

Research Paper

Tropical Fruit Nurseries and Propagation Activities in Ethiopia: Developments and Challenges

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Fruit nurseries in Ethiopia were clustered into three categories namely public, micro-enterprise, and advanced. Number of seedlings in public nurseries was 61,797.3 while avocado and mango were propagated at a larger proportion. Micro-enterprise private nurseries had been producing 1,500 to 30,000 seedlings yearly with average of 13,665 seedlings. Major constraints and challenges identified in public and micro-enterprise private nurseries included lack of shade net and mother stock for sourcing scion, poor seed quality for rootstock, technical gaps, and pests and diseases. Shade structures constructed from local materials such as bamboo and dried vegetation were commonly used, except few which were supplemented with a modest net-house. About 50,000 mango and citrus seedlings were being multiplied in a greenhouse nursery at Upper Awash Agro-industry Enterprise. The Israel's Agency for International Development supported nurseries had produced 368,186 grafted avocado seedlings in three consecutive years since 2016, to strengthen export of avocado fruits for international market. Advanced nurseries are characterized by having better capacity and facilities that enable them to produce large number of seedlings, as compared to the other two nursery types. Therefore, stakeholders have significant role to support nurseries and address challenges to achieve producing seedlings with required standards.

Key words: Constraints, facility, fruit seedlings, nursery, propagation

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INTRODUCTION

Ethiopia is endowed with wide ranging agro-ecological zones and diversified resources that enable to produce most of the fruit crops ranged from dates of dessert to apple of highland fruits (Awulachewet *al.*, 2007b; Avihai and Workafes, 2011). Ranges of tropical fruits are being produced in the country and the major fruits are banana, avocado, mango, papaya, orange, lemon, guava and pineapple, in that order (Edossaet *al.*, 2016).

They have significant role to improve nutritional status and income of Ethiopian smallholder farmers. About 7.0 million smallholder farmers were engaged in growing of tropical fruits in 2020/21 cropping season to produce 1.4 million tons of different fruits on 161.5 thousand hectares of lands in Ethiopia (CSA, 2021). Development of the subsector plays important role in the national economy; it can save hard currency through import substitution and exports of fresh and processed

products (EHDA, 2011; Yeabsira, 2014). Although, huge amount of fresh and processed fruit products, are being imported to the country; about 6,754 tons fresh and processed fruit products had exported and 8.6 million dollars earned in the year 2017 (ERCA, 2018).

Despite of these, over all yield and quality of the crops are very low as compared with the regional and global levels. Lack of improved varieties, effective propagation and nursery management options are among the major reasons (Edossaet *al.*, 2016). These situations might be considered as an opportunity for fruit plant propagator to supply quality plants. To propagate quality planting materials, development of modest fruit nursery is crucial thereby improve production, productivity and quality of fruit crops.

The success or failure of an orchard is largely dependent on how well the propagating and growing of fruit trees has been done in the early stage. To achieve this, it requires improved mother block, reliable water source(s), soil media, propagation structure and the convenience of transportation of the products with minimum or no damage (Derbew and Soon, 2014; Krishnan, 2014). It could vary greatly in size, facilities and capacity (Yosef *et al.*, 2013). Multiplication of improved varieties is stated as one of strategic issues in tropical fruit research and development in Ethiopia (EIAR and ATA, 2016). Increased engagement of public and private sectors in production and supply of improved horticulture plants has a major importance to enhance production and productivity (Avihai and Workafes, 2011).

Development and popularization of improved agricultural technologies are among core mandates of Ethiopian Institute of Agricultural Research (FDRE, 1997; 2013). During the past five decades, research efforts have been made on major tropical fruit crops to address the gaps and challenges, and improve the existing status in the subsector (Asmare and Derbew, 2013). Melkassa Agricultural Research Center (MARC) has been coordinating the national fruit crops research program and delivering fruit crops technologies of tropical fruits. The Center is responsible for release or registration and maintenance of about 70% of improved fruit varieties in Ethiopia (MoA, 2016). It has been involved in multiplication of initial planting materials of improved varieties and providing mother trees of tropical fruits. It has been supplying more than 492 thousand seedlings of improved varieties for research centers, higher learning institutions, fruit nurseries and model farmers between 2009 to 2015. In collaboration with regional Bureaus of Agriculture, 24 public nurseries were established or strengthened in Amhara, Oromia, Southern Nations Nationalities and People's (SNNP) and Tigray regions (Edossaet *al.*, 2016).

With the aim of popularizing fruit technologies and supporting the increasing demand of the fruit subsector, various developmental organizations also have been involved in supporting establishment of nurseries to produce seedlings for different fruit trees in Ethiopia. Establishment and management of public nurseries in most districts have owned and lead by Ministry of Agriculture and Natural Resources (MoANR) and Regional Bureau of Agriculture (BoA). Israel's Agency for International Development Cooperation (MASHAV) had been engaged for establishment, financing, technical support and management of several fruit nurseries in Ethiopia (Avihai and Workafes, 2011). Currently seedlings businesses are emerging with many individuals are involved in raising ornamentals, indoor plants, forest, and fruit seedlings in many urban and semi-urban areas. Some farms such as Upper Awash Agro-Industry Enterprise (UAAIE) and private micro-enterprises have also involved in multiplication and supply of some fruits (Edossaet *al.*, 2016).

However, scientific information about fruit nursery development in the country is hardly available since its activities in the country have not be well accessed and documented. Therefore, the objectives of the study were to: (i) assess and evaluate status of fruit nursery in Ethiopia and document available information; and (ii) point out opportunities and challenges fruit nursery development and multiplication activities for future uses and interventions.

METHODOLOGY

Primary and secondary data; and review of relevant literatures were sources of information. Primary data were collected for selected nurseries through semi-structured questionnaire and focus group discussion. Sources of the secondary data were activity records, annual reports and publications. Model nurseries were selected with assistance of horticultural experts of respective areas. Purposive sampling method was used to identify and select fruit nurseries for the assessment. The nurseries were clustered in to three categories such as public, micro-enterprise and advanced fruit nurseries. Fruit nursery assessments were made from 2016 to 2017.

