



GEORGIA HORTICULTURE SECTOR DEVELOPMENT ASSESSMENT

FINAL

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Author: David Picha

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Reviewed by:

Zurab Chekurashvili, ASC Deputy Component Team Leader

Dennis Zeedyk, ASC Component Team Leader

ABSTRACT

The purpose of the assignment was to assess and recommend future USAID-Economic Prosperity Initiative (EPI) project interventions in the horticulture sector that will result in increased domestic and export volume/value of a diversity of vegetable and fruit crops and agro-processed products. The project's objective is to significantly increase investments in the horticulture sector during the next three years which will make it more domestically and globally competitive.

All of the horticultural crop value chains within the country were reassessed in order to determine which ones could provide the greatest return on USAID's investment, considering the timespan required to implement the training and technical assistance interventions of the project and their potential economic impact on product farm-gate value, import substitution, and export volume/value.

ABBREVIATIONS

EPI - Economic Prosperity Initiative

ppm - parts per million

USAID - United States Agency for International Development

CIS – Commonwealth of Independent States

IQF – Individual Quick Freeze

PHH – Post Harvest Handling

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I. EXECUTIVE SUMMARY

Georgia is an agro-climatically diverse country suitable for the production of numerous fruit and vegetable crops. However, multiple improvements are needed to overcome existing constraints in crop production practices, harvesting methods, postharvest care, packaging, agro-processing, and marketing. The existing constraints result in low crop yields, short product postharvest life, low market quality, and limited duration of product availability. Specific interventions were identified for implementation by the EPI project to improve crop yield and quality, postharvest life, and product market duration and value.

Considerable training and technical assistance is required for growers, packers, and storage operators in the form of demonstration plots, detailed crop production and postharvest care publications, videos, and other educational materials. Cooperation of Farm Service Centers, collection centers, and progressive growers is needed for efficient information dissemination to the horticulture sector stakeholders in each of the major production regions. Adoption of the improved production and postharvest care practices will result in more consistent supplies of higher quality products, which is required by the horticulture sector to be competitive in domestic and international markets.

Immediate economic impact can be realized by improved production and postharvest care practices for open-field and greenhouse vegetables, mandarins, and hazelnuts. Long-term economic impact can be realized by improved production and postharvest care practices for tree fruit and berry crops. Significant domestic and international market opportunities exist for those Georgian growers who can provide consistent supplies of high-quality products at competitive market prices.

Market demand and availability will be the forces that sustain the development and expansion of the Georgian horticulture sector. Significant opportunities exist in the domestic market by replacing vegetable and fruit imports with Georgian-produced products. Examples include numerous vegetable crops from Turkey, apples from Ukraine and Europe, and pomegranates from Azerbaijan. In addition, significant export market opportunities exist for Georgian producers and agro-processors. These include expansion of mandarin exports to multiple Commonwealth of Independent States (CIS) countries and Europe; hazelnuts to numerous destinations, herbs to Europe; processed berry, pomegranate, and vegetable products to multiple countries; and market expansion of other value-added horticulture products. The proximity to developing regional economies (i.e., CIS countries, Middle East, Europe) provides Georgian horticulture crop producers and agro-processors significant potential for future market growth.

Multiple interventions will be necessary to advance the horticulture sector and make it more competitive in domestic and export markets. Attention should be given to training and technical assistance to growers and farm managers on improved crop production and postharvest care practices in order to obtain higher marketable yields of the targeted vegetable crops, mandarins, and hazelnuts. This will include information dissemination using a combination of demonstration plots, written technical guides, training events by domestic and expatriate specialists, videos, etc. Detailed crop-specific production and postharvest care guides specific to Georgia are needed for all of the major vegetable crops, mandarins, and hazelnuts.

For optimal and most efficient training impact, the demonstration plots illustrating improved production and postharvest care practices would most logically be located in cooperation

with Farm Service Centers, private sector stakeholder production sites, mandarin fruit collection centers, packinghouse/cold storage facilities, and hazelnut processing facilities.

All production practice areas need improvement in order for growers to increase their yields of marketable product. Average horticultural crop yields in Georgia are low compared to many other countries. Yield increases of 25-100% are possible for many fruits and vegetables within the life of the EPI project by implementation of proper production practices. The production practice areas which require detailed training and technical assistance to the Georgian vegetable, mandarin, and hazelnut producers include: soil preparation, plant establishment, variety selection, mulching, irrigation methods, fertilization practices, insect control, disease control, weed control, pruning and renovation of existing mandarin and hazelnut trees, harvesting practices, and greenhouse/protected structure design.

All areas of product postharvest care need improvement within the Georgian horticulture sector. Average marketable "yield" increases of 10% are possible for many fruits and vegetables within the life of the EPI project by implementation of proper postharvest care practices, which reduce postharvest decay, minimize weight loss, and preserve product quality. Georgian growers and exporters generally do not properly grade, pack, and cool their products. Value is lost due to inadequate postharvest care and rapid product deterioration in warm temperature storage and transport environments.

Consistent supplies of high-quality fruits and vegetables and their processed products can only be realized by the utilization of proper postharvest care. This will include necessary improvements in cooling to remove the field heat from the harvested product, proper temperature and humidity control during storage, proper product cleaning, better sorting and grading to improve product uniformity, postharvest decay control, waxing, better packaging, and other improved postharvest technologies. Proper equipment for product cleaning, sorting/grading, decay control, and packing is needed throughout the horticulture crop growing regions. In addition to improved packinghouse equipment and infrastructure, more cold storage capacity is needed within the country to preserve the market life and quality of the perishable horticultural crops.

The main focus of the EPI-funded interventions in the horticulture sector should be on training, technical assistance, and technology transfer. Historically, there has been a dearth of information available to horticultural crop producers and agro-processors in Georgia. The lack of awareness and understanding of appropriate production practices, inadequate application of modern production technologies, lack of planting of higher-yielding crop varieties demanded in the marketplace, and improper postharvest care have all been major limitations to the advancement and competitiveness of the Georgian horticulture sector. Empowering the producers, agro-processors, and support service personnel with detailed crop-specific production, postharvest care, and market quality information will provide the sector the knowledge base required to develop a competitive and sustainable horticulture industry. Awareness and application of the best agricultural practices appropriate to the financial situation of the stakeholder is necessary in order to provide the market with consistent supplies of high-quality product at competitive prices.

