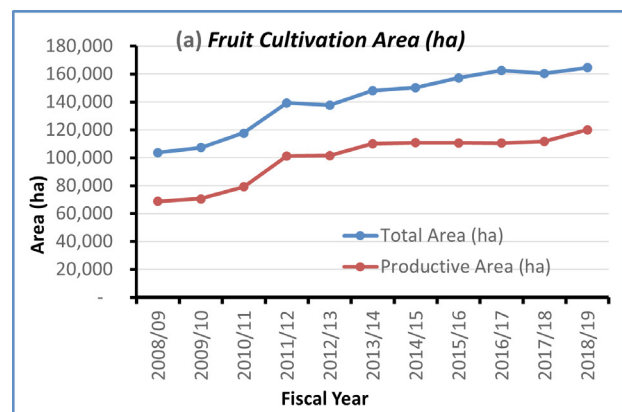


Figure 1. Trend of Recent Eleven Years for (a) Area, (b) Production, and (c) Yield of Different Fruit Crops in Nepal. Data source: MoALD, 2020

Fruit sapling production:

For fruit sapling production, there are five central horticultural development farms under NCFD (Table 1) and eight under the province governments (Table 2). Altogether, these resource centers produce and sell about four

lakhs (0.4 million) saplings each year (Figure 2). Most of these saplings are supplied as mother plants to the private nurseries. The rest of the demand for fruit plantation is fulfilled by the private nurseries.

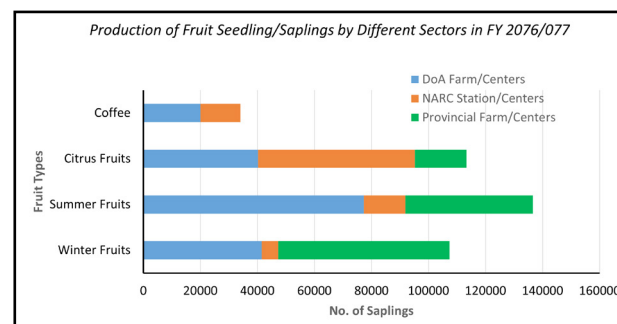


Figure 2. Production of Fruit Saplings by Public Sector Farms/ Stations of Nepal Including the Provinces.

As the demand for saplings is increasing rapidly, the farm centers under both federal and provincial governments have been prioritizing the sapling production at their full capacity (Table 1a, Table 1b).

Table 1a. Horticultural Development Farms Centers Under NCFD

Name and Address of Horticulture Farms under NCFD	Area (ha)	Crops Conserved	Fruit Saplings Produced in FY 2019/20	Vegetable Seed, Seedling Produced
1. Temperate Horticulture Development Center, Marpha, Mustang	8.5	Apple, Apricot, Walnut, Pear, Almond, Peach, Plum	50,000	Seed potato (4 t), leafy vegetable seed (Marpha Rayo), Radish, Cabbage
2. Citrus Development Center, Tansen, Palpa	9.25	Citrus (Suntala, Junar, Kagati-Lime, Pummelo)	50,000	Radish (Pyuthane Rato Mula), Bean (Chaumase simi)
3. Warm Temperate Horticulture Center, Kirtipur, Kathmandu	16	Citrus, Pear, Persimmon, Pecan nut, Kiwi, Peach, Plum	50,500	
4. Coffee Development Center, Aanpachaur, Gulmi	11.8	Coffee	20,000	12 varieties but all mixed up, need to establish separate varietal blocks
5. Tropical Region Horticulture Center, Nawalpur, Sarlahi	185.54	Mango (35 varieties), Litchi (9), Avocado (5), Banana (5), Guava (6), Coconut (2), Pomegranate, Rose (77), Croton (25), Palm (7)	300,000 (+30,000 flower and ornamental plants)	Tomato (5 varieties), Potato (7), Eggplant (3), Radish (2), Cauliflower (2), Okra, Beans, Cucumber

Table 1b. Horticultural Development Farms Centers Under Province Governments

S.N.	Name	Area (ha)	Commodity	Future Works
1	Temperate Fruits Rootstock Development Center, Boanch, Dolakha (Bagmati Province)	16.5	Resource center for temperate fruits mostly Kiwi	a) Registration of fruit varieties conserved and multiplied by the farm b) Characterization, Identification and tagging of the fruit trees
2	Subtropical Provincial Horticulture Development Center, Trisuli, Nuwakot (Bagmati Province)	14.0 ha	Resource center for subtropical fruit crops	a) Registration of fruit varieties Characterization, Identification and Tagging of the fruit trees

S.N.	Name	Area (ha)	Commodity	Future Works
3	Temperate Horticulture Nursery Center, Daman, Makawanpur (Bagmati Province)	76.7 ha	Resource center for temperate fruits and vegetable seed production	a) Registration of fruit varieties b) Tagging of the fruit trees c) Certification or truthful labelling of the vegetable seeds
4	Floriculture Development Centre, Godawari, Lalitpur (Bagmati Province)	3.72 ha	Resource center for lapsi, flowers and ornamental plants	a) Registration of flower and ornamental plant varieties b) Tagging of ornamental plants and flowers c) Technology development in different floriculture sectors
5	Dry Fruit Development Centre, Satbanjh, Baitadi (Sudurpaschim Province)	90.0 ha	Resource center for dry fruits mainly walnut and apple	a) Develop grafting technology for sapling production b) Maintaining genetic purity of mother plants c) Registration of fruit varieties d) Tagging of the fruit trees
6	Horticulture Centre Phaplu, Solukhumbu (Province 1)		Resource center for temperate fruits and vegetable seed production	a) Registration of fruit varieties b) Tagging of the fruit trees c) Certification or truthful labeling of the vegetable seeds
7	Tropical Horticulture Nursery Development Centre, Janakpur (Province 2)		Resource center for tropical fruits	a) Registration of fruit varieties b) Tagging of the fruit trees
8	Horticulture Resource Centre, Malepatan, Kaski (Gandaki Province)		Will serve as a resource center for subtropical horticulture plant species	a) Appropriate commodity selection for development of the resource center b) Development of mother plants' blocks and nursery blocks

Similarly, NARC has thirteen resource centers (research stations and commodity research programs) altogether at different ecological regions to conduct research as well as conserve varieties and produce planting materials of several horticultural crops (Table 1c).