A total of 20 nurseries found in four administrative regions were assessed and evaluated for their status and seedling production capacity (Annex Table 1). Information was collected through interviewing extension service workers, nursery managers or foremen. The nurseries were visited to recorded more data through direct observations. Some information for public nurseries was adapted from annual report of 'Validation and Dissemination of Quality Fruit Trees In Ethiopia and Uganda', a project had funded by Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) which was implemented in collaboration with MARC (ASARECA, 2014). Results of selected public nurseries are presented and discussed in this paper.

Performance of three licensed private nurseries namely Masresha Nursery Micro-Enterprise, TEAZ Fruit Nursery Micro-Enterprise and Mojo Youth Cooperative Fruit Nursery were assessed and the results are presented and discussed.

Assessment of Advanced Nurseries was focused on fruit nurseries supported by the Israel's Agency for International Development (MASHAV) and nursery of UAAIE. For MASHAV supported nurseries most information was adapted from annual reports of MASHAV Smallholders Horticulture Project. Fruit Nursery activities and modern green house of UAAIE was visited and data were collected through focus group discussion, personal observation and secondary data from activity record book and sales reports of the enterprises. Results of advanced nurseries are discussed.

Collected data were analyzed through descriptive statistics to generate summaries and tables using SPSS version 20 and Microsoft Office Excel spreadsheet.

RESULTS AND DISCUSSIONS

Public Nurseries

Fruit nurseries in different part of the country have attempted to produce and popularize grafted fruit seedlings. A total of 20 nurseries found in four regions were assessed and evaluated for its status and seedling production capacity (Figure 1). During the time of assessment, improved fruit propagation activities were active in all assessed nurseries in Amhara and Tigray Regions; while in Oromia and Southern Nations Nationalities and People's (SNNP) Regions it was observed only in 29% and 50% of assessed nurseries, respectively (ASARECA, 2014). Relatively detailed assessment and evaluation was done for ten selected fruit nurseries in Amhara and Tigray regions and hence discussion in following sections is focused on those.

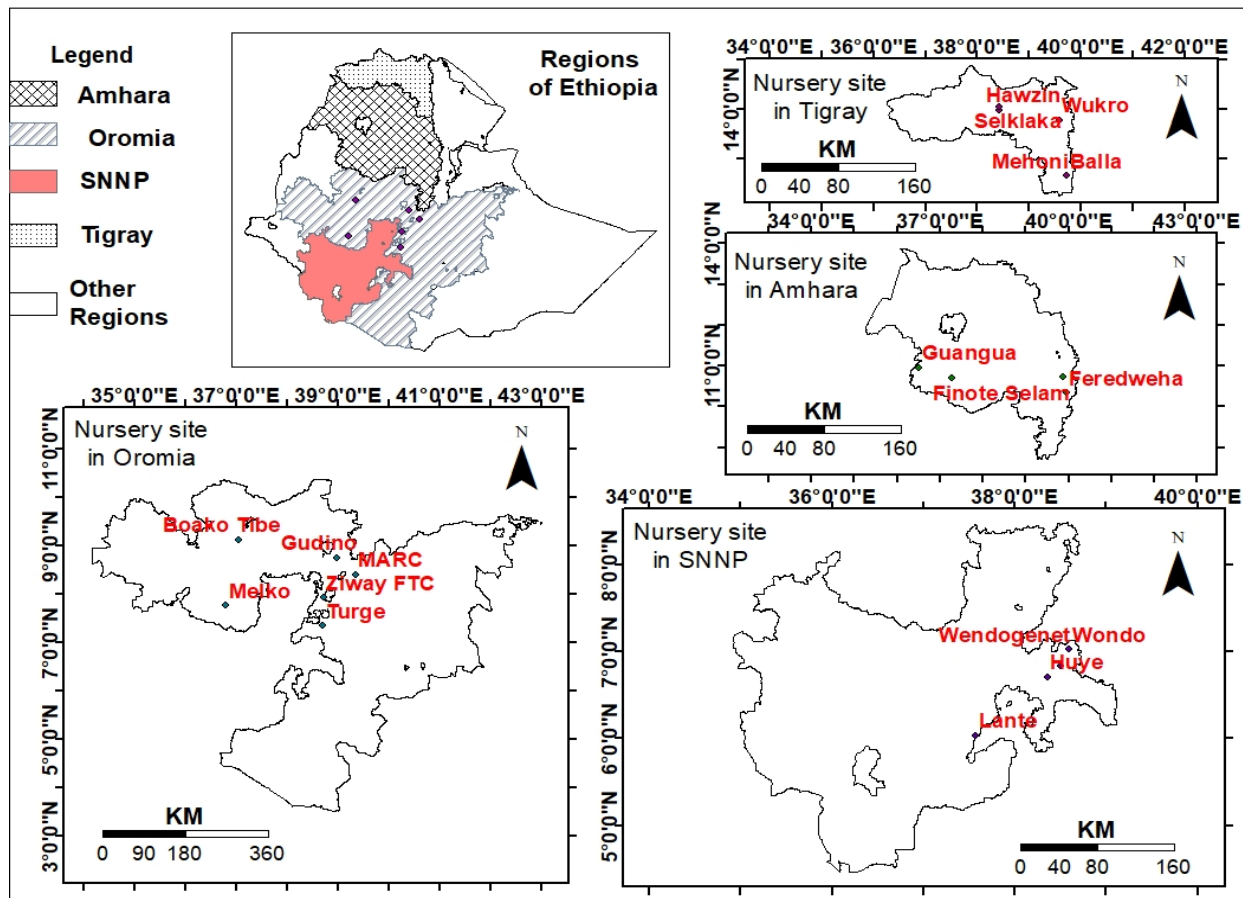


Figure 1: Geographical locations of the selected public nurseries in Tigray, Amhara, Oromia and SNNP regions of Ethiopia

Establishment and Nursery Facilities

As presented in Table 1a, fruit nurseries in Amhara region were established between the years 1964 to 1995. The oldest nursery was Finoteselam which had established in 1964. Tigray region, the nurseries had established between the years 1983 to 2013. A fruit nursery established at Mehoni Agricultural Research Center was the recent one which had established in 2013. Land area allocated to the nurseries was ranged from 1.5 to 6.3 hectares. Finoteselam (Amhara region) was with largest land area and Seleklaka fruit nursery (Tigray region) was with the least. Most of the nurseries were close to main road except two nurseries namely Seleklaka in Tigray (7km) and Feredweha in Amhara region (5km). All of the nurseries have modest roads that allow vehicle to travel up to the site.

