

2. Plant Production and Health Sub theme

Research on Plant Production and Health has been conducted for several decades and encouraging results have been obtained both at regional and national scales. However, the crop production and productivity is constrained with many problems in Eastern Ethiopia. The climate change, erratic rainfall, recurrent drought and moisture stress in Eastern Ethiopia need to be addressed through technologies generated by researchers. Researchers may not address all the problems of crop production and productivity of the region in a short period of time and therefore problems that need urgent solution have been identified in each research area. Efforts have been made by research teams to address the identified problems with research projects; and high priority research projects are selected. These projects mainly focused on development of technologies for drought tolerant and moisture stress, farmers' participatory selection of technologies, development of technologies for multi-constraints and multi-cycle production, crop protection, germplasm enhancement and maintenance, quality seed multiplication, characterization and evaluation of fruit crops, neglected crops, plant species, indigenous trees and shrubs, as well as medicinal and aromatic plants. Thematic research approach has been attempted to apply in the process of identifying high priority research projects. The importance of professionals' participation from wide range of fields of specializations and the establishment of multidisciplinary teams in each research project should be considered for the success of the projects. The projects should have statement of the problems, objectives, research components/activities and expected outputs. However, for the purpose of the research call only the research projects titles and research components/activities to be executed to achieve the objectives and outputs of the projects are presented under each research area.

2.1. Field Crops Research Area

a. Participatory Evaluation of Cultivars, Production Packages, and Integrated Pest Management of Sorghum in Eastern Ethiopia

Sorghum is the major crop produced in Eastern Ethiopia. However, the production and productivity of the crop is very low due to frequent drought, moisture stress and short growing season brought about by the global climate change. Disease and pest problems associated with the crop also need to be addressed. Promotion of production packages compatible with the production system are also among the major production constraints. Therefore, participatory evaluation of cultivars, production packages, and integrated pest management of sorghum are the research priorities in Eastern Ethiopia. The research components are:

- Participatory Evaluation and Identification of Moisture Stress Tolerant and Short Duration Sorghum Varieties for Eastern Ethiopia;
- Participatory Evaluation and Identification of Agronomic Packages Suitable to Sorghum Production System in Eastern Ethiopia;
- Development, Participatory Evaluation and Selection of Integrated Pest Management for Sorghum in Eastern Ethiopia.

b. Generation and Promotion of Maize Technologies in Eastern Ethiopia

In Eastern Ethiopia, the major problems in maize production and productivity are drought, moisture stress, disease and insect pest. The adaptability of maize varieties with enhanced nutritional qualities (Protein quality, Pro Vitamin A and improved feed traits) in Eastern Ethiopia has not been tested at large and farmers have not participated in selection of maize technologies. The following research components are identified as high priority to address the problems within a short period of time. Components under this research area are:

- Participatory Evaluation and Promotion of Improved Maize Varieties at Different Agro-ecologies of eastern Ethiopia;
- Assessment of Ecological Distribution of Parasitic- and Non-parasitic Weeds, Maize Stalk Borer, Diseases and Pest, and Development of Integrated Weed, Disease and Pest Management in eastern Ethiopia, and
- Improved Agronomic Management Options for Maize Production in Eastern Ethiopia.

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c. Development of Technologies for Small Cereals that fit to eastern Ethiopia

The production of wheat, tef and barley is low and they have low contribution to the agriculture sector in Eastern Ethiopia. However, farmers' interest to produce these crops is increasing. This crop production in Eastern Ethiopia is mainly constrained by unavailability of crop varieties adaptable to the region, disease and pest, and abiotic stresses. The following research components are believed to address the major problems. The research components under this are:

- Identification of Disease Resistant, High Yielding and Wide Adaptable Wheat, Tef and Barley Varieties in Eastern Ethiopia;
- Development of Integrated Weed, Disease and Pest Management for Wheat, Tef and Barley in Eastern Ethiopia;
- Development of Improved Agronomic Practices for Wheat, Tef and Barley and Farmers' Participatory Evaluation of Technologies in Eastern Ethiopia.

d. Integration of Technologies to Alleviate Multiple Constraints of Lowland Pulse Crops Production in Eastern Ethiopia