Table 1c. Horticulture Resource Centers Under NARC

Ecological Regions	Name of Research Institutions	Major commodity
Temperate	Horticulture Research Station, Jumla	Apple, Walnut
Sub-temperate	Horticulture Research Station, Dailekh	Citrus
Sub-tropical	Ginger Research Program, Salyan	Ginger
	National Horticulture Research Center, Khumaltar	Vegetables

	Potato Research Program, Khumaltar	Potato
	Horticulture Research Station, Malepatan	Macadamia nut, Coffee
	Agriculture Research Station, Dhankuta	Avocado, Citrus
	National Citrus Research Program, Dhankuta	Citrus
	Directorate of Agriculture Research, Lumle	Citrus, Walnut,
	Coffee Research Program, Gulmi	Coffee
Tropical	Directorate of Agriculture Research, Nepalgunj	Tropical fruits
	Directorate of Agriculture Research, Parwanipur	Tropical fruits
	Directorate of Agriculture Research, Tarahara	Tropical fruits

In addition to different government resource centers, there are 506 private nurseries within the country producing planting materials of different fruit crops depending on their location and production sites (Table 2).

Table 2. Province-wise Distribution of Fruit Nurseries Owned by Private Sector

S.N.	Province	No. of Nurseries	Sapling Production of Major Fruit Crops
1	Province 1	104	Mango, Litchi, Citrus, Kiwi, Avocado, Walnut, Dragon fruit, Peach, Pear, Apple, Plum, Tea
2	Province 2	88	Mango, Litchi, Guava, Jackfruit, Lime, Arecanut, Coconut, Bael, Papaya, Pomegranate, Amla, Banana
3	Bagmati Province	57	Citrus, Kiwi, Avocado, Walnut, Dragon fruit, Peach, Pear, Low chilling apple, Plum, Persimmon, Coffee, Chestnut, Banana
4	Gandaki Province	55	Citrus, Apple, Almond, Apricot, Peach, Pear, Plum, Kiwi, Macadamia nut, Walnut, Coffee
5	Lumbini Province	45	Citrus, Papaya, Banana, Coffee, Mango, Litchi, Guava, Jackfruit
6	Karnali Province	110	Apple, Walnut, Peach, Pear, Apricot, Plum, Citrus, Grapes, Persimmon
7	Sudurpaschim Province	47	Citrus, Walnut, Apple, Pomegranate, Apricot, Peach, Pear, Plum, Coffee, Olive, Mango, Litchi, Jackfruit
	Total= 506		

Fruit sapling import:

Due to increased demand of grafted saplings and interest in new fruits, the import of fruits sapling is also increasing in recent years. In FY 2018/19 (2076/77) total of 5,45,420 saplings of different fruits (mainly apple, walnut, banana) were formally imported in Nepal from Italy, China, India, and Turkey which is the highest number during the last four consecutive years (Figure 3a, Figure 3b). This is

due to the increased demand for grafted walnut and feathered branch apple saplings for high-density plantations.