Training, technical assistance, and demonstration plot activities will need to be developed for incorporation into the EPI project work plan and to obtain the desired goal of improved production and postharvest care practices for horticultural crops. The training and educational activities should focus on overcoming the existing weak links and constraints in the vegetable crop, mandarin, and hazelnut value chains. An example of a specific EPI project intervention pertaining to improved postharvest care and marketing of mandarin fruit is described in the report. Demonstrations should be conducted at one or more of the major

mandarin collection centers in southwest Georgia to show the potential benefits of adopting these improved postharvest care technologies. The demonstrations should involve the use of proper packinghouse procedures and equipment (i.e., cleaning, sorting/grading, fungicide application, waxing, shrink-wrap packaging, and cold storage at 4° C). Successful implementation of these training and demonstration activities will allow the mandarin growers and marketers to add value to their fruit, extend the marketing period, and penetrate additional domestic and export markets.

RECOMMENDATIONS

- Conduct large-scale training and technical assistance for growers, packers, and storage operators in the form of demonstration plots, detailed crop production and PHH publications, and other educational materials. Whenever possible, these should be done in conjunction with FSC's, processors, collection centers and cold storage facilities who may act as the final buyers.
- Demonstrate economic impact that can be realized from improved production and PHH practices for open-field and greenhouse vegetables, mandarins and hazelnuts. This should follow the actual technical demonstration to show actual operators what needs to be done.
- Demonstrate the significant opportunities that exist in the domestic market by replacing imported fruit and vegetable products, as well as the export market due to seasonal advantages as a result of Georgia's earlier production and proximity to regional markets.

II. APPENDICES

- A. BACKGROUND**
- B. METHODOLOGY**
- C. FINDINGS**
- D. RECOMMENDATIONS**
- E. ADDITIONAL INFORMATION**

A. BACKGROUND

The horticulture sector represents one of the highest potential sources of economic growth in Georgian agriculture. Cultivation of horticultural crops typically allows producers to obtain substantially higher rates of return compared to the principal agronomic crops of wheat, sunflower, and corn. The characteristic high value per unit area of horticultural crop production is particularly important to those areas where available land for cultivation is limited.

The demand for fruits and vegetables is generally increasing in both the domestic and international market. This bodes well for the future of the Georgian horticulture sector. Further development of fruit and vegetable crop production and value-added products in Georgia will result in increased rural income, enhanced employment, and a positive economic impact among multiple segments of the population.

The assignment involved numerous meetings with producers, agroprocessors, Farm Service Center personnel, produce buyers, and marketers. Site visits were made to the main horticulture crop producing regions in the country. This resulted in a better understanding of the opportunities and challenges in the horticulture sector. Four different regional value chains were assessed and appropriate interventions were identified to advance the horticulture sector in each region. The regional value chains included 1) fruit crops (i.e., mandarins, apples, berries); 2) storage organs (i.e., potatoes, onions); 3) greenhouse vegetables (i.e., tomatoes, cucumbers, peppers, eggplant, herbs); and 4) open-field vegetables (i.e., tomatoes, peppers, watermelons, melons, cabbage).

Significant growth opportunities exist in the domestic market by the replacement of imported fruits and vegetables with domestically grown products. In addition, export volume of existing and new fresh and processed horticultural products has significant growth potential. Realization of these growth opportunities in the horticulture sector will require significant improvements in crop production practices, better postharvest care, and additional cold storage infrastructure to preserve product quality after harvest and extend market life.

HORTICULTURE SECTOR SITUATION

Georgia has a diversity of agro-climatic zones suitable for the commercial production of numerous temperate and subtropical fruits and a wide diversity of open-field and greenhouse vegetable crops. Flat valley areas with favorable soil conditions and access to good quality irrigation water exist throughout the country. Abundant sunlight and access to geothermal energy also provide comparative advantages for the production of greenhouse vegetables. An adequate workforce is generally available to perform the numerous production practices, harvesting, and postharvest handling and packing requirements of the labor-intensive horticulture sector. An established agroprocessing industry also exists. These are all highly desirable conditions that favor the long-term development of the horticulture sector. However, the short-term development potential is restricted by poor crop production practices, low yields, use of older varieties, high post-harvest losses, lack of economy-of-scale operations, limited access to financing, and underdeveloped market opportunities.

With the exception of wine grapes, the horticulture industry is mostly based on small-scale (<0.5 hectare) inefficient production units. Even the relatively “large-scale” growing operations of more than several hectares would be considered small-scale on an international basis. The lack of large, modern, and efficient growing operations is a constraint to the development of the horticulture sector in Georgia. The absence of

GlobalGAP-certified production operations also restricts export market opportunities targeted to the high-value retail supermarket trade in many European countries.

A lack of information exists among growers, packers, and storage facility operators regarding the most desirable crop production practices and postharvest care. Optimization and modernization of production practices, planting of newer fruit and vegetable crop varieties, and improved postharvest care practices will be essential in order to obtain higher crop yields, reduce postharvest losses, increase crop value, and extend the market life of all fruits and vegetables. High amounts of postharvest losses, in the range of 15-35% of the harvest volume, constrain many fruit and vegetable growing operations in Georgia. This can be attributed to a lack of product cooling after harvest, a lack of cold chain maintenance, inadequate humidity control, deficiencies in the packing process, and poor quality packaging materials.

Minimal change in the Georgian horticulture sector has occurred during the last several decades. The crop varieties being grown, production practices, harvesting methods, packaging materials, and lack of postharvest care is similar now to a decade or two earlier. This stagnation has not allowed the horticulture sector to establish itself as a significant supplier in the competitive global marketplace. The problem is further compounded by the lack of research and extension efforts in the public sector on modern technologies for horticultural crop production and postharvest care. Horticulturists with knowledge of the latest technologies coupled with significant field experience are not available to the farming community at the regional level. The lack of certified disease-free planting stock is also a major constraint. Furthermore, growers are not aware of, nor have access to, the latest varieties of fruit and vegetable crops that are being grown commercially in other countries with similar agro-climatic conditions to Georgia. These varieties are often the ones with the greatest demand in the global marketplace.

The domestic fresh market continues to remain the primary market outlet for the vast majority of Georgian-grown products. However, development of the export market represents the area with the most growth potential for the horticulture sector. Lack of export market opportunity awareness is a constraint that limits the expansion of the sector. In addition, GlobalGAP certification by producers and ISO/HACCP certification by agro-processors is required for penetration of many high-value horticulture product export markets.

There is a minimal amount of agroprocessing capacity for horticultural crops in Georgia. Agroprocessing operations include several fruit juice processors, a fruit and vegetable bottling and canning plant, several fruit preserving operations, and a small fruit block-freezing operation. There is no individual quick freeze (IQF) processor or fruit/vegetable dehydrating plant in the country.