All assessed fruit nurseries both in Amhara and Tigray regions had access for irrigation water. Source of irrigation water was river to all nurseries in Amhara region while it was underground water for most nurseries in Tigray region except for Seleklaka and Enticho nurseries. No nursery was fenced by modest fencing materials such as mesh wire though most nurseries were protected by local wood or living fence. Most nurseries (80%) had no modern shade house which is required to grow seedling and perform grafting activities; and it was mentioned as one of the constraints of these nurseries. But they had been using shading materials constructed by locally available materials such as bamboo and dried vegetation (Figure 3). Only two nurseries such as Enticho in Tigray and Feredweha in Amhara had net shade which was supported by FAO and MARC, respectively (Figure 4).

Most nurseries in Amhara and Tigray regions were established in ideal environment and fulfill basic requirements to select a given site for fruit nursery establishment including climatic condition, availability of water resource, topography and closeness to main road (Derbew and Soon, 2014). Fencing is important to protect seedlings from physical damage by animals attack and people. Shade net is also very basic to shade /protecting the seedlings and nursery workers from higher radiation. Net shading is one of facilities and important pre-conditions to run successful plant propagation business of any type (Avihai and Workafes, 2011). Krishnan *et al.* (2014) described nutrient rich soil, sustainable water source and shade net nursery (insect proof net) as important facility for nursery. Thus, most of the public nurseries were with poor facilities so that may not fulfill standard for modest fruit nursery.

Table 1a: Public Fruit Nurseries in Amhara and Tigray regions: establishment, location and facilities*

No	Name of Nursery	Region	Year of establishment	Area (ha)	The nearest Town	Distance from the town (km)	Source Irrigation	Fence type	Shade net (+/-)
1	Dolu	Amhara	1979	2.5	Kemise	0.5	River	living	-
2	Feredweha	Amhara	1995	3	Ataye	5	River	living	+
3	Finoteselam	Amhara	1964	6.3	Finoteselam	0.3	River	wire	-
4	Guangua	Amhara	1980	7	Chagni	1	River	living	-
5	Meriye	Amhara			Kemise	2	River	living	-
6	Enticho	Tigray	1994	2.5		2	River	wire	+
7	Hawzin	Tigray	1983	3	Hawzin	0.75	Ground water	local	-
8	Mehoni	Tigray	2013	4	Mehoni	2	Ground water	living	-
9	Seleklaka	Tigray	1999	1.5	Axum	7	River	living	-
10	Wukro	Tigray	1992	2	Wukro	0.5	Ground water	local	-
Average				4		2			

*Adapted from ASARCA annual report 2014

Capacity of Seedling Production

Avocado and mango were propagated in all accessed nurseries in Amhara and Tigray regions. Papaya was propagated only at Finoteselam (Amhara region) and Seleklak (Tigray region) nurseries. Whereas banana, guava and grapevine were propagated each in only one site; Meriye, Hawzin and Enticho fruit nurseries, respectively (Table 1b).

Avocado and mango rootstock seeds were collected from local markets in Central and Southern Ethiopia mainly Arbaminch and Wendogenet areas. For citrus rootstock seed they had been collecting from UAAIE. Only two fruit nurseries in Amhara regions, Chagni and Finoteselam, had their own mother trees for root stock; but still they had been purchasing more seed from market. During assessment only three fruit nurseries (Chagni, Finoteselam and Hawzin) had their own mother trees for scion sources. Most nurseries were supplied mother trees of improved varieties from national fruit coordinating center, MARC, in the years 2013 to 2014. Six avocado varieties (Bacon, Ettinger, Fuerte, Hass, Nabal, and Pinkerton) and four mango varieties (Apple mango, Keitt, Kent, Tommy Atkins) were established to each fruit nurseries. Since mother tree were too young to collect scions, the nurseries had been supplied from MARC and UAAIE.

Table 1b: Public Fruit Nurseries in Amhara and Tigray regions: their human resource and propagation capacity*

No	Name of Nursery	Region	Total Employers	No. of Grafter	Number of seedling produced in 2016				
					Avocado	Mango	Citrus	Others	Total
1	Dolu	Amhara	14	8	7,444	5,238	52	-	12,734
2	Feredweha	Amhara	80	11	25,000	32,800	10,000	-	67,800
3	Finoteselam	Amhara	100	5	13,480	35,680	-	5,000 ^P	54,160
4	Guangua	Amhara	94	10	67,642	52,400	-	-	120,042
5	Meriye	Amhara	11	2	-	12,000	-	24,000 ^B	36,000
6	Enticho	Tigray	40	NA	20,000	34,500	5,000	2,500 ^{GV}	62,000
7	Hawzin	Tigray	25	2	80,000	20,000	8,000	11,500 ^G	119,500
8	Mehoni	Tigray	-	-	-	-	-	-	-
9	Seleklaka	Tigray	35	NA	13,460	11,880	-	14,600 ^P	39,940
10	Wukro	Tigray	NA*	1	39,000	5,000	-	-	44,000
Total			399	39	266,026	209,498	23,052	57,600	556,176
Average			49.9	5.6	33,253.3	23,277.6	5,763.0	11,520.0	61,797.3

*Adapted from ASARCA annual report 2014. NA=Data not available; B=banana; P=papaya; G=guava; GV=grapevine

The public nurseries had been supplying grafted seedling primarily to smallholder farmers in discounted selling prices. The price of non-grafted seedlings was 2 to 5 Ethiopian Birr (ETB) per seedling. Selling price for a grafted seedling was ranged from 10 ETB at Seleklaka to 25 ETB at Chagni.