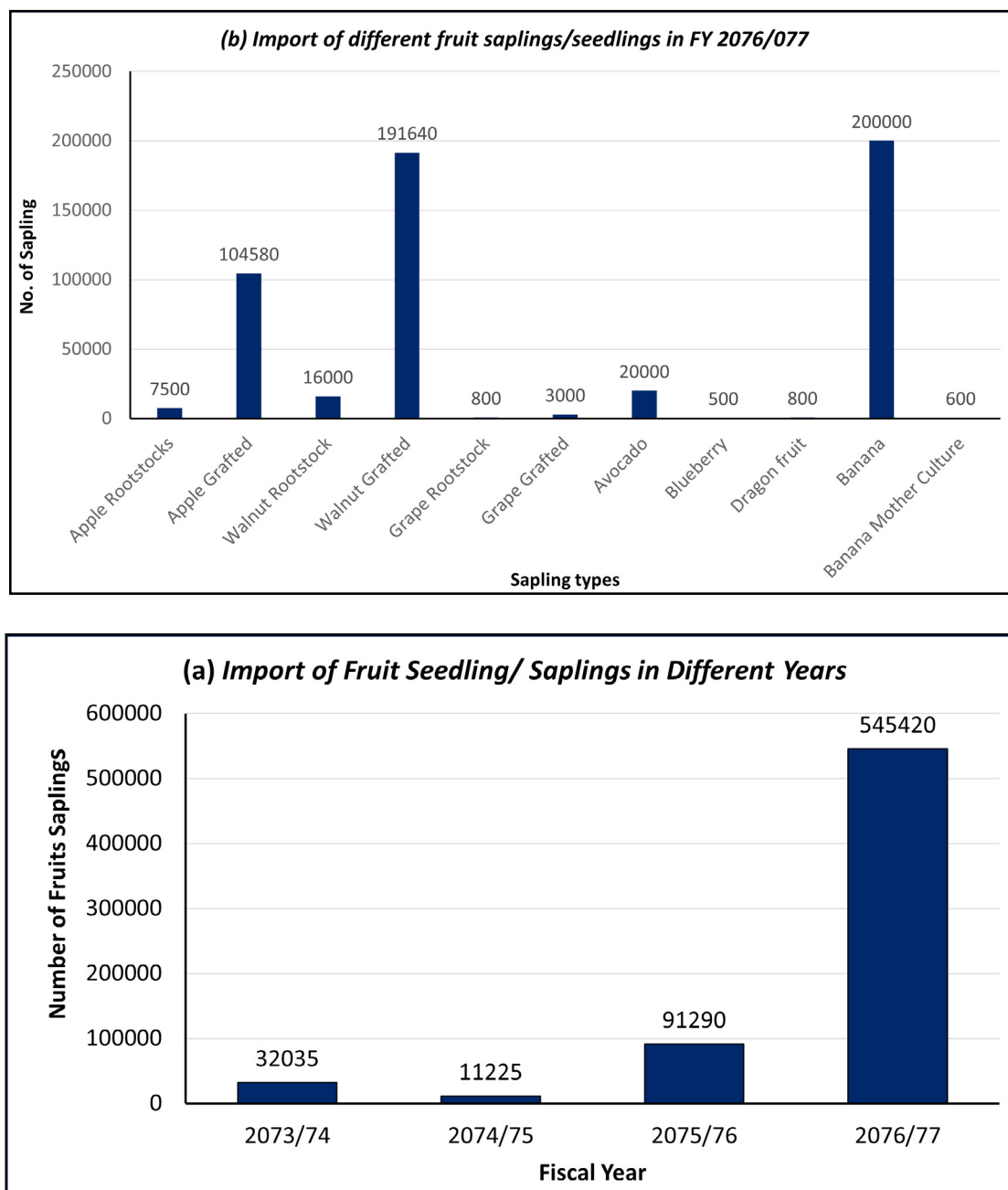


Figure 3. The Trend of (a) Import of Fruit Saplings and (b) Types of Saplings Imported.

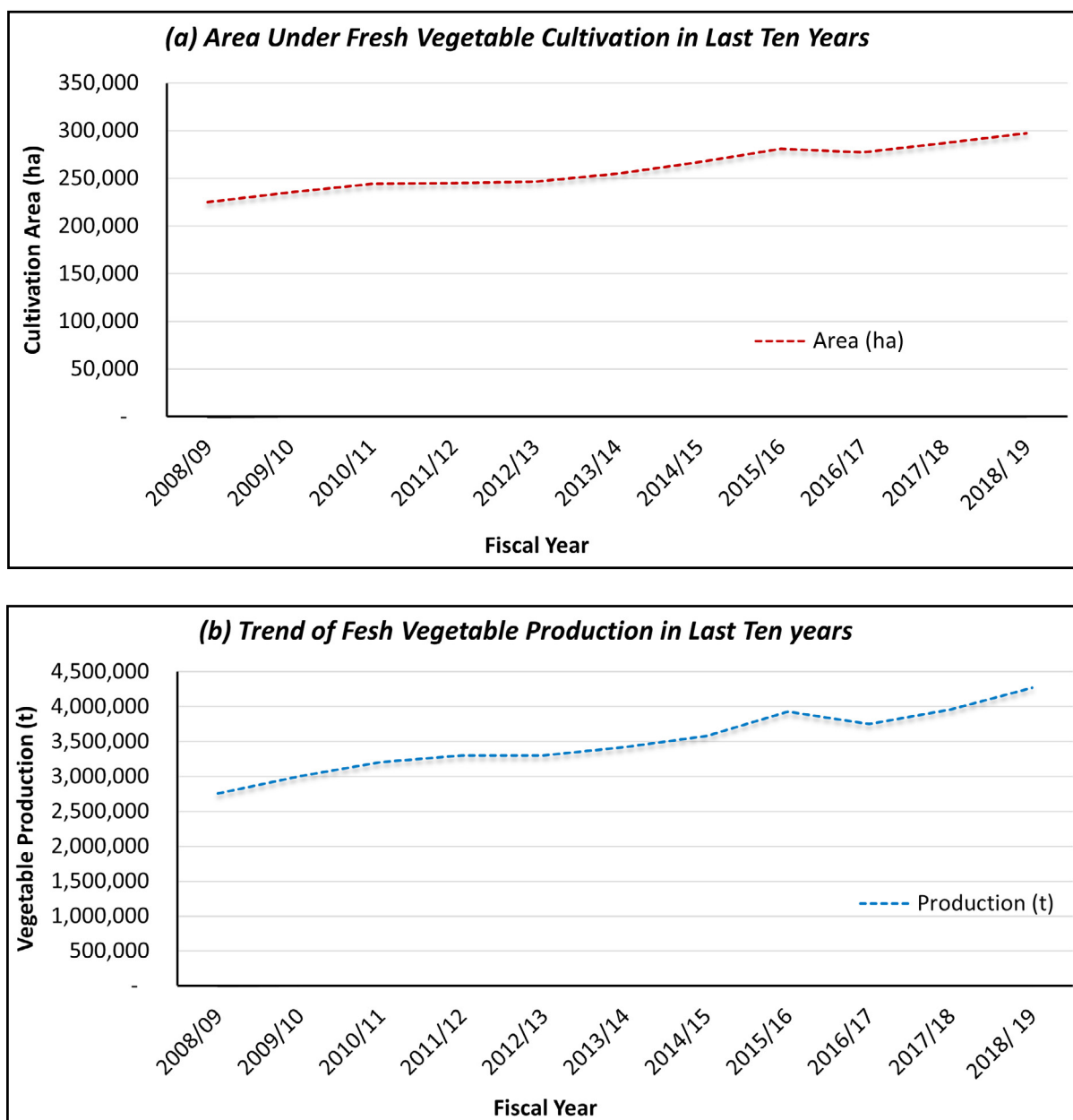
For tissue culture saplings, the sapling demand should be made six to seven months before planting time so that the tissue culture labs can produce accordingly. If this advance notification on sapling demand is made, sufficient number of banana tissue culture saplings can be produced within the country thereby reducing the import. In addition to this, import data from Floriculture Association of Nepal (FAN) showed

that more than 0.4 million (> 4 lakhs) nuts and fruit saplings were imported together with different planting materials of flowering species. Therefore, our import data is not direct since the commodities imported get mixed up under different headings which are creating difficulties in obtaining/compiling accurate data.