Increasing the volume of fresh and agro-processed fruit and vegetable crop exports from Georgia will have the most economic impact and stimulatory effect on the horticulture sector. Crop yield and quality must be improved for all commodities in order to be able to provide the various market outlets with consistent supplies of high-quality products. The horticulture sector in Georgia must modernize and give preference to the highest valued crops, and value-added products, in order to remain competitive and increase market share. Horticultural crop competition from Turkey, Ukraine, and other CIS countries must be overcome in order to expand the Georgian product domestic and regional export market positions.

Principal Fruit and Vegetable Crops

The leading horticulture crops in Georgia are shown in Table 1 below.

Table 1. Leading Horticultural Crop Production Volume and Value in Georgia (2009).

Crop	Production Volume (metric tons)	Average Farmgate Price (\$/kg)	Production Value (\$)
Potato	216,800	0.42	91,056,000
Mandarins	90,500	0.42	38,010,000
Tomato	51,400	0.36	18,504,000
Cucumber	30,900	0.60	18,540,000
Hazelnut	21,800	2.53	55,154,000
Onion	10,200	0.60	6,120,000

Source: EPI Project

The potato is the leading fresh market horticultural crop produced in Georgia. Production volume was 216,800 metric tons in 2009, with a farm-gate value of \$91 million. Hazelnut is the second most important horticulture crop in terms of production value (\$55 million), while mandarins are the leading fruit crop in production volume. Tomatoes, cucumbers, and onions are the next most important vegetable crops produced in the country after potatoes. The leading agro-processed fruit is the grape, which is mostly grown for wine production. Apples and peaches are other major fruit crops produced in Georgia. Watermelons, melons, peppers, cabbage, and eggplant are the other leading vegetable crops produced in the country.

Market Opportunities

Market demand and availability will be the forces that sustain the development and expansion of the Georgian horticulture sector. Significant opportunities exist in the domestic market by replacing vegetable and fruit imports with Georgian-produced products. Examples include numerous vegetable crops from Turkey, apples from Ukraine and Europe, and pomegranates from Azerbaijan. In addition, significant export market opportunities exist for Georgian producers and agro-processors. These include expansion of mandarin exports to multiple CIS countries and Europe, hazelnuts to numerous destinations, herbs to Europe, processed berry, pomegranate, and vegetable products to multiple countries, and market expansion of other value-added horticulture products. The proximity to developing regional economies (i.e., CIS countries, Middle East, Europe) provides Georgian horticulture crop producers and agro-processors significant potential for future market growth.

The global market for fresh produce and value-added agro-processed fruit and vegetable products continues to grow as world population expands and per capita fruit and vegetable

consumption increases in many countries. Significant domestic and export market opportunities exist for those Georgian producer/exporters that can provide consistent supplies of high-quality product at competitive market prices. Private sector participation in annual trade fairs, such as Fruit Logistica in Berlin, are excellent opportunities to develop new market linkages and opportunities and establish additional buyer contacts.

B. METHODOLOGY

METHODOLOGY FOR HORTICULTURE SECTOR DEVELOPMENT

Multiple interventions will be necessary to advance the horticulture sector and make it more competitive in domestic and export markets. Attention should be given to training and technical assistance to growers and farm managers on improved crop production and postharvest care practices in order to obtain higher marketable yields of the targeted vegetable crops, mandarins, and hazelnuts. This will include information dissemination using a combination of demonstration plots, written technical guides, training events by domestic and expatriate specialists, videos, etc. Detailed crop-specific production and postharvest care guides specific to Georgia are needed for all of the major vegetable crops, mandarins, and hazelnuts.

For optimal and most efficient training impact, the demonstration plots illustrating improved production and postharvest care practices would most logically be located in cooperation with Farm Service Centers, private sector stakeholder production sites, mandarin fruit collection centers, packinghouse/cold storage facilities, and hazelnut processing facilities.

All production practice areas need improvement in order for growers to increase their yields of marketable product. Average horticultural crop yields in Georgia are low compared to many other countries. Yield increases of 25-100% are possible for many fruits and vegetables within the life of the EPI project by implementation of proper production practices.

The areas which require detailed training and technical assistance to the Georgian vegetable, mandarin, and hazelnut producers include soil preparation, plant establishment, variety selection, mulching, irrigation methods, fertilization practices, insect control, disease control, weed control, pruning and renovation of existing mandarin and hazelnut trees, harvesting practices, and greenhouse/protected structure design.

All areas of product postharvest care need improvement within the Georgian horticulture sector. Average marketable “yield” increases of 10% are possible for many fruits and vegetables within the life of the EPI project by implementation of proper postharvest care practices, which reduce postharvest decay, minimize weight loss, and preserve product quality. Georgian growers and exporters generally do not properly grade, pack, and cool their products. Value is lost due to inadequate postharvest care and rapid product deterioration in warm temperature storage and transport environments.

Consistent supplies of high-quality fruits and vegetables and their processed products can only be realized by the utilization of proper postharvest care. This includes forced-air cooling to remove the field heat from the harvested product, proper temperature and humidity control during storage, proper product cleaning, better sorting and grading to improve product uniformity, postharvest decay control, waxing, better packaging, and other improved postharvest technologies. Proper equipment for product cleaning, sorting/grading, decay control, and packing is needed throughout the horticulture crop growing regions. In addition to improved packinghouse equipment and infrastructure, more cold storage capacity is needed within the country to preserve the market life and quality of the perishable horticultural crops.

The postharvest care areas that need improvement in order for growers to maximize the amount and duration of marketable product include proper cooling, proper cold storage, humidity control, cleaning, grading/sorting, decay control, waxing, packing, and packaging materials.

Illustrated below is an overview of the main pre-and post-harvest links in the crop value chain that need strengthening by appropriate EPI project training and technical assistance interventions during the next 3 years. A detailed training and technical assistance implementation strategy will need to be developed for each of the weak links, focusing on the prioritized vegetable crops, mandarins, and hazelnuts.



C. FINDINGS

INTERVENTIONS TO OVERCOME CONSTRAINTS IN THE HORTICULTURE SECTOR

Numerous constraints or weak links exist in the farm-to-fork horticulture crop value chain in Georgia. These constraints will need to be overcome in order to strengthen the horticulture sector and make it more competitive for domestic and export markets. Interventions needed to overcome existing constraints in the horticulture sector include availability and planting of superior fruit and vegetable varieties, improved crop production and pest management practices, better harvesting methods, improved postharvest technologies, use of better packaging materials, modernization of agroprocessing facilities, improved market intelligence and producer-buyer networking, training/technical assistance to the growers in numerous aspects of horticulture crop production and postharvest care, and favorable credit policies. Significant infrastructure investments are also needed in packinghouse equipment, cooling, and cold storage infrastructure to extend the market life and maintain the postharvest quality of perishable horticultural crops over an extended period of time.