Seven tropical fruit crops namely avocado, mango, citrus, papaya, banana, guava and wine had been propagated in the nurseries. Among which, propagation of avocado and mango had undertakentall fruit nurseries with the highest number of seedlings which might indicate that these fruits had the highest demand and priority in the two regions. Citrus and papaya found in four and two of assessed nurseries which might indicate medium demand and priority for these crops. The remaining fruit crops, banana, guava and wine had been propagating each in single nursery which might indicate their least demand or priority. On other hands, fruit crops with less proportion in the nurseries might require further promotion.

As presented in Figure 2, among fruit seedlings that had been propagated in 2014 at 10 selected fruit nurseries in Amhara and Tigray the top majority were of avocado (51.6%) and mango (36.5%). Citrus (3.6%) was being propagated in four nurseries and papaya (3.0%) was obtained in two nurseries. The rest fruits, banana, guava and wine were each propagated in single nursery and their proportion were 3.7%, 1.8% and 0.4%, respectively.

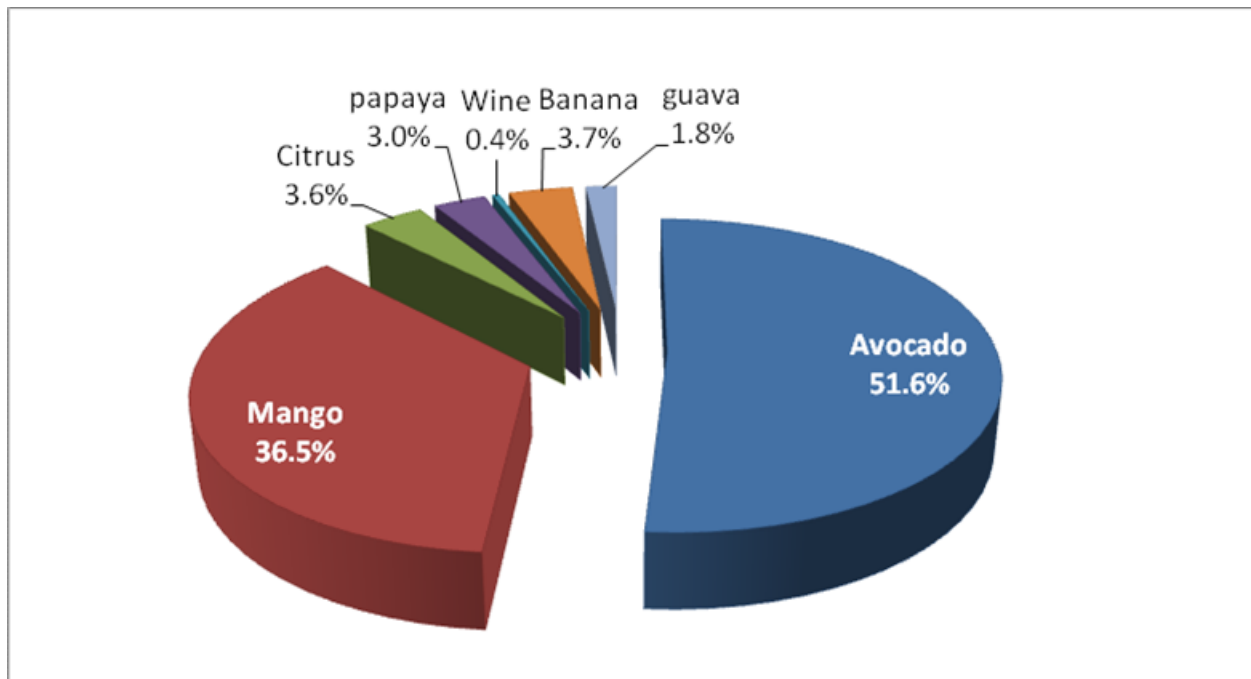


Figure 2: Proportion of seedlings/saplings produced in 2014 at 10 selected fruit nurseries in Amhara and Tigray regions. (Adapted from ASARCA annual report 2014).

Constraints and Challenges

About nine constraints and challenges were identified for the accessed nurseries in Amhara and Tigray regions. According to nursery workers and personal observation, the top four constraints and challenge of the nurseries were absence of shade net, absence of mother stock for scion source, poor seed quality for rootstock and, technical gap of nursery workers, in that order. Shade net was not available for almost all evaluated fruit nurseries. Most nurseries had been using local materials such as bamboo and dried vegetation to construct shade house. Only two nurseries had net house during the survey. Pests and diseases, quality of grafting equipment, lack of some materials (ice box, tools and grafting tape), lack of polyethylene and shortage of irrigation water were also mentioned as constraints in some fruit nurseries (Table 2).

Lack of mother trees for scion source was critical challenges for 80% of the nurseries. However, two nurseries in Amhara region (Chagni and Finoteselam) had mother trees for scion source. Edossa *et al.* (2016) indicated that these nurseries were among which that had been supported by MARC. Later on, avocado and mango mother trees were planted for most selected nurseries (ASARECA, 2014).

Most of the nurseries had no their own mother plants for rootstock seed; rather they collect seeds from distant market in central and southern Ethiopia. According to nurserymen and district horticulturalists, poor quality of rootstock seed was critical challenge in most nurseries (60%). Sometimes total rootstock seed purchased from distant market failed to germinate. There are two possible reasons for poor rootstock seed quality. The first reason could be the fruits might be harvested before maturity. Another reason could be that it may take too long time to purchase, collect and distribute the seeds to nurseries; hence result to lose its viability, reduce germination or seedling vigor. Since most fruits are known to be recalcitrant seed type, it is recommended that rootstock seed should be planted with in few weeks after harvest (Lemma and Asmare, 2012).

The nurseries had been using non-registered local seeds as rootstock for avocado and mango propagation. Avocado root rot disease and salinity problem for mango are potential constraints in popularizing these crops. Development of tolerant rootstock varieties should be given attention for sustainable production of the fruit crops.