Planting materials of potato, vegetable, and spice crops produced by the government resource centers:

Vegetable germplasm maintenance and seed production status:

The area and production of fresh vegetables are in increasing trend in the last ten years (Figure 4a, Figure 4b, Figure 4c) (MoALD, 2020). The availability of quality seeds on time is crucial for better production. There are 39 open-pollinated varieties of 21 vegetable crops released so far for different ecological belts of Nepal (SQCC, 2018) and 300 open and hybrid varieties of 37 crops registered and recommended for commercial production.



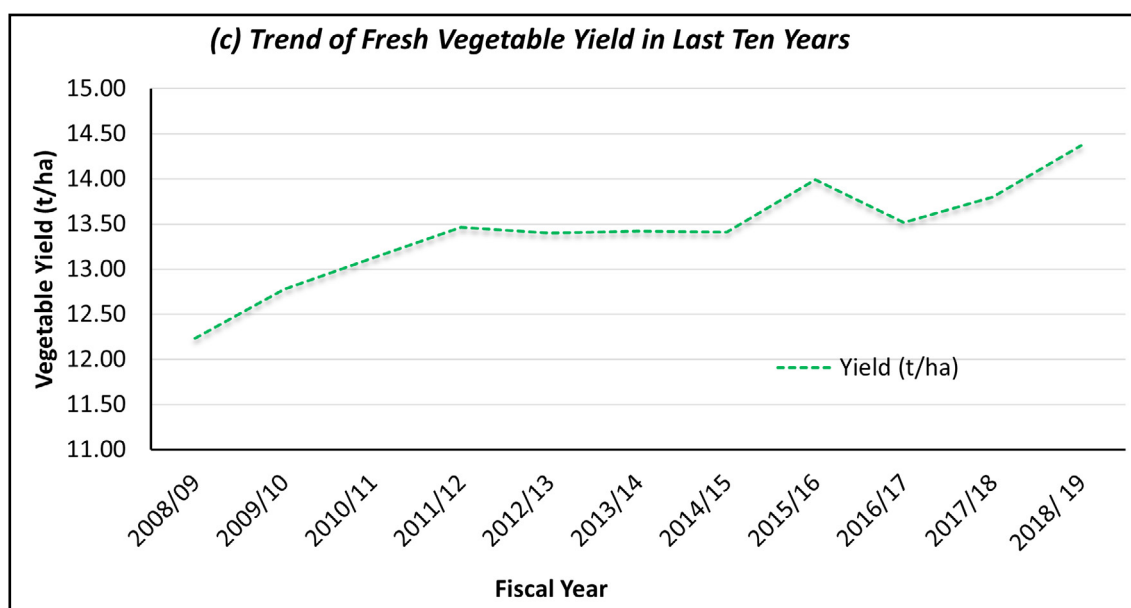


Figure 4. The Trend of (a) Area, (b) Production, and (c) Yield of Fresh Vegetables in Last Ten Years.

The total vegetable growing area of Nepal in 2018/19 (2076/77) was 2,97,195 ha (MoALD, 2020) and the vegetable seed requirement was about 1800 t. The formal source of domestic seed including public sector production was only 428.1 t (NCPVSD, 2077 unpublished data). The three years data (Figure 5) indicates the domestic seed production trend is not encouraging as compared to the projected production target of Seed Vision, 2013 (1909 t for 2020). A large part of the requirement is supported by an informal source of farmer-managed seed system of the country and by the import of hybrid and open pollinated varieties.

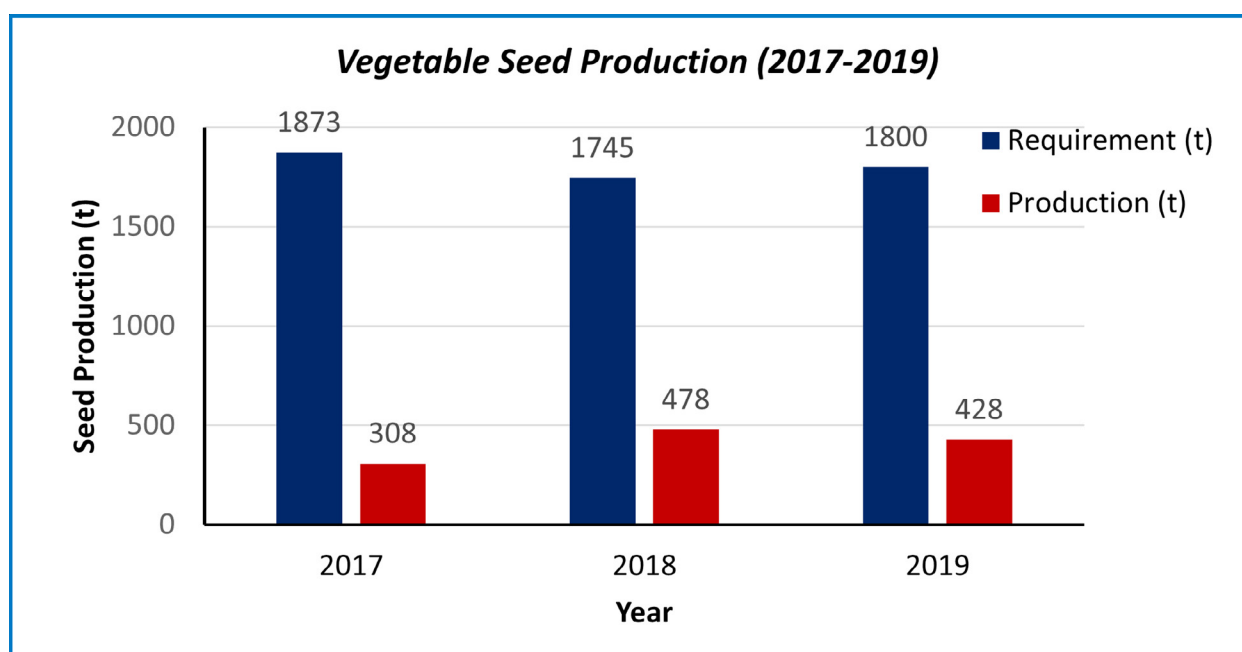


Figure 5. The Trend of Vegetable Seed Production (2017-2019).