It will be necessary to address each of the constraints in the crop value chain in an integrated manner in order for the Georgia horticulture industry to be able to provide consistent supplies of high-quality product. Quality begins with planting of the appropriate varieties best adapted to the agro-climate conditions of the specific growing region. The varieties must be ones with strong market demand, high-yield potential, and favorable market qualities. This must be followed by the use of appropriate and modern production practices during the growing season. The crop must be harvested at the proper harvest maturity stage and in a careful manner. Product quality maintenance continues after harvest to include all the proper postharvest care practices required during grading/sorting, packing, cooling, cold storage, and transport to market.

Substantial technical assistance and training is needed to increase the knowledge level of the producer and Farm Service Center specialists who support the fruit and vegetable crop producers. Growers must be provided with adequate training to improve their knowledge base on proper production practices, harvesting methods, postharvest care, and marketing. Human resource capacity building and workforce development needs considerable strengthening in order for the Georgian horticulture industry to be competitive in the future. Significant strengthening of the horticulture crops training and technology transfer activities is needed to support the private sector. Multiple on-farm demonstration plots are needed to overcome the knowledge gaps existing all along the crop value chain.

Marketing is also a serious constraint facing the horticulture sector. Georgian growers need to establish stronger links with domestic and international buyers in order to obtain more profitable returns. Currently, the majority of the fruit and vegetable crop production volume in Georgia is marketed for relatively low prices in local bazaars, or procured by traders who obtain the products from the growers at less than premium prices. The most important constraints facing the Georgian horticulture sector are discussed below, including recommendations for overcoming these constraints.

Crop Variety Availability

A large percentage of the Georgian fruit and vegetable crop volume is based on old varieties introduced years ago. There is a noticeable absence of modern varieties which are grown

throughout the world in agro-climatic conditions similar to Georgia. For example, it is estimated that only 30 hectares of high-density improved apple varieties (Granny Smith, Fuji, Gala, etc.) grafted onto a dwarf rootstock (M-9) have been planted in the main fruit production region of Kaspi/Gori. There is little availability of seedless table grapes in the country, extended season day-neutral strawberries, cultivated blueberry varieties, and fall-bearing raspberries. Also, there is very limited planting of a new hybrid variety vegetable crops, which limits the product portfolio available for marketing.

Another constraint Georgian fruit and vegetable growers face is the lack of availability of true-to-type and disease-free certified nursery plants and certified vegetable seed for purity and germination. There is a serious lack of high-quality planting stock in Georgia. In many cases, growers save their own seed from one year to the next and inadvertently are spreading virus and other diseases into newly planted fields. The yield and crop quality of disease-infected planting stock and/or seed is adversely affected. The most important item influencing the yield potential of any fruit or vegetable planting is the vigor and health of the planting stock. The yield potential of any crop is a function of its genetic purity, disease-free sanitary status, and the production practices used during growth. If the planting material is contaminated with disease and/or variable in genetic purity, the yield potential of the crop will be seriously compromised. In an increasingly competitive global market, maximizing the yield and quality of any crop is of paramount importance.

Improved Cultural Practices

The crop cultural practices followed by most fruit and vegetable growers in Georgia are not consistent with producing optimal yields of high-quality product. The cultural practices of soil preparation, plant establishment, irrigation method, fertilization, pruning, and pest management all need to be significantly improved by the vast majority of growers. Rehabilitation of existing tree crop plantings by the application of improved cultural practices will increase fruit yields, which on average are low, compared to the world's leading horticulture crop exporting countries.

Soil Preparation and Plant Establishment

Fruit and vegetable crops generally prefer well-drained soils of medium texture (silt-loam), high in organic matter, and with a pH between 6 to 7. It is important the soil be properly prepared before planting, as making alterations in the soil after fruit tree or vegetable crop establishment is difficult. In addition, the liberal incorporation of organic matter in the soil prior to planting will improve the nutrient content and water holding capacity of the soil. Prior to fruit tree and vegetable crop planting, growers should analyze their soil for pH, salinity, percent organic matter, and nutrient content. It is important to know the soil fertility level, percent organic matter, and soil pH in order to apply the proper amount and balance of macro and micronutrients to the crop. Easy-to-use, rapid, and accurate soil monitoring devices are available for growers and training on their use should be incorporated into the demonstration plots. Technical information should also be disseminated to growers on the proper planting sites, soil preparation, row orientation, and optimal planting density. This information should be provided in demonstration plot training sessions and published technical guides.

Sustainable On-Farm Water Delivery Methods

Water stress is a common constraint to obtaining optimal yields of horticultural crops in Georgia. Where irrigation is available, the water is typically applied by flooding or by furrow. These water delivery methods are inefficient and wasteful and result in undesirable soil

compaction. Increased root rot disorders, including *Phytophthora* and *Fusarium* rots, are accentuated by surface flooding of the soil. Use of more efficient drip and microsprinkler irrigation methods is very limited in Georgia. These improved water delivery methods are standards in the horticulture industry worldwide and they allow for optimal crop water use efficiency. In order to maximize yield and quality of high-value horticultural crops, in addition to conserving valuable water resources, it is highly recommended the horticulture sector adapt modern drip and microsprinkler irrigation practices. These irrigation methods can save more than 50 per cent of the available water used by flooding, significantly increase crop yield, and improve product harvest quality. Combined with the use of soil mulches, these water application methods will maximize water use efficiency. Demonstration plots should be established comparing the results between flood irrigation and drip/microsprinkler irrigation on a diversity of horticultural crops.