Technical gap and lack of training was one on serious challenge in many nurseries. A nurseryman stated that sometimes grafting failed up to 100% most probably due to improper scion handling and technical gap. Different composition soil media were used in the nurseries for potting. Various pot sizes were observed sometimes too small which was below standards.

Occurrence of diseases and pests were also mentioned as another constraint in fruit nurseries. The major were red scale and white fly on citrus; white mango scale on mango; and powdery mildew on mango and papaya in many nurseries and they have been applying pesticides like Mancozeb and Redomil.

Table 2: Constraints identified for 10 selected nurseries in Amhara and Tigray regions*

No	Challenges faced by the nurseries	Proportion of nurseries facing the problem (%)
1	Absence of shade net	90%
2	Absence of mother stock for scion source	80%
3	Poor seed quality	60%
4	Technical gap and lack of training	50%
5	Pests and diseases	40%
7	Quality of grafting equipments	30%
6	Lack of some materials (Ice box, tools and grafting tape)	20%
8	Lack and expense of polyethylene	10%
9	Irrigation water	10%

*Adapted from ASARCA annual report 2014

To address these challenges, stakeholders engaged in research and development of horticulture such agricultural universities, research centers, other GOs and NGOs have to take its part to support the fruit nurseries and address the challenges they are facing. Availing improved technologies, training, facilitation and technology promotion should be strengthened to improve performance of the nurseries to produce seedlings with required standards.



Figure 3: Fruit nurseries under shade constructed by locally available materials; Seleklaka(a), Wukuro(b) Finoteselam(c) and Dolu (d)



Figure 4: Fruit nursery under net shade at Feredweha (Attaye), supported by MARC.

Micro-Enterprise Private Nurseries

Along with the expansion of the horticulture sector in Ethiopia, the demand for planting materials of improved fruit varieties is increasing. Many professionals and organizations have been recommending involvement of private sector to propagate planting materials of horticultural crops to contribute for the ever-increasing demand of the industry (Avihai and Workafes, 2011). Implementing resource-generating strategies such as marketing of seedlings of high value fruit trees was suggested to sustain supply of planting materials (Yosef *et al.*, 2013). Private nursery enterprises are recently emerging sub-sector in the country. Limited numbers of nurseries for tropical fruits that have started in recent times were identified and most of them were concentrated in central part of the country. Based on information obtained from primary and secondary sources, status and activities of three private nurseries located in East Shewa zone namely TEAZ Fruit Nursery Micro-Enterprise, Masresha Nursery Micro-Enterprise and Mojo Youth Cooperative Fruit Nursery were assessed (Annex Table 2). The discussion was focus on establishment, propagation activities and constraints of each selected nurseries.

TEAZ Fruit Nursery Micro-Enterprise

TEAZ Fruit Nursery Micro-Enterprise was a licensed private nursery in Adama City (East Shewa, Oromia) and owned by a group of people which contained seven active members. According to the manager of the nursery it was established in the year 2008 to propagate and market mango seedlings. Establishment of mother tree and propagating ornamentals and other fruit crops were stated as future plan of the nursery.

Up to the 2017 the nursery has been propagated and distributed 176,200 fruit seedlings (Table 5). During the assessment, there was 5,200 grafted and 9,000 non-grafted mango seedlings were available in the nursery site. The nursery was protected within a compound and covered by shade net.

Unit price of a grafted seedling had been increased from 35 to 70 ETB from the year 2009 to 2017. Main customers to purchase their fruit seedling were different NGOs mainly World Vision Ethiopia, SOS, Care Ethiopia and Catholic Relief Service; and Agricultural offices from Oromia region, Silitezone and Gurage zone. Individuals and residents of Adama city had also been purchasing seedlings from the nursery.

The main scion sources of nursery were MARC and Ziway Prison Administration since they don't have their own mother stocks. They had been also getting bud-stick from plantation who has planted known varieties such as Genet's orchard at Alemtena who growing about 200 mango trees and individuals' home garden in Adama city. Other constraints of the nursery were irrigation water expense, market linkage and appearance of diseases and pests.

Table 5: Number of seedlings produced by TEAZ fruit nursery

Year	No of seedlings per year	Average price per seedling (ETB)
2009-2012	7,000	35.00
2013-2015	30,000	50.00
2016-2017	19,400	70.00
Total	176,200	50.00

Masresha Nursery Micro-Enterprise

Masresha Nursery Micro-Enterprise was one of private nursery located in Adama city (East Shewa, Oromia). It was licensed and owned by a woman called Masresha. According to the owner and manager of the nursery it was established in 2011 to propagate seedlings of fruit crops mainly avocado, mango and papaya. It has planned to propagate ornamental plants along with fruit seedlings.

In the year 2012, the nursery had prepared about 2,000 fruit seedlings from which 50% were grafted while the remaining were distributed without grafting. In 2013, 7000 seedlings were multiplied and sold. In the next two consecutive years 1500 and 3000 grafted seedlings had propagated, respectively. The main scion sources of nursery were MARC and individuals' home gardens in Awash Melkassa town. Manager of the nursery had trained and get technical support from MARC. Local varieties were used for root stocks from local markets. For papaya, seeds were collected from MARC and local markets.

Market price per grafted seedling was 35 to 40 ETB during the first two years and 65 to 70 ETB during next two years. Their customers were NGO and agricultural offices from different parts of the country including Jimma, Wollega and Harar. Individuals from Adama, Debre Zeit and Addis Ababa had also been purchasing grafted seedlings.

Constraints of the nursery which were pointed out by the owner of the nursery were scion shortage, delay of providing permanent nursery site from the city municipality, and occurrence of a pest called 'mango white scale'.

Mojo Youth Cooperative Fruit Nursery

The third licensed private owned nursery was Mojo Youth Cooperative Fruit Nursery. It was situated in Mojo Town (Oromia, East Shewa). The nursery was established in the year 2014 and owned by youths of 13 members and named as Gudatu Irrigation Users Cooperative. According to chairperson of the youth cooperatives, several assistances had been given by MARC such as training, provision of bud-stick and avocado varieties for mother stock establishment. Net house was also supplied and construction by MARC. Some nursery materials (ice box, alcohol and grafting knife) were provided by Agricultural Growth Program. Currently they are working on multiplication of avocado, mango and papaya seedlings. In future they want to extent the activity to multiply forest trees and ornamentals.