There are 39 varieties released and seed-producing areas are also identified. All horticulture research and development farms are mandated for breeder and foundation seed production and variety maintenance. In this context, in FY 2018/19, out of the total released varieties, only 15 varieties of 9 crops were used for producing breeder seed. Similarly, 27 varieties of 18 crops were used for

foundation seed production (NCPVSD, 2020 unpublished data). It indicates a detached chain of seed production and maintenance of breeder and foundation seeds. The continuous maintenance and production of breeder and foundation seeds support the production of the improved seeds in the farmers' fields and a technical chain of seed flow should be maintained to sustain the seed business.

Only one hybrid seed of tomato is recommended in Nepal so far, whereas 20 varieties should have been developed by now according to the seed vision projection. More than 200 imported hybrid varieties are being registered and marketed among the commercial areas. In FY 2019/20, about 214 t of vegetable seed was imported including hybrid seeds from different countries (Table 3).

Table 3. Vegetable Seed Import and Export Data

F.Y	Import		Export	
	Quantity (t)	Value (Rs in lakh)	Quantity (t)	Value (Rs in lakh)
2015/16	249.99	3750.98		
2016/17	342.33	4166.65	0.345	36.07
2017/18	509.67	4403.17	0.513	17.64
2018/19	424.33	5530.88	0.537	8.96
2019/20	214.33	3589.04	0.800	13.59

Source: Department of Customs, Ministry of Finance, Nepal (Website: customs.gov.np/)

The total available formal source of seed was about 642 t (domestic: 428 + import: 214) in FY year 2075/76 (2019/20). The remaining seed demand is being managed from the informal source of the farmer-managed seed system, which is about 64 %. It shows there is a huge gap in seed demand and supply. The problem is associated with not full utilization of released and recommended varieties by supporting continuously in breeder and foundation seed production and maintenance by the public sector. The private sector is now handling more than 90 % of seed business but their capacity in terms of quality maintenance, processing, testing and safe marketing has not been up to the mark. In new federal structure, the seed chain is not functioning well in linking value chain actors from central to local governments. The source seed maintaining mechanism is being detached and some of the varieties have been losing the breeders' seed chain to continue the

seed production process. A concerted effort by the stakeholders is urgently required to improve the vegetable seed sector in Nepal (Poudel, et al, 2020). Seed zoning, infrastructure support, ensured resource seed supply, strong regulatory and harmonized seed contract and buyback system will give motivation to all stakeholders of the chain to sustain the seed business.

Potato germplasm maintenance and seed potato production status:

Potato is one of the major cash crops of Nepal mostly used for vegetables and has potential for food security in remote parts of the country. The cultivation of potatoes is in an increasing trend in terms of area and production, and it acquired high average productivity of 16.05 t/ha in FY 2075/76 (Table 4, MoALD, 2020).

Table 4. Total Area, Production, and Productivity of Potato in Nepal

Year	Area (ha)	Production (t)	Productivity (t/ha)
2016/17	185,879	2,591,686	13.94
2017/18	195,268	3,088,000	15.81
2018/19	193,997	3,112,947	16.05

Based on the total cultivated area, the seed potato requirement is about 300000 tones (t). It has potentiality in all parts of the country and is suitable for two-season cropping system. Due to the huge quantity required, seed potato handling and availing them in the remote parts of the country is a challenge. There are 11 varieties released and 5 varieties including TPS are registered and recommended. In FY 2076/77, 229.87 t seed potato import was recorded from formal source (Department of Customs, 2019) but it has also been reported that the illegal entrance of seed potato through porous border is common in Terai areas.

Pre-basic seed potato (tuber-lets) production of size 0.5 to 10 gm from virus-free potato plant is being implemented in Nepal since FY 2053/54. This tissue culture-based technology is expensive and needs specialty in technology and infrastructure. There are five major pre-basic seed (PBS) potato producers including public sector and total production was 534095 tuber-lets in FY 2018/19 (NCPVSD, 2020) which has further increased to more than a million PBS mini-

tubers in FY 2019/20 (NCPVSD, unpublished data). The major objective of PBS production program is to maintain the varietal character and increase the production capacity of the crop. The seed production chain of pre-basic seeds will maintain its quality and production capacity for 6-7 years in hills and 5 years in terai if managed a recommended seed chain system. About 80,000 tones of fourth-generation basic seeds were produced from available tuber-lets of FY 2075/76 by following the seed production chain. This fourth-generation basic seed can be planted in 50000 ha of land which can produce sufficient improved seed for ware potato production in the present potato growing area (193997 ha, MoALD 2018). But this seed potato chain is not functioning well. The pre-basic or first- and second-generation seeds are directly being used for ware potato production which is the main challenge for sufficient seed potato production. Horticulture farms namely Daman, Marpha, Sarlahi, Nigale, Bonch are producing basic seed potato which is the main source of seed potato in the country (Table 5).

Table 5. Basic Seed Potato Production by the Government Sector in FY 2019/20

Name of Horticulture Centre	Potato Basic Seed Production (t)
Potato Development Center, Nigale, Sindhupalchowk	10
Tropical Horticulture Center, Sarlahi	24
Temperate Horticulture Development Center, Marpha, Mustang	4.5
Cardamom Development Center, Fikkal, Illam	2.5

Similarly, there are two varieties of TPS (True Potato Seeds) TPS-1 and TPS-2. This technology was developed to minimize the seed potato handling difficulties, especially focusing on the remote parts of the country like Nepal. Seedling tuber production is the major objective of this program in remote areas by using true potato seed. The problem faced by this program is also related to the seed chain follow-up. Due to hybrid varieties, seedling tubers are recommended for one-time potato production. But the farmers are using second-generation seeds and facing problems of segregation and low productivity. The TPS is produced in

public farms at Nigale and Sarlahi. In 2077 TPS production was 15.0 Kg in Nigale and 5.0 Kg in Sarlahi.