Tree Pruning and Canopy Formation

Proper pruning of the limbs and branches of mandarins, hazelnuts, apples, pears, stone fruit, and other fruit and nut crops is critical to formation of the desired tree shape. Fruit and nut trees should be trained and pruned in their formative years to establish a limb framework that allows for maximum light penetration through the tree canopy. This will increase crop yield and allow more sunlight into the tree for maximizing fruit color. Insect and disease control and crop protectant applications are also more difficult on thick canopied trees. The majority of mandarin and hazelnut growers in Georgia do not use proper tree pruning practices. The result is a poorly shaped tree with an undesirably thick canopy, poor limb structure, excess fruit shading, and reduced fruit yield. Proper pruning practices will encourage earlier production and the development of a strong structural framework capable of supporting heavy fruit and nut crops in future years. The pruning program should continue on an annual basis, which produces trees that will be easy to manage in later years. Correct pruning canopy management practices are essential for high yields, optimum fruit quality, and efficient tree management. Technical assistance, demonstration plots, and training programs should be initiated for mandarin and hazelnut growers on proper tree pruning. Demonstration plots in existing plantings should also be established to show how to renovate older trees that have not received the proper pruning. The demonstration plots will be effective in showing the difference in mandarin and hazelnut crop productivity between current and improved pruning practices.

Pest Management

Numerous insect, disease, and weed pests negatively impact Georgian fruit, vegetable, and nut crop yield and quality. It is imperative for growers to adopt an integrated pest management strategy which uses a multifaceted approach to pest control. This should include the planting of pest-resistant varieties, proper soil preparation, field sanitation, appropriate plant density, proper fertilization and irrigation to keep plant growth vigorous, predator insect establishment, and use of crop protectants. Use of resistant varieties can significantly reduce the amount of pesticides that need to be applied. Most growers in Georgia do not know the best integrated pest management management practices to follow or the best crop protectants to use to combat specific insect, disease, and weed pests. There is a lack of information dissemination to the farmers. The result is a proliferation of numerous pests which negatively impacts the health, vigor, and yield of the fruit and vegetable crop.

Harvesting Practices

Improper harvesting practices can result in significant losses in fruit and vegetable crop market quality. Horticultural crops are very delicate and extreme care must be taken to avoid bruising or mechanical damage to the fruit or vegetable at harvest. Rough harvesting practices are common and they impart significant damage to the fruit or vegetable, reducing the postharvest life and lowering market quality. Also, the field containers used for harvesting are often not appropriate for protection of the fruit or vegetable against mechanical injury and bruising. The rough unfinished surface of many field containers can cause significant product skinning, followed by postharvest decay. The field sacks used in harvesting some crops results in compression bruising and a reduction in product quality and storability. The proper field container for harvest is a strong, well-ventilated plastic crate. This type of container provides the best protection to the harvested product and can be stacked multiple layers high. Training and technical assistance to the field workers in proper harvesting practices and harvest containers is needed to improve product market quality.

Harvest Maturity

Proper harvest maturity is important to obtain the optimal product market life and eating quality. A constraint negatively impacting the quality of Georgian fruit and vegetable crops is the high amount of variability in crop maturity during harvest. There is a wide range in fruit and vegetable maturity, from over-ripe to immature. Such wide variation in fruit and vegetable crop maturity is difficult to grade and classify into a uniform packed product. This variability can be avoided by educating the pickers on the proper harvest maturity stage for each fruit and vegetable, coupled with multiple harvests per tree. Simple field instruments also exist that are capable of objectively measuring various product quality and maturity parameters. Training should be offered to field workers on proper harvesting procedures and maturity indices for each crop.

Proper Postharvest Care

High amounts of fruit and vegetable crop losses occur after harvest due to improper postharvest care. Considering the entire value chain, constraints in the postharvest area may be the weakest links and in need of immediate attention in order to improve the consistency and quality of Georgian horticultural crops. This includes product cooling after harvest, cold storage, cleaning, grading/grading, waxing, packing, and temperature/humidity control during transport and distribution of the product to market. It is common for growers to suffer between 15-35% postharvest loss for fresh produce due to inadequate cooling and cold storage and improper postharvest technologies. Product deterioration and postharvest decay is high due to inadequate temperature and humidity control, inadequate disease management, improper containers for storage and transport, and nonrefrigerated transport. Unfortunately, no significant effort is being made within the Georgian horticulture sector to improve the grading, packaging, and postharvest care of the harvested products. This negatively impacts product market quality and results in significant postharvest losses, negatively impacting both smallholder and larger-scale farmers. Significant improvements in postharvest cooling and maintenance of the cold chain for fresh horticultural products are needed in Georgia to extend market life and improve consistency of supply and product market quality.

The lack of appropriate cleaning, grading, packing, and cooling/cold storage facilities severely limits the ability of producers to provide the market with consistent supplies of high-quality products. The absence of a postharvest cold chain during the distribution of highly perishable fruit and vegetables to market also results in high amounts of product spoilage. Availability of appropriate packinghouse facilities and temperature/relative humidity-controlled storage will allow producers to have more control of their market. Potentially

higher farm-gate prices can be obtained if marketing gluts can be avoided by product storage, followed by improved packing and more efficient distribution of the product to market. In the absence of a cold chain, most perishables grown in Georgia have to be sold immediately to traders or in the local markets which cannot absorb the product volume. Consequently, the prices obtained by the grower remain depressed. Adequate postharvest cooling and maintenance of the cold chain during storage and transport to market will allow growers to obtain higher market prices and extend the duration of market availability for their products.

Grade Standards

Lack of product uniformity within a container is a serious constraint to marketing fresh produce, particularly for export. It is very important to have as much uniformity in size, shape, and color within the market container as possible. Clean, well-packed, uniform-sized, and attractive fruit and vegetable products are essential for the high-value export market. This is generally not the case for domestic marketed fruit and vegetable crops.

Many countries have national grade standards for individual fruit and vegetable crops that growers must adhere to in marketing their products. Such grade standards do not exist in Georgia, and therefore a wide variation in fruit quality is common in the domestic market. This does not facilitate orderly marketing of the products and buyers are reluctant to pay premium prices because of this lack of product consistency. It is not uncommon to have poorer quality product put in the bottom layers of a wooden crate, with the top layers reserved for the better appearing fruits or vegetables. Bruised and partially decayed products are often mixed in the same container as good product. Currently, only an informal grading system is used in classifying horticultural crops for domestic marketing.

Industry-developed grade standards for each horticultural crop would improve the orderly marketing of fresh fruit and vegetables in Georgia. The grade standards should be based on internationally accepted norms, such as Codex Alimentarius, E.U. standards, or U.S.D.A. standards. The result will be stronger confidence in the domestic marketing system, higher prices for better quality product, and discipline imposed within the industry in marketing fresh fruit and vegetable crops. Currently, there is no uniformity of product quality in the wholesale and retail markets. The domestic produce trade currently uses a subjective and vague classification system for marketing fresh produce. The lack of clearly defined and objective grade standards for individual fruit and vegetable crops is not conducive to an orderly produce marketing system.