They had practicing grafting activity by themselves; in early times they had been supported by grafting experts from MARC. About 5,000 avocado, 5,000 mango and 10,000 papaya seedlings were being propagated in the nursery during assessment. The nursery supplied scions from MARC for several years with no charge. Mother-block for scion source of improved avocado varieties were established with support of MARC. Small holder farmers and urban dwellers were their main customers to purchase the seedlings. Price of per a grafted seedling was about 50 to 60 ETB in 2015 and rose to 75 ETB in 2016.

Gaps or challenges had faced by the nursery in relation with fruit propagation were shortage of capital budget, shortage of scion materials, poor quality rootstock seed, and market linkage especially for less demand for papaya seedling and lack of polyethylene bags with appropriate size.

Advanced Nurseries

The word 'advanced' is a relative term to indicate the nurseries to be discussed in sub section were well equipped by basic facilities as compared to the rest of public and private nurseries in the country. As discussed above, most fruit nursery development and propagation activities in Ethiopia were traditional. Despite of great contribution for dissemination of improved fruit varieties to smallholder farmers and some commercial growers, they lack basic nursery facilities and standards. Among fruit nurseries assessed in Ethiopia, MASHAV supported nurseries and nursery of Upper Awash Agro-Industry Enterprise were considered as advanced nurseries. They had better nursery facilities such as shade net, irrigation system and fencing. It was observed that they also had better capacity to produce large number of seedlings.

Fruit Nurseries Supported by MASHAV

A technical program, Smallholder Horticulture Project (SHP), had been operated in Ethiopia by joint cooperation of The United States Agency for International Development (USAID), Israel's Agency for International Development (MASHAV) and Ministry of Agriculture (MoA) to address constraints and build the capacity of smallholder farmers to develop a competitive and sustainable horticulture sector. The program had been providing technical and financial support to disseminate technologies that have the potential to increase productivity and improve quality standards in order to ultimately increase farmers' income (http://embassies.gov.il/addis_ababa/).

The first phase of the project was started in 2005 as a pilot project in SNNP Region at Butajira and Areka fruit nursery centers. Later, the project centers were extended to Alamata, Picolo and Uke nursery centers in Tigray, Amhara and Oromia regions, respectively. But the activity at Uke nursery center was suspended due to occurrence of new quarantine insect pest called white mango scale (*Aulacaspistubercularis*). In next phase, USAID-MASHAV-MoA project was supporting five project nursery centers (Picolo, Butajira, Alamata, Areka and Kersa) and four satellite nursery centers (Chagni, Bure, Jabi Tehan and Mehoni) (MASHAV, 2018).

Fruit nurseries supported by MASHAV had many advanced facilities and activities as compared to the other nurseries in Ethiopia. These include a shade net with relatively larger area, efficient use of water through drip irrigation system, supplying plant nutrients by fertigation and using special grafting tape known as 'parafilm' used for wrapping the grafted plant (graft-union). Solar drip irrigation system (Figure 5) was installed to Common Interest Group (CIG) of women owned nursery center in Kersa woreda of Jimma zone in collaboration with the Oromia Irrigation Development Authority and the Ethiopian Agricultural Transformation Agency (MASHAV, 2018).



Figure 5: Advanced MASHAV supported fruit nursery under net shade at Kersa (Meri): Solar power for drip irrigation (a, b), net shade(c), mother trees for scion source (d)

Grafted fruit seedling production

About half a million grafted seedlings of avocado, citrus and mango were propagated in five project nurseries during the years 2010 to 2016 out of which majority (65%) were avocado seedlings (Table 6a). After 2016 the nurseries focused to propagate single fruit crop, avocado, with the objective of expanding avocado fruit production and in turn enhance its export

to some international markets. Most of seedlings were from Hass variety which has the best demand in the market with some amount of Ettinger variety (Table 6b). In response to scion shortage in the country, the project imported more than 144,800 scions from Israel (MASHAV, 2017).

Table 6a: Fruit seedling production and supply by MASHAV supported nursery centers during the years 2010 to 2016*

Fruit crop	Nursery involved	Amount produced and supplied
Avocado	Butajira, Picolo, Areka, Uke, Alamata	313,037
Mango	Butajira, Picolo, Areka, Uke, Alamata	164,662
Citrus	Picolo, Alamata	15,086
Total		492,785

Adapted from MASHAV annual report 2018

Table 6b: Avocado seedlings propagation and supply by MASHAV supported nursery centers during the years 2016 to 2018*

Year	Nursery involved		Amount produced and supplied	and Remark
	Project centers	Satellite centers		
2016	Butajira, Picolo, Areka, Uke and Alamata	-	44,805	
2017	Butajira, Picolo, Areka, Uke and Alamata	Chagni, Bure, Jabi Tehan and Mehoni	152,000	About 32% was by satellite nurseries
2018	Butajira, Picolo, Areka, Alamata and Kersa	Chagni, Bure, Jabi Tehan and Mehoni	171,381	About 30% was by satellite nurseries
Total			368,186	

Adapted from MASHAV annual report 2018

Seedling delivery

Goal of the project was to promote economic growth in rural Ethiopia through strengthening commercialization of small farmers in avocado production in areas with recognized market potential. The purpose was to develop a competitive and sustainable fruit development sector focusing on establishing a base to export avocado from Ethiopia (MASHAV, 2018). Grafted avocado seedlings have been supplied to 'clustered' farmers in potential avocado growing areas in the four regions of Ethiopia. Amount of avocado export showed more than 30 fold increase during 2015 to 2017 (ERCA, 2015; 2017). Such impact in export was most probably the result of nursery development and the popularization of improved avocado in clustering and commercialization approach.

The project had also supplied 3,840 grafted avocado seedlings free of charge in four regions (Amhara, Harari, Oromia and Sidama) as well as in Dire Dawa city administration to established Mother Clone Plantation of Hass variety in various districts (Table 7). This will help the regions to provide adequate scions for grafting and expansion of avocado plantation.