Spice germplasm production and plant production status:

Spices in our context are Large Cardamom (*Amomum subulatum*), Ginger (*Zingiber officinale*), Turmeric (*Curcuma longa* L.), Garlic (*Allium sativum*) and dried chilies (*Capsicum* sp.). The area and production status of these crops are as follows (Table 6). Nepal is the fourth largest producer of ginger in the world and ginger is one of the priority export products of Nepal (tepc.gov.np).

Table 6. Status of Spice Crops Production in Nepal FY 2017/18

Crop	Area (ha)	Production (t)	Planting materials production
Large Cardamom	15055	7954	Enough saplings produced domestically
Ginger	22132	297512	Need of quality rhizome
Garlic	10107	71902	
Turmeric	10160	98904	
Dry Chili	10692	67167	
National total	68603	544260	

Source: MoALD, 2018

The total area of spices in the country is about 68000 ha with 544260 t production. Large Cardamom and Ginger are top priority commodities of National Trade Integrated Strategy (NTIS). Nepal is the largest producer and exporter of Large Cardamom in the world. Problem is, we have only Indian market for raw products, so prices fluctuate due to monopolization. Ginger is another exportable commodity but its trade also depends on the Indian market. Turmeric, Garlic and Dry Chili are other major spices of Nepalese household which have year-round use as herb ingredients and tastemakers.

Large Cardamom germplasm maintenance and plant production program is managed by Cardamom Development Center (Horticulture

Farm), Fikkal, Illam. There are 14 varieties of large cardamom conserved and cultivated in the center out of which five varieties have been very recently recommended or registered for commercial use namely Dambersai, Golsai, Ramsai, Bharlang and Jirmale. The sapling production was about 0.1 million in FY 2019/20 and there are many private nurseries in different parts of the country which together produce enough saplings domestically. The Cardamom growing area is mostly concentrated in eastern part of the country but now the area is expanding in the central and western parts of the country.

Ginger and turmeric germplasm maintenance and basic seed production programs are being implemented in Kapurkot, ARS of NARC. There are two released varieties of ginger namely

are Kapurkot Aduwa 1 and Kapurkot Aduwa 2. Similarly, turmeric also has two released varieties Kapurkot Haledo 1 and Kapurkot Haledo 2. Increased quantity of planting materials of these crops is needed every year. Source planting materials of ginger are being produced by the National Ginger Research Program, and Regional Agricultural Research Station (now the Directorate of Agriculture Research), Lumle. Availability of fewer amounts of quality planting materials of these spice crops is hampering the total production and productivity.

Garlic and Dry Chili generally come under vegetable (spices) category and these crops are being maintained by different horticulture farms mostly in subtropical and tropical regions. Garlic is a local crop that has been used since time immemorial by our community as a herb and tastemaker whereas for Chili, there is one released and 16 registered varieties recommended for commercial use. Chili is a major spice in the Tarai region and also is becoming popular in the hill community as a tastemaker. The commercial varieties of Chili are being developed, maintained and seed produced in horticulture farms. Garlic planting materials are based on the farmer-managed local informal sources, being exchanged from farmers to farmers and maintained naturally.

Major issues and recommendation for immediate action:

- Seed certification to ensure seed quality
- Development of OP and hybrid varieties as demanded by the consumers
- Regulation of the informal and illegal seed business

Planting materials of flowers and ornamental plants produced by government and private resource centers:

There is only one Government Horticulture Center taking care of the Floriculture sector development in the country located in Godawari,

Lalitpur. However, other Horticulture centers like Tropical Horticulture Center in Sarlahi also has conserved 77 rose varieties, 25 varieties of croton, and 7 varieties of palm, and this center also produces saplings of the different germplasm conserved in the farm (NCFD, 2020). In FY 2019/20, Sarlahi farm produced more than 35,000 saplings of roses and ornamental plants, and the Floriculture Development Center, Godawari produced 2,64,000 saplings.

The floriculture development in Nepal is mainly initiated by the private sector. About 732 private nurseries are producing the planting materials of various flowers, indoor and outdoor ornamental plants (FAN, 2020). The rest of the demand is fulfilled by the import.

Imported floriculture planting materials during the last three years:

The import quantity of floriculture-related planting materials is in increasing order in recent years and the import value has increased from Rs 11,54,55,199.00 in FY 2017/18 to Rs 26,89,31,985.00 in FY 2019/20 (Table 8). Nepal should emphasize producing various seasonal flowers' planting materials within the country. Also, the cultivation of indigenous flowers and ornamentals should be promoted. Germplasm of orchids and wildflowers should be collected, conserved, and selected for multiplication as required.

Table 8. *Import of Floriculture Related Planting Materials*

HSCODE	Commodities/ country	Unit	2017/18		2018/19		2019/20	
			Quantity	Value in Rs	Quantity	Value in Rs	Quantity	Value in Rs
Chapter total	Live trees and other plants: bulbs, roots and the like: cut-flowers and ornamental foliage			115,455,199		209,258,984		268,931,985
06011000	Bulbs, tubers, tuberous roots, corms, crowns and rhizomes, dormant	Pcs.	1,704	128,220	326,756	3,862,574	33,972	940,861
06012000	Bulb, tubers, tuberous roots, corms, crowns, and rhizomes, in growth or flower, chicory plants, and roots.	Pcs.	77,797	1,534,819	191,683	4,330,466	490,827	16,041,299
06021000	Unrooted cuttings and slips	Pcs.	0	0	445,390	4,187,950	249,260	4,681,468
06022000	Edible fruits or nuts trees, shrubs and bushes, grafted or not	Pcs.	104,757	9,152,588	86,921	16,371,313	412,477	67,083,759
06023000	Rhododendrons and azaleas, grafted or not	Pcs.	28	100,446	0	0	354	57,120
06024000	Roses, grafted or not	Pcs.	0	0	0	0	1,129	114,895
06029000	Live plants	Pcs.	1,584,711	70,184,781	3,036,853	102,962,110	2,383,900	83,871,485
06031100	Roses	Pcs.	880	39,461	6,007	48,609	146,615	1,064,732
06031200	Carnations	Pcs.	0	0	0	0	200	18,001
06031300	Orchid	Pcs.	124,832	1,304,216	140,320	1,437,954	73,350	1,382,415