Cooling and Cold Storage Infrastructure

Fresh fruits and vegetables have a high respiration rate and need to be cooled as soon as possible after harvest to their ideal storage temperature in order to maximize their market life. However, there is a lack of cooling and cold storage infrastructure for horticultural crops in Georgia and the rate of product deterioration is rapid at high ambient temperatures. Most horticultural crops are very perishable and quickly lose market quality and price without adequate postharvest cooling and cold storage. Strengthening the postharvest infrastructure and cold storage capacity is critically needed in order to improve the texture, flavor, and arrival quality of Georgian fresh fruits and vegetables in the marketplace. Modern cooling and cold storage infrastructure on the farm or at nearby collection centers is essential to improve the competitiveness of Georgian produce. The existing cold storage facilities for holding perishable products in Georgia are limited and many facilities are old and incapable of precise temperature and relative humidity control. This results in accelerated quality deterioration of the stored product. Consistent and high-quality product will only be

obtainable by rapid product cooling after harvest and precise maintenance of the cold chain during storage and distribution to market.

The maximum storage life of any fruit or vegetable is obtained by removal of the field heat as soon as possible after harvest. Ideally, the pulp temperature of the harvested product should be lowered to its optimal storage temperature within four to six hours after harvest. Highly perishable fruit crops, such as strawberries with pulp temperature of 30° C will lose one day in market life for every hour of cooling delay. Even less perishable crops, such as apples can lose their firmness and market quality after several months of storage if the rate of initial field heat removal is slow.

Inadequate internal air ventilation inside the storage rooms can lead to a build-up of ethylene. Ethylene causes accelerated ripening and deterioration of fruits and vegetables and significantly reduces the storage life. Even at very low concentrations (parts per million range), ethylene will cause breakdown of the tissue. For example, cucumbers are particularly sensitive to ethylene damage, with the fruit becoming soft and discolored. Apples also lose their firmness and become soft when exposed to ethylene. The build-up of ethylene in an enclosed storage room is very detrimental to the postharvest quality of stored fruits and vegetables. The degree of product damage depends upon the commodity, concentration of ethylene, length of exposure time, and temperature. Fortunately, there are practical methods and equipment available to reduce the concentration and negative impacts of ethylene exposure during storage.

Improved Packaging

Wooden crates and large sacks are the common types of packaging material used in the domestic marketing of fruits and vegetables. The rough inner surface of the wooden crate can result in significant physical injury to the delicate skin of the commodity if it comes in direct contact with the rough wood surface. Newspaper is commonly used to protect the fruit inside the wooden crate, but this is not appropriate for export market destinations. Furthermore, the crates are often over-filled and considerable abrasion and compression bruising of the product occurs inside the crate. Also, food safety regulations and packaging restrictions against the use of wood containers in many export markets will preclude the use of this type of packaging in many international market destinations.

Strong, well-ventilated, attractive corrugated cartons are the norm in packaging fruit for export. Georgian growers/exporters will have to adopt this type of packaging to be successful in the export market. Improved product appearance, more uniform grading, and more attractive packaging materials will also help increase domestic product sales. Due to the strong competition and the large amount of supply options available to the importers, it is imperative that Georgian exporters pack their fruit products in high-quality, attractive corrugated cartons.

D. RECOMMENDATIONS

EPI PROJECT ACTIVITY RECOMMENDATIONS

The main focus of the EPI-funded interventions in the horticulture sector should be on training, technical assistance, and technology transfer. Historically, there has been a dearth of information available to horticultural crop producers and agro-processors in Georgia. The lack of awareness and understanding of appropriate production practices, inadequate application of modern production technologies, lack of planting of higher-yielding crop varieties demanded in the marketplace, and improper postharvest care have all been major limitations to the advancement and competitiveness of the Georgian horticulture sector. Empowering the producers, agro-processors, and support service personnel with detailed crop-specific production, postharvest care, and market quality information will provide the sector the knowledge base required to develop a competitive and sustainable horticulture industry. Awareness and application of the best agricultural practices appropriate to the financial situation of the stakeholder is necessary in order to provide the market with consistent supplies of high-quality product at competitive prices.

Training, technical assistance, and demonstration plot activities will need to be developed for incorporation into the EPI project work plan and to obtain the desired goal of improved production and postharvest care practices for horticultural crops. The training and educational activities should focus on overcoming the existing weak links and constraints in the vegetable crop, mandarin, and hazelnut value chains. An example of a specific EPI project intervention pertaining to improved postharvest care and marketing of mandarin fruit is discussed below. Training, technical assistance, and postharvest demonstrations can begin soon, for implementation during the fall and winter seasons. Successful implementation of these training and demonstration activities will allow the mandarin growers and marketers to add value to their fruit, extend the marketing period, and penetrate additional domestic and export markets.

Mandarin Fruit Quality Improvement and Market Life Extension

Mandarin fruit are typically available in Georgia from November through January. Without proper postharvest care, packaging, and refrigeration, the harvested fruit loses significant amounts of moisture resulting in peel shriveling and loss of firmness after several weeks of ambient storage. Postharvest decay is also a major cause of fruit market loss. Use of improved postharvest care practices can allow Georgian mandarins to store well for three to four months after harvest. In addition, degreening of the peel of early season harvested fruit can advance the marketing period by several weeks. Therefore, mandarin fruit in Georgia can have a six to seven month potential market availability period with the use of improved postharvest technologies. This will involve the use of liquid ethephon or ethylene gas to degreen the peel during the early season (two week earlier marketing period) and proper postharvest care to extend the late-season harvested fruit for three to four months (shrink-wrap packaging, plus 4° C storage). Improved grading/sorting, fruit waxing, and postharvest decay control are additional postharvest care practices that will significantly extend mandarin market life and maintain fruit quality.

Demonstrations should be conducted at one or more of the major mandarin collection centers in southwest Georgia to show the potential benefits of adopting these improved postharvest care technologies. The demonstrations should involve the use of proper packinghouse procedures and equipment (i.e., cleaning, sorting/grading, fungicide application, waxing, shrink-wrap packaging, and cold storage at 4° C).

Green-peeled fruit treated with three to five parts per million (ppm) ethylene for 24 or 36 hours begins to degreen within several days after treatment. Green-skinned fruit colors to 90% yellow-orange within seven days (Figure 1).