In Eastern Ethiopia, the production of lowland pulses has multiple advantages including the compatibility of crops to the existing intercropping crop production, enhancement of soil fertility, withstanding drought and moisture stress, providing protein rich food to the community and cash income as an export commodity. However, the production of these crops is constrained by multiple problems, and production agroecology shift is observed due to climate change that is not addressed by the University and National Project researches. The severity and frequency of drought also cannot be tackled with the existing lowland pulses species. The tackling of these problems requires identification of varieties to mid and high land altitudes, introducing drought tolerant species, alleviating disease and pest management problems, and demonstration of lowland pulses products. Components are:

- Adaptation and Farmers' Participatory Selection of Common Bean Varieties in Mid and Highlands of Eastern Ethiopia;
- Demonstration and Farmers' Participatory Selection of Drought Tolerant Mung Bean Varieties and Cowpea Genotypes for Food Security and Income Generation in Eastern Ethiopia;
- Characterization and Product Development of Common Bean, Cowpea and Mung Bean in Eastern Ethiopia;
- Testing of the Compatibility of Mung bean Varieties in Existing Intercropping Crop Production System in Eastern Ethiopia;
- Integrated Management of Diseases, Insect Pests and Weeds of Common Bean, Cowpea and Mung Bean in Eastern Ethiopia.

e. Generation of Highland Pulses Technology Packages in Eastern Ethiopia: Emphasis to Participatory Evaluation, Improved Management Practices and Promotion of Products

Haramaya University has been developing technologies for highland and lowland pulses. Most of the technology development focused on varieties releases. However, the varieties were not properly demonstrated to farmers and farmers have not participated in the selection of technologies. In addition, variety development for some crops such as chick pea for Eastern Ethiopia is not well developed or/and released varieties are not tested for adaptability. Disease and pest problems also become the major production constraint in these crops not only in Eastern Ethiopia but also throughout the country. Therefore, tackling of production problems in highland and lowland pulses in Eastern Ethiopia is not only ensuring nutrition and food security problems but also income generation for farmers from international market. The short term research activities suggested in to alleviate the problems indicated above include:

- Participatory Evaluation and Selection of Improved Varieties and Agronomic Practices of Faba bean in Eastern Ethiopia;
- Participatory Evaluation and Selection of Improved Varieties and Agronomic Practices of Chick pea in Eastern Ethiopia;
- Survey, Identification and Integrated Management of Diseases, Insect Pests and Weeds of Faba bean and Chick pea in Eastern Ethiopia;

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- Product Development, Characterization and Promotion of Faba bean and Chick pea Varieties for Improved Nutrition and Health in Eastern Ethiopia.

f. Enhancing Groundnut and Linseed Productivity and Production in Eastern Ethiopia

Eastern Ethiopia is among the major groundnut producing regions in the country. The crop has a potential to alleviate food and nutrition security problems. It is also a high potential crop as export commodity that will be a good opportunity to generate additional income to poor farmers in moisture stress areas of lowland Ethiopia. However, the production and productivity of the crop is constrained as a result of either unavailability of technologies to farmers. In addition, Aflatoxin contamination limited export to international market. These problems have not been well addressed by the National Research Project in Eastern Ethiopia. Therefore, Haramaya University needs to take the responsibility in alleviating the problems. Though the alleviation of the problems requires a long term research, the research team has identified the short term research activities in this project. The research components are:

- Integrated Management of Aflatoxin Contamination in Groundnut;
- Scaling Up of Groundnut Sheller in Eastern Hararghe;
- Scaling-up of Improved Groundnut Varieties through Community based Small-Scale Seed Production Scheme in East Hararghe ;
- Training on Groundnut Product Development for Enterprises and Smallholder Farmers
- Trainings and preparation of aflatoxin management guideline
- Pre-Scaling Up of Groundnut Technologies in Major-Growing of Eastern Hararghe
- In-vitro Selection of Groundnut (*Arachis hypogea* L.)genotypes for Resistance Against *Apergillus* Spieces (*Aspergillus flavus* and *Aspergillus parasiticus*)
- Development of Disease Resistant, High Yielding and Wide Adaptable linseed Varieties in eastern and western Hararghe;
- Development of Improved Agronomic Practices for linseed production in eastern and western Hararghe,;
- Popularization and seed multiplication of improved linseed varieties in eastern and western Hararghe;