HSCODE	Commodities/ country	Unit	2017/18		2018/19		2019/20	
			Quantity	Value in Rs	Quantity	Value in Rs	Quantity	Value in Rs
06031900	Cut flowers and flower buds of a kind suitable for bouquets or ornamental purposes	Pcs.	955,214	31,140,913	1,312,295	75,340,699	29,516	546,467
06039000	Cut flowers, dried, dyed, bleached, impregnated	Pcs.	5,489	156,687	12,688	334,713	13,370	413,665
06042000	Foliage, branches, and other parts of plants, without flowers or flower buds, and grasses, mosses, and lichens, being goods of a kind suitable for bouquets or ornamental purposes.	Pcs.	9,765	403,629	2,700	87,173	26,728	892,917
06049000	Foliage, branches, and other parts of plants, without flowers or flower buds, and grasses, mosses, and lichens, being goods of a kind suitable for bouquets or ornamental purposes.	Pcs.	0	0	500,000	295,421	7,769	264,087
06049900	Foliage, branches and other parts of plant	Pcs.	0	0	0	0	40	4,619
12093000	Seeds of herbaceous plants cultivated principally for their flowers	Kg.	0	0	0	0	599	21,934,308

Source: FAN, 2020

Recent efforts to produce quality planting materials:

Infra-structures in many nurseries were built to produce quality planting materials in recent years. The summary of these efforts are as follows.

A. Implementation of the fruit decade program to strengthen fruit nurseries.

1. Establishment of nursery infrastructures: 70 nursery infra-structures were developed in FY 2016/17 in various districts for citrus, olive, and temperate fruits.
2. In FY 2020/21, a conditional budget was allocated to 230 local levels for 230 new nurseries establishment and to 102 local levels to upgrade existing nurseries
3. To produce disease-free citrus saplings, 10 screen houses will be constructed in FY2020/21 under NCFD's program
4. For regulation of production and distribution of quality planting materials, priority has been given to the following activities:

To regulate the standard of planting materials, horticultural crops' nursery directive is under preparation.

Registration of fruit varieties has been emphasized (19 varieties under registration

pipeline: Apple-5, Kiwi-4, Litchi-6, Mango-3 and Papaya-1) and this will be continued for other fruits in the coming years

Registration of large cardamom (5 varieties)

Training of nursery owners and nursery workforce in farm centers

Increase in seed potato (PBS) production: 5,34,095 mini-tubers in FY2018/19 and 11,19,101 in FY2019/20

B. Fruit crop area expansion: In FY 2018/19, 426.3 ha was expanded by NCFD's program (NCFD, 2020). In FY 2020/21, budget was allocated to 175 local levels to expand fruit plantation in 3,000 ha to implement the fruit decade program. The plantation drive of the Ministry of Forests is also emphasizing plantation of fruit saplings as it has mentioned that of the total tree plantation at least 30% will be of the fruit trees. Therefore, demand for quality planting materials is increasing every day.

NHRC is in the final stage of testing towards releasing of few newly bred Gladiolus varieties.

Production of disease-free planting materials through tissue culture:

Many private tissue culture laboratories have been established with government's support and are producing various types of planting materials including PBS of potato and banana saplings (Table 9).

Table 9. Details of Private Tissue Culture Laboratories Producing Planting Materials

S.N.	Name of the Laboratory	Address	Contact Person	Remarks
1	Shree Ram Niketan Biotech Pvt. Ltd.	Godavari 3, Lalitpur	Manju Agrawal, Nitin Kedia	Self investment
2	Tripathi Group Pvt. Ltd.	Ratnanagar Municipality 13, Chitwan	Dr. Giri Raj Tripathi	Rs 40,00,000.00 grant from the Fruit Development Directorate (FDD)

S.N.	Name of the Laboratory	Address	Contact Person	Remarks
3	Agriculture and Forest Conservation Research Center Pvt. Ltd.	Madyabindu Nagarpalika 3, Nawalparasi	Megh Raj Shrestha	Rs 40,00,000.00 grant from FDD
4	Nepal Biotech Nursery Pvt. Ltd.	Lalitpur 25, Bhaishapati	Nabin Sahuwal	Self investment
5	Nepal Biotech and Nepal Agri-forestry	Ratnanagar Pithuwa, Chitwan	Khusal Dhital	
6	Green Research and Technology Lab	B a n e s h w o r , Kathmandu	Dr. Mukunda Ranjit	
7	Kalapas Biotech	Dhulikhel Kavre	Kishun Ghalan	
8	Mega Agrotech Pvt. Ltd.		Sarvakanyan Kandel	
9	One Stop Agriculture Solution Pvt. Ltd.	Dhangadi-5	Dilli Raj Joshi	Rs 57,06,351.00 from National Potato Development Program (NPDP)
10	Nepal Biu Bijan Utpadan Kendra	Godawari, Lalitpur	Kayamuna Nepal	Rs 32,00,000.00 from PACT and 1,30,000.00 from NPDP
11	Nepal Krishi Anusandhan तथा Bikas Kendra	Hetauda -18	Mahendra Bahadur Magar	Rs 95,06,728.00 from NPDP
12	Kushal Agricultural Research and Development Center Pvt. Ltd.	Koteshwor and Bardiya	Ram Bharos Nepal	Rs 62,00,000.00 from RISMFP and 18,00,000.00 from NPDP
13	Pragatishil Yuwa Krishak Samuha	Nala, Kavre	Kiran Shrestha	Rs 80,00,000.00 from PACT, PMAMP
14	Khadhynna तथा Biu Aalu, Alaichi तथा Falfool Nursery Udhog	Kushadevi-3, Kavre	Rajendra Thapa	Rs 94,06,728.00 from NPDP
15	Sanjiwani Hi-Tech Nursery and Tissue Culture	Birgunj 15, Parsa	Aarti Kushwa	
16	Ficus Biotech Pvt. Ltd.	Budhanilkantha 2 and Gaurdaha 2, Jhapa	Anurup Manandhar, Durlav Karki	Rs 97,20,623.00 grant from NPDP

Similarly, eight government horticulture centers have established or are in the process of establishing tissue culture facilities to produce fruit saplings and seed potatoes (Table 10).