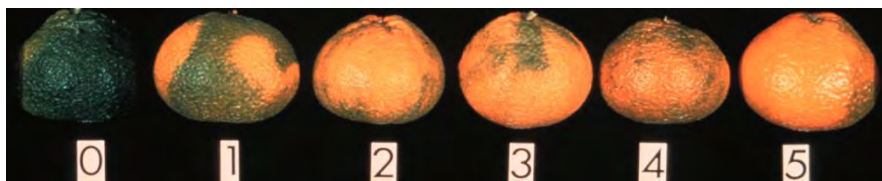


Figure 1. Degreened mandarin fruit seven days after ethylene treatments (0-5 ppm).

In the case of liquid formulations of ethylene (i.e., ethephon), submergence of green-skinned satsuma fruit in 500-1000 ppm ethephon for 30 seconds provides effective degreening (Figure 2).



Figure 2. Degreened mandarin fruit five days after ethephon treatments (0-1000 ppm).

After seven days of posttreatment ripening at 21° C, 3-5 ppm ethylene gas exposure and 30 seconds of ethephon submergence at 500-1,000 ppm give equally effective 90% yellow-colored fruit. Thus, Georgian mandarin growers have a choice between these two equally effective degreening treatment protocols.

Individual shrink-wrapping of mandarin fruit will significantly extend the market life of mandarins. It dramatically reduces peel desiccation and fruit softening. It is also a widely accepted value-added marketing technique. The process of shrink wrapping involves packaging individual fruit in shrink-wrap film, followed by heat-sealing the film to adhere it tightly to the peel. This creates an attractive, clean fruit which can be stored for extended periods of time with very minimal weight loss and peel shrivel (Figure 3). The film is readily available from package-supply vendors and usually arrives on rolls cut to the desired length and width. A recommended shrink wrap film to use for mandarins is Cryovac D955 with a film thickness of 100 microns (100 gauge).



Figure 3. Appearance of shrink-wrapped mandarin fruit after three months at 4° C.

Film type: Cryovac D955; source: Sealed Air Corp., 200 Riverfront Blvd, Elmwood Park, New Jersey 07407, USA.

Telephone: 201-791-7600; e-mail: www.sealedair.com

Shrink-wrapping adds value to fresh-market mandarins by enhancing appearance, reducing weight loss, and allowing for individual fruit labeling. The cost of a shrink-wrapping system that will process about 8-10 fruit per minute is approximately \$15,000. This includes the manually operated cutter/heat sealer and heat tunnel (Figure 4). The cost of the shrink-wrap film (not including equipment or labor) is about a half-cent (\$0.005) per fruit. Although shrink-wrapping equipment does represent a major investment, grower/packers in Georgia can expect to receive a premium market price for this value-added product compared with bulk-packed fruit. Significant market growth potential exists for value-added forms of mandarins, such as individually shrink-wrapped fruit. The technology for packaging mandarins in this manner is widely available from multiple commercial vendors. Shrink-wrap packaging and heat-sealing equipment can be obtained to match any size of operation, from small domestic marketing operations larger export firms. The equipment and supplies required to take advantage of this technology are easy to use by any mandarin packing operation.



Figure 4. Shrink-wrap packaging system components include an L-bar sealer and heat tunnel. Source: Heat Seal LLC, 4580 East 71 St., Cleveland, OH 44125 USA; telephone: 216-341-2022; e-mail: custserv@heatsealco.com

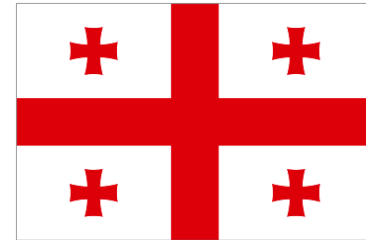
A market life of three to four months can be obtained from shrink-wrapped fruit held at 4° C, with a final weight loss of less than 2%. This contrasts to a market life of six weeks and a weight loss range of 10-12% with unwrapped fruit held at 4° C. Even in the absence of postharvest cold storage, shrink wrapping has a positive effect on extending fruit quality and market life of mandarins. For example, the market life of unwrapped fruit held at 21° C, 40% relative humidity is about three weeks, with a weight loss of around 20%. In contrast, shrink-wrapping can extend the market life of mandarin fruit held at 21° C for up to 11 weeks, with a final weight loss ranging between 5-6%.

E. ADDITIONAL INFORMATION

POWER POINT PRESENTATION OF REPORT

Slidedeck is included in the following pages.

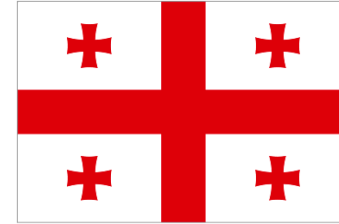
Horticulture Sector Development Strategy for Georgia



Objectives:

- Increase the competitiveness of the horticulture sector by appropriate interventions in the value chain of selected vegetable crops, mandarins, and hazelnuts
 - Improvement in targeted crop production practices to obtain higher yields
 - Improved postharvest care, packaging, cooling, and cold storage to enhance product market quality and extend product market duration
- Expand domestic market (including import substitution) and export market volume/value for fresh and agro-processed vegetable crops, mandarins, and hazelnuts

Horticulture Sector Development Strategy for Georgia



Methodology:

- Training, technical assistance, and human resource capacity building in best agricultural practices and postharvest technologies for vegetable crops, mandarins, and hazelnuts
- Demonstration plots with improved targeted crop production practices, better varieties, and improved postharvest technologies
 - affiliated with Farm Service Centers, innovative growers, and commercial storage facilities
- Crop specific production guides, postharvest care manuals, training videos, etc.
- Increase in the number of GlobalGAP-certified growers
- Develop reputation within the horticulture sector for providing consistent supplies of high quality products
- Facilitate orderly marketing of the targeted horticultural products by developing individual crop quality standards

Constraints to Georgian Horticultural Crop Exports



- Lack of market opportunity awareness
- GlobalGAP certification required for many high value export markets
 - international standards of Good Agricultural Practices (GAP)
- Inadequate availability of latest germplasm and rootstocks
- Lack of advanced production practice technologies
- High amounts of postharvest loss (15-35 % of harvest)
 - lack of product cooling after harvest
 - poor quality packaging
 - lack of cold chain maintenance

Comparative Advantages of Georgia Horticulture



Favorable soils for a wide range of tree fruit, berries, and vegetable crops

High quality water for irrigation

Temperature conditions are conducive to year-round production

- open-field crop production from March through November
- off-season production (winter, spring) of high value vegetables and berry crops inside protected structures (high tunnels, greenhouses)
- established agro-processing sector
- competitive labor costs

Reducing Horticulture Sector Constraints by EPI Interventions

Grower Education/Training in Proper Production Practices

(yield increases of 25-100 % possible)