2.2. Horticultural Crops Research Area

a. Assessment, Development and Promotion of Technologies for Underutilized Crops: Emphasis to Okra and Amaranthus

Ethiopia is claimed to be the origin of Okra. The highly mutinous Amaranthus is grown as weed in the country. The production of Okra is only in pocket area of the country but grown as a wild plant at large in the country. Okra and Amaranthus can be potential to food and nutrition security in the country; the crops withstand moisture stress and potential export crop (particularly Okra). However, technologies have not been developed for these crops in the country and are not included in the National Research System. But Haramaya University has started to address the problem since the beginning of this decade. However, the successes of the past efforts of the University depend on the continuation of the started research activities which are listed below. The focus areas are:

- Assessment of the Genetic Diversity and Potential Utilization of Amaranthus Germplasm in Ethiopia;
- Characterization and Evaluation of Ethiopian and Exotic Okra Genotypes for Tender Fruit and Seed Yield and Quality;
- Demonstration and Farmers' Participatory Selection of Exotic Amaranthus Varieties in Eastern Ethiopia;
- Development and Demonstration of Okra and Amaranthus Products, and Characterization of Nutritional Contents.

b. Development of Potato Technologies for Sub-optimal Irrigation Production in Eastern Ethiopia

The farmers in Eastern Ethiopia are producing potato with two and three production cycles in a year using local cultivars with short dormancy period under sub-optimal irrigation. The local cultivars are disease susceptible and cannot be used for main cropping season. However, the improved potato varieties have long

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dormancy period that cannot be used for successive production under irrigation. Neither the University nor the National Research System had addressed these issues to alleviate the potato production system in Eastern Ethiopia. But the interlinked production problems are not to be tolerated any more due to the production of the crop below its potential in the region as results of under optimal irrigation water application aggravated with climate change, the ever increment of production area and the demand of the farmers for technologies that fit the production system. Therefore, the following research activities have been identified as urgent to alleviate the potato production problems in Eastern Ethiopia. The research components are:

- Identification of Potato Cultivars that Produced High Tuber Yield Under Sub-optimal Irrigation Water;
- Assessment of Tuber Yield Reduction due to Sub-optimal Irrigation Water and the Changing Climate;
- Assessment of Potato Production Constraints Under Sub-optimal Irrigation Water;
- Development of Integrated Technologies fit to Potato Production System in the Changing Climate in Eastern Ethiopia.

c. Collection, Characterization and Evaluation of Fruit Crops in Eastern Ethiopia

In the current agriculture, Eastern Ethiopia has not contributed much to the production of fruit crops. The tragedy is that the declining fruit production status of the region is due to production constraints not addressed by research. The University needs to address the critical fruit production problems before fruit production become nonexistent in the region. Though it is known that fruit research requires decades and huge amount of investment, research activities are identified as stepping stones as follows. The research components are:

- Establishment of Orchard for Research, Demonstration and Training;
- Assessment of Fruit Crops Production Constraints in Eastern Ethiopia;
- Collection, Characterization and Evaluation of Fruit Crops Importance to the Region ;
- Collection, Characterization, Evaluation and Conservation of Fruit Crops Varieties in Eastern Ethiopia.

d. Development of Potato Technologies for Multiple Cycles and for Multipurpose in eastern Ethiopia

Potato is co-staple food, the second most important crop next to Kahat and market oriented to export in eastern Ethiopia. Most farmers living in this region have small land about quarter a hectare and produce potato throughout the year under irrigation. However, this multiple cycle production is suffering by lack of disease resistant, early maturing varieties and with short tubers dormancy period. Due to these farmers produce potato from local cultivars during dry and “belg” season which are susceptible to disease during “meher”. In addition, the local cultivars are producing tubers with low dry matter content not suitable for processing. The region is known with iron and zinc malnutrition in Ethiopia where the existing potato genotypes do not have sufficient amount of these minerals. The research in the University as well as in the nation did not produce technologies fit the potato production system in eastern Ethiopia. The seed tubers used for production are poor quality, not produced for the purpose at separate farms and tubers produced with unlimited generation from the source planting materials that leads to high disease degeneration and reduction of yield year after year. Therefore, research effort has to be made to alleviate these problems specific to the region by designing project that focus:

- Searching early maturing genotypes having short dormancy period, disease resistant with required tuber dry matter content suitable for multipurpose,
- Training of farmers on quality seed tubers production and establish demonstration fields for quality tuber seeds production,
- Generating technology for tuber dormancy breaking as alternative remedy measures, and
- Introduction and evaluation of biofortified potato genotypes (with iron and zinc) and develop potato varieties rich in mineral contents

e. Determination and Designing of Methods for Quality Processed Potato Products in eastern Ethiopia

Starting the introduction of potato, the crop was used for preparation of traditional foods such as “dinch wot”, boiled potato etc. However, currently, tubers are processed to produce French fries, chips and others at small

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scale and flourishing in cities, big and small towns. But a toxic compound known as Acrylamide is produced in high heated starchy foods in which the products are possible carcinogen. The problem is becoming more critical when tubers with low dry matter content are fried with vegetable oils not to be used for chips and French fries processing for many cycles of frying beyond the optimum limit of temperature. Therefore, chips products by small business people are expected to have this toxic compound at high content. Therefore, it is necessary to design project focusing on the following research activities.

- Assessing the chips/potato processed products methods in eastern Ethiopia,
- Estimating the toxic substances in the end products of processed potato products,
- Evaluation of tubers used for processing under proper processing and traditional methods,
- Designing easy method(s) for identification of tubers for processing to be used by small business people,
- Generate policy brief to be provided to the regional government, and
- Producing manuals for healthy potato processing and provide training of small business people.

f. Introduction, Evaluation and Development of Sweet potato Varieties Rich in Minerals and Vitamins Contents

Haramaya University has released two Sweet potato varieties (Adu and Berkume) which are cultivated in eastern Ethiopia. Eastern Ethiopia is one of the known regions where chronic malnutrition of Fe, Zinc and Vitamin A are among the major problems of the society. Biofortified sweet potato genotypes rich in Fe, Zinc and Vit. A are developed elsewhere in the world and some of the genotypes are introduced in the country, therefore, it is possible to develop varieties for the region through introduction and evaluation. This will help to alleviate the malnutrition problems reaching to the rural community. Therefore, a project is required to be designed and executed focusing on development of varieties rich in Fe, Zinc and Vit. A through determination of nutrition quality of storage roots, development of products and postharvest handling of storage roots with the following major components of the research project.

- Introduction and evaluation of disease free biofortified sweet potato genotypes and development of minerals (Iron and Zinc) and vitamin (Vit A) rich varieties in eastern Ethiopia
- Determination of agronomic management (planting method, spacing and fertilizer rates) and postharvest handling for biofortified sweet potato varieties in eastern Ethiopia
- Determination of nutrition quality (Fe, Zinc and Vit A) of storage root of biofortified Sweet potato varieties in eastern Ethiopia under different agronomic management and locations
- Development of products from storage roots of biofortified sweet potato varieties

g. Development of Agronomic and Postharvest Handling Management Packages for Shallot Bulb and Seed Production”

Seed production from shallot is one of the most challenges in horticulture crops and the researchers in horticulture are thriving to produced seed from this crop throughout the world. However, the researchers in the Haramaya University were capable to produce seeds from this crop successfully with uninterrupted efforts made for more than a decade. With the production of seeds from Huruta variety, the researchers also have a chance to improve the bulb yield through bulb-seed to bulb method. The variety is proposed for release as essentially derived variety of Huruta. However, the agronomic management and postharvest handling of this variety have not yet developed. Therefore, it is necessary to develop packages to recommend this variety for cultivation at large areas of eastern Ethiopia. For the purpose, the research project is required to be designed and executed addressing the following major research components.