Table 7: Grafted avocado seedlings supplied in 2017 for Mother Clone Plantation in different part of the country*

No	Location	Seedling supplied	Regions
1	Bahir Dar University	400	Amhara
2	Gonder Zuria	500	Amhara
3	Sekota and Gazgibila	250	Amhara
4	Dire Dawa	70	Dire Dawa
5	Harari	500	Harari
6	Kersa Woreda	500	Oromia
7	Aletawondo	400	Sidama
8	Dara	250	Sidama
9	Shebedino	385	Sidama
10	Shebedino woreda	585	Sidama
Total		3,840	

*Source: MASHAV, 2017

Fruit Nurseries of Upper Awash Agro-Industry Enterprise

Upper Awash Agro-Industry Enterprise (UAAIE) was first established in 1975 as a joint venture by local and foreign private investors. In 1993, it was re-organized as a public enterprise having four farms and one processing plant under it. In 2013, UAAIE was privatized and came under the management of HORIZON Plantations PLC, a company affiliated to MIDROC Ethiopia Group. It is the biggest producer of oranges, mandarins and other tropical fruits like mango and papaya in Ethiopia. The company was also producer and supplier of tomato paste, tomato juice, orange marmalade and guava nectar. Out of its 4,200 ha total arable land, about 2,200 ha of the land is occupied by perennial crops (1,200 ha of citrus, 400 ha of mango, and the remaining land is occupied by papaya, guava, lemon, lime and grape vine).

(<https://horizonplantations.com/upperawash-horizon.html>).

UAAIE has been propagating and marketing grafted fruit seedlings, mainly of mango, for more than a decade. In this regard the enterprise has contributed a lot in promoting improved fruit varieties in the country (Edossaet *et al.*, 2016). According to Kahsay *et al.* (2009) and FAO (2016) many farmers had been getting grafted seedlings of mango from UAAIE.

Propagation of fruit seedlings in conventional nursery

Total of 415,092 mango seedlings were distributed in five consecutive years (2011 to 2016) and nearly 11 million ETB income was generated (Table 8). Main customers were private farms such as Segel PLC and Tigray Development Association. Agricultural Offices from Amhara, Oromia and SNNP were also clients to purchase the seedlings and distribute for smallholder farmers in their respective regions. Selling price of grafted mango seedlings has been increasing through years and showed 425.8% increase between the years 2012 and 2016. During the assessment, 310,000 mango and citrus seedlings were available for distribution in year the 2017.

Table 8: Marketing information of grafted mango seedling by UAAIE in five consecutive years

No	Budget year	Grafted seedling sold	Value (ETB)	Unit price (ETB)
1	2012	242,922	3187,904.62	13.12
2	2013	71,984	2,397,260.25	33.30
3	2014	50,173	2,546,212.48	50.75
4	2015	42,445	2,288,338.68	53.91
5	2016	7,568	522,080.00	68.99
Total		415,092	10,941,796.00	44.01

Adapted from UAAIE annual reports, 2012-2016

Propagation of fruit seedlings under greenhouse

Recently UAAIE had constructed modern green house (1.3 ha area) with modern facility to control micro-environment mainly temperature and relative humidity (Figure 6). The fruit nursery under the greenhouse could be considered as 'advanced' because of its latest technologies such as automated greenhouse and watering systems. More than 50,000 mango seedlings were growing in the green house during the assessment. It was conducive for fast growing and had resulted in better grafting success (at least 95%). Mango seedlings growing in green house were found to grow fast may be due to optimum growing temperature and relative humidity; hence they reach for grafting and transplanting in a shorter period of time as compared to the conventional conditions. Since the temperature and humidity were being controlled, seedlings could be grafted in any months of a year which is not possible under conventional fruit nurseries.

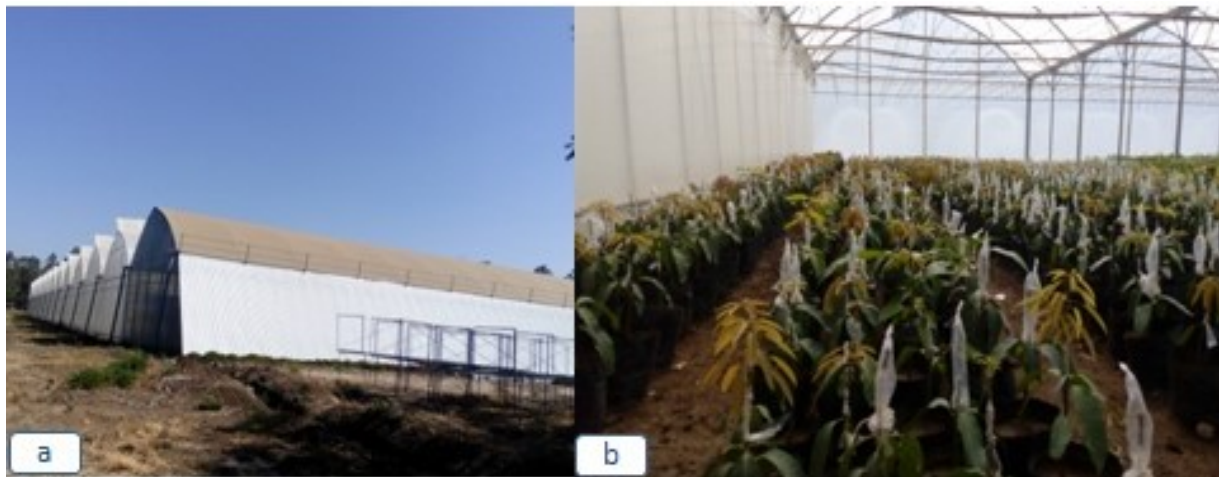


Figure 6: Advanced fruit nursery under greenhouse condition at UAAIE: greenhouse structure (a), grafted mango under green house (b)

SUMMARY AND CONCLUSION

Three categories of fruit nurseries: public, micro-enterprise and advanced nurseries were assessed to evaluate and document available information; and point out challenges and opportunities for future uses and interventions. Quantity of seedling production per year for public, micro-enterprise private and advanced nurseries ranged from 12,734 to 120,042; 3375 to 20,000 and 70397 to 122,728, respectively. The highest number of seedlings was produced by advanced nurseries followed by public nurseries. Maximum selling price of a grafted fruit seedling was 25 ETB at public nurseries and 75 ETB in private nurseries. Public nurseries have delivered seedling for smallholder farmers with subsidized price while most private were selling in higher price since they are profit oriented.