- soil preparation
- crop variety and rootstock selection
- plant establishment
- irrigation
- fertilization
- pruning practices
- pest management
 - insect, disease, weed control
- harvesting methods



Reducing Horticulture Sector Constraints by EPI Interventions

Training and Technical Assistance in Proper Postharvest Care

(marketable “yield” increases of 10 % possible by less postharvest loss)

- cooling
- cold storage
- cleaning
- grading/sorting
- decay control
- waxing
- packaging



Reducing Horticulture Sector Constraints by EPI Interventions



Market Development

Expand Domestic Market

Import Substitution

-replace Turkish vegetable imports with domestic production

Export Volume Increase

Expand Agro-processed Product Volume and Value



Mandarin Market Opportunities



- Strong domestic market
- Export markets in Ukraine, Armenia, Azerbaijan, Belarus, Baltic States, Central Asia
- Mandarins have 6-month potential availability period with improved postharvest care
- De-greening of early-season harvested fruit (2-week earlier market potential)
- Cold storage and improved packaging of late-season harvested fruit (3-4 month potential storage duration)

Expanding Mandarin Fruit Marketing Season



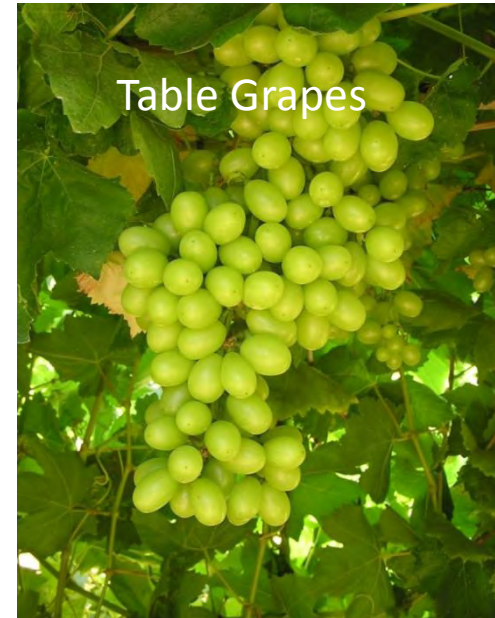
- De-greening of early-season harvested fruit (October)
- Improved postharvest decay control
- Waxing
- Proper storage temperature management (4° C)
- Improved packaging



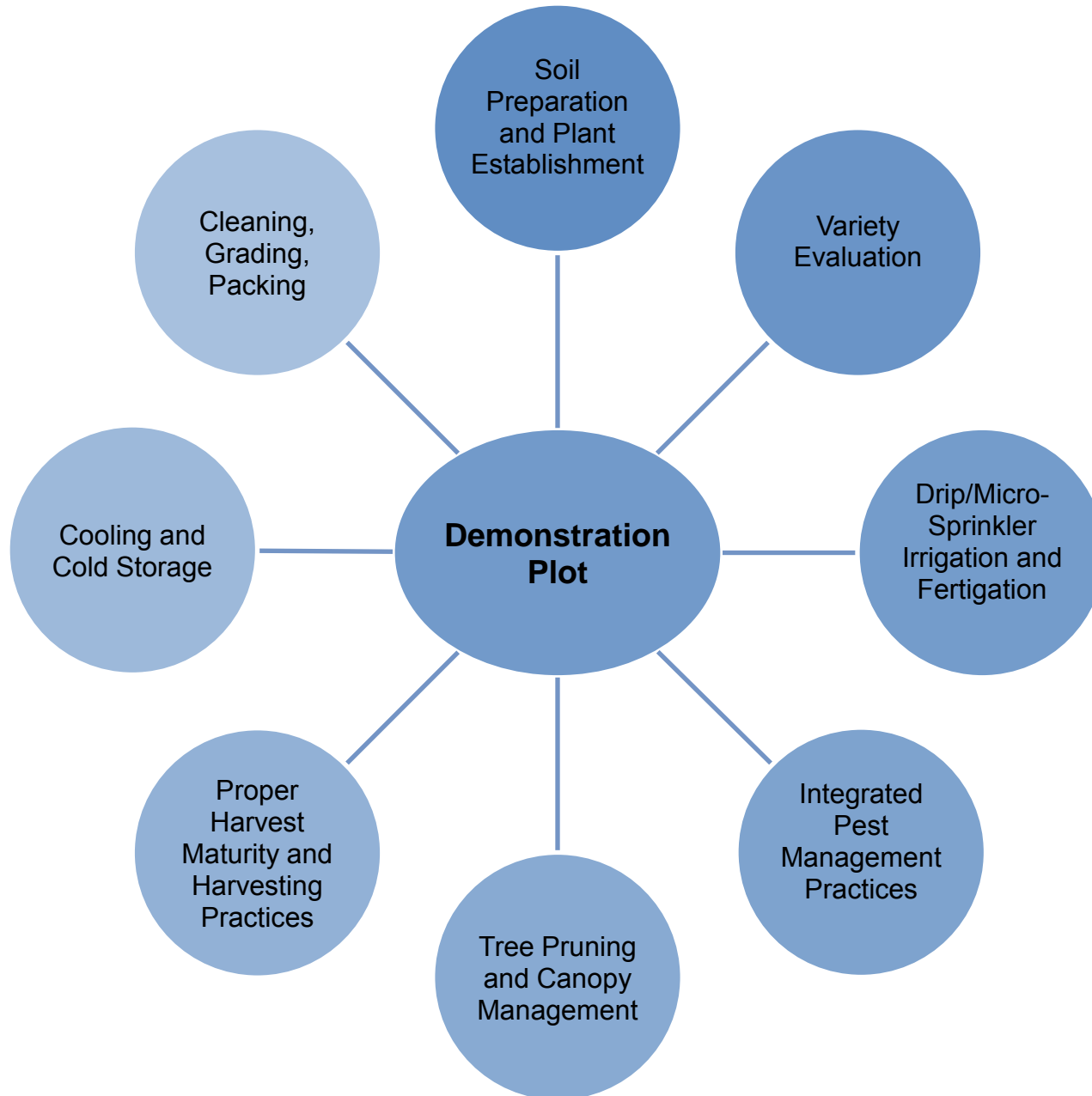
New Vegetable Crops for Georgia with Export Market Potential



New Fruit Crops for Georgia with Export Market Potential



Establish Demonstration Plots for Grower Training



USAID Economic Prosperity Initiative (EPI)
6 Samgebro St.

Tbilisi, Georgia

Phone: +995 32 43 89 24/25/26

Fax: +995 32 43 89 27