Table 10. *Details of Tissue Culture Laboratories in Different Government Horticulture Centres*

S.N.	Name of the Centres / Programs	Status	Major Commodity
1	National Potato Research Program, Khumaltar, Lalitpur	Running at full capacity	Seed potato
2	Warm Temperate Horticulture Centre, Kirtipur	Initial phase of production	Different fruits
3	Tropical Horticulture Centre, Sarlahi	Will be equipped in this FY	Banana
4	Temperate Horticulture Development Centre, Marpha	Under construction, will be equipped in this FY	Temperate fruits
5	Citrus Development Centre, Palpa	Will be equipped in this FY	Citrus
6	Potato Development Center, Nigale, Sindhupalchok	Initial phase of production	Seed potato
7	Large Cardamom Development Center, Phikkal, Ilam	Initial phase of production	Large Cardamom
8	Floriculture Development Center, Godawari	Under construction	Flowers and ornamental plants

With the implementation of tissue culture laboratory standards prepared by SQCC, it will be easy to regulate the quality of the products produced by these companies and institutions. We still need to set the standards of different planting materials produced through tissue culture so that the expected high quality will be maintained.

Regulation practices/system required

For internal quality control

The seed certification system should be strictly followed so that the seed cycle (Breeder seed, Foundation seed, Certified seed to Improved seed) will be completed. Not maintaining (not completing) the seed cycle is one of the major reasons for lack of quality seed for vegetables including that of potato. Lack of quality and certified source seeds has hampered the various stages of seed production process as well as the seed cycle. Therefore, NARC should focus on producing enough breeders' seeds and coordinate in subsequent production processes. For apple, production of feathered saplings within the country should be promoted by training the technicians in the horticultural research and

development farm centers and then expand this technology to the private nurseries. For walnut, development of efficient technology for grafted sapling production should be prioritized. Citrus saplings are being sold just after 6 months of grafting which makes them under-aged and under-sized. Maintenance of genetic purity and superiority of the varieties should be maintained. Characterization, identification, and registration of different varieties should continue. There is a need to increase the development and production of hybrid seeds for vegetables and flowers. Regulation of production of quality planting materials (meeting the standards) and ensuring appropriate distribution should be prioritized. Sapling price must be stabilized.

Import related quality control mechanisms in place:

- Germplasm Exchange Authority Committee (GAC) for research materials.
- Working group led by PQPMC to study the case, documents and recommend/reject for issuance of the entry permit.
- Regulation of import of planting materials as well as distribution should be closely monitored and regulated by the Federal Government.

Existing Acts, laws, regulations, and related documents for regulation of planting materials:

Seeds Act, 2045 (1988)
 National Seed Policy, 2056 (1999)
 Agro-biodiversity Policy, 2063 (2007)
 Plant Protection Act, 2064 (2007)
 Plant Protection Rules, 2066 (2010)
 National Seed Vision, 2013 – 2025
 Agriculture Development Strategy (ADS) 2015 - 2035

Recommendation

Development and effective implementation of the nursery laws, standards, regulations and inspection services for all horticultural nurseries should be emphasized and followed by effective and regular monitoring/inspection of nurseries to ensure quality sapling production. Certification of the planting materials must be done. Implementation of strict quarantine measures with effective/efficient on-site testing laboratory facility to control/stop flow of substandard saplings as well as to control spread of diseases and pests along. For effective international import and export regulation, develop crop-specific HS CODE. This will also help in keeping accurate database of the import/export. The nursery owners and government institutions should establish mother blocks with proper isolation for easily cross-pollinated crops such as walnut. Similarly, there is urgent need to

develop improved varieties as per consumer's preferences. To meet demand of quality seeds, completion of the seed cycle for all the vegetable seed production programs must be made mandatory. Standard grading, packaging and labeling of the planting materials should be in place. To achieve these above mentioned recommendations, coordinated effort by all the stakeholders is required to improve the quality of the planting materials during production process with quality control system in place after harvesting and during handling.

Seed zoning, infrastructure support, ensured resource (breeder, foundation) seed supply, strong regulatory and harmonized seed contract and buyback system are required to motivate the concerned stakeholders of the seed production chain to sustain the seed sector. For citrus, shift in transplantation time of saplings to winter season with irrigation facility could help to meet the age, standard size of the sapling and reduction of the mortality rate as well. To introduce improved varieties of various crops it is necessary to import genetically pure source materials of the comparatively superior varieties, but these have to be tested and tried first. Once proven more productive and can adapt to Nepalese conditions, only then these need to be registered and multiplied for commercial cultivation. Importing untested varieties and selling them to farmers for cultivation should be discouraged and properly regulated.

Conclusion

Timely availability of standard quality planting materials for each crop is required for both area expansion and productivity/yield enhancement to meet the supply gaps existing in various horticultural commodities. Production and productivity can be increased notably by planting designated quality saplings, introducing high-yielding varieties, improving orchard management, with timely practice of plant protection measures, and reducing pre-harvest

and post-harvest losses. Area expansion is to be emphasized for establishing large size orchards utilizing the fallow lands with some policy changes and attracting commercial cultivation. For this, there is a need of strengthening the capacity of public and private nurseries to produce seeds, seedlings and saplings of appropriate quality with designated standards that can be planted with trust and ensured sustainable high yields with proper crop management.

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Declaration of conflict of interest and ethical approval

All authors have significant contributions in drafting this article. All authors declare that there is not any type of competing interest regarding the current manuscript. The current article does not include any human participants or animals.

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