Bureaus of Agriculture in respective districts played vital role in providing land for nursery establishment and supervision of activities for public nurseries. Research centers particularly MARC has contributed significant role in nursery development of tropical fruits through providing improved varieties, training, supplying scions, tools and facility for public and private nurseries. Some nurseries had provided nursery tools from NGOs and other institutions such as FAO had supporting some fruit nurseries in the country. MASHAV and UAAIE have exerted great role in introducing advanced nursery facility and delivering large number of grafted fruit seedlings.

Nursery facility was a serious constraint for public and micro-enterprise nurseries that most of them do not have basic infrastructure particularly shade house. Few nurseries supplied a shade net but most of them have still using shade house constructed from local materials. Advanced nurseries were with better basic infrastructure such as net house and irrigation facilities. Only few public nurseries have their own mother trees (mother-block) for scion source. The nurseries supported by MASHAV had solved scion shortage by importing scions from Israel. In long run the issue of availability of scion would not continue to be a challenge for public and MASHAV supported nurseries because they have planted mother trees to be used as scion sources. Fortunately, UAAIE do not have any challenge with regard to scion, because they have plantation of improved varieties in large areas. It is difficult to solve problem of mother trees for private nurseries, as most of them do not have own land to grow mother trees. Concerned government bodies have to take into account to provide them land plots for

nursery, mother stock plantation and marketing of seedlings. Poor rootstock seed quality, technical gap and lack of some tools were also mentioned as constraints of many nurseries.

Generally, stakeholders engaged in research and development of horticulture such as universities with agriculture, colleges, research centers, and other governmental and non-governmental organizations have to take their part to support the fruit nurseries and address the challenges that the nurseries are facing and to improve performance of the nurseries to produce seedlings with required standards. Research innovations required to solve some of the constraints for sustainable seedling and fruit productions. Tolerant rootstock varieties for avocado root rot disease and salinity problem for mango should be developed. Standardizing media composition, optimizing radiation level and temperature deserve research attention to improve graft success and growth of grafted seedlings. Integrated pest management has to be developed to managing white mango scale. Moreover, regulation, standards and certification process have to be developed for fruit nurseries and grafted fruit plants production.

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ANNEXES

Annex Table 1: Public or government nurseries that had supported by MARC – ASARECA project

No	Name of Nursery	Region	Nearest town	Distance from the town (km)	Altitude (m a.s.l)	Geographical coordinates	Target fruit crop
1	MARC	Oromia	Adama	15	763	8°24'N 39°21'E	Avocado, Banana Citrus, Mango, Papaya
2	Feredweha	Amhara	Ataye	5.5		10°20'N 39°57'E	Avocado, Mango
3	Sitir nursery	Amhara	Dawa chefa	6	1,424	10°43'N 39°52'E	Avocado, Mango
4	Finoteselam	Amhara	Finoteselam	3	1850	10°42'N 37°16'E	Avocado, Mango
5	Guangua	Amhara	Chagini	2	1,583	10°57'N 36°30'E	Avocado, Mango
6	Gudino	Oromia	Adea	10	1,920	8°45'N 38°59'E	Avocado
7	Ziway FTC	Oromia	Adamitulu	5	775	7°56'N 38°43'E	
8	Turge	Oromia	Arsinegele	15	2,043	7°21'N 38°42'E	Avocado
9	Wondo	Oromia	Wondo	18	1,723	7°1'N 38°35'E	Avocado
10	Boako Tibe	Oromia	Bako	10	1743	9°08'N 37°03'E	Mango
11	Melko	Oromia	Jimma	25	1753	7°46'N 36°47'E	
12	Wendogenet	SNPP	Wendogenet	20	1,723	7°1'N 38°35'E	Avocado
13	Sedeka	SNPP	Shebedino	30			
14	Huye	SNPP	Aletachuko	25			
15	Lante	SNPP	A/Minich	10	1,285	6°2'N 37°33'E	Mango
16	Balla	Tigray	Rayaazebo	3	1468	12° 39'N 39°44E	Avocado, Mango
17	Mehoni	Tigray	Rayaazebo	1.5	1468	12° 39'N 39°44E	Avocado, Mango
18	Wukro	Tigray	Kilteawlalo	0.5	1,972	13° 47'N39° 35'E	Avocado, Mango
19	Hawzin	Tigray	Hawzin	1			Avocado
20	Selklaka	Tigray	Medebayzana	10			Avocado, Mango

Annex Table 2: Micro-enterprise andMASHAV Supported Fruit Nurseries

No	Name of nursery center	Region	Zone	Nearest town	Distance from the town (km)	Target fruit crop
1	TEAZ Micro-Enterprise	Oromia	East Shewa	Adama	0	Avocado, Mango
2	Masresha Micro-Enterprise	Oromia	East Shewa	Adama	0	Avocado, Mango
3	Mojo Youth Cooperative Fruit Nursery	Oromia	East Shewa	Mojo	2	Avocado, Papaya, Trees
4	Areka Fruit Nursery	SNNP	Wolayta	Areka	0	Avocado, Mango
5	Butajira Fruit Nursery	SNNP	Gurage	Butajira	1	Avocado
6	Merewa Fruit Nursery	Oromia	Jimma	Jimma	18	Avocado
7	Picolo Fruit Nursery	Amhara	East Gojam	Bahir Dar	15	Avocado, Citrus, Mango
8	Timuga Fruit Nursery	Tigray	Southern Zone	Alamata	3	Avocado, Citrus, Mango