- Determination of fertilizer rates and spacing for improved Huruta shallot variety for bulb yield in eastern Ethiopia
- Determination of fertilizer rates and spacing for improved Huruta shallot variety for quality seed and high seed yield production in eastern Ethiopia

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- Determination of harvesting time and postharvest handling for high bulb yield and quality of Huruta shallot variety
- Identification of optimum planting time, suitable location(s), bulb quality and bulb handling for quality seed and high seed production of Huruta shallot variety

h. Introduction, Evaluation and Generation of Technologies for High Value Vegetable Crops in eastern Ethiopia

The technologies demand is increasing for high value vegetable crops such as tomato, egg plant and cabbage in eastern Ethiopia. However, the improved technologies for such crops are not available in sufficient quantity and quality. For some of the crops such as egg plant, there are no improved varieties recommended in the country. The agronomic packages and postharvest handling of these crops are not developed for eastern Ethiopia in particular and in the country in general except for tomato. The shelf life quality and nutritional content of these crops need also to be determined to serve the purposes of end users. The problems can be addressed through introduction, evaluation and identification of adaptable high yielding varieties and generation of agronomic and postharvest handling technologies for eastern Ethiopia. Therefore, project need to be designed and executed focusing on the following major components.

- Evaluation of high yielding and disease resistant tomato varieties in eastern Ethiopia
- Determination of fertilizer rates, spacing and other related agronomic management practices for tomato in eastern Ethiopia
- Generation of postharvest handling practices to increase shelf life of tomato and determination of tomato varieties fruits physical quality and nutritional constitute.
- Identification of methods for quality seed extraction from improved tomato varieties easily adaptable by farmers in eastern Ethiopia
- Introduction and evaluation of commercial egg plant varieties in eastern Ethiopia
- Determination of fertilizer rates, spacing, postharvest handling and fruit quality of introduced egg plant varieties
- Introduction and evaluation of commercial cabbage varieties in eastern Ethiopia
- Determination of fertilizer rates, spacing, postharvest handling and head cabbage quality of introduced varieties

2.3. Crop Protection Research Area

Plant protection forms one of the major components of crop production, as yield is obviously far lower than the potential of the crops due to plant diseases, insect pests, plant-parasitic nematodes and weeds. Susceptible food crops could totally fail while some others bear substantial yield loss due to these pests. In addition to yield loss in the field, food crops are also lost in transport and storage unless properly handled and managed. Despite the remarkable progress made in increasing food production at the global level, approximately half of the population in the Third World still does not have access to adequate food supplies. Evidence suggests that food losses occurring in the postharvest and marketing system tend to be highest in these countries where the need for food is highest. Both quantitative and qualitative food losses of extremely variable magnitude occur at all stages in the post-harvest system from harvesting, through handling, storage, processing and marketing to final delivery to the consumer.

Fruit, vegetables and root crops are much less hardy and are quickly perishable, if care is not taken in their harvesting, handling and transport, and they will soon decay and become unfit for human consumption. Postharvest rotting of cereal grains and of legumes is also quite common and the losses caused by it are quite significant. Such losses occur primarily at the large bins or warehouses of the growers, wholesalers, or manufacturers and are seldom observed by the general public. Storage losses are both in quality and quantity to the extent that it becomes detrimental to human health.

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Some of the pests are imported from other countries, as the quarantine system of our country is also poor. Containment of such exotic pests requires regular survey and research to recommend proper policy measures. The success of plant protection programs depends on the ability to detect pests. Detection schemes can be designed in different forms of regular surveys. That is, because well designed survey program includes regular monitoring for insect pests, diseases, weeds, nutrient deficiencies, irrigation problems, sanitation, and much more. Early intervention is instituted as soon as signs of damage are detected, rather than later when they are irreversible. Plants and pests are continuously confronted with each other during evolution in a battle for growth and survival. In this rivalry plants have evolved a stunning array of structural, chemical, and gene-based defenses, designed to combat the pests of different nature and, so as the some pathogens by developing new races. Many plants both in nature and in agriculture are resistant to multiple diseases. Although much of the plant innate immunity system provides highly specific resistance to pest organisms, there is emerging evidence to support the hypothesis that some components of plant defense are relatively nonspecific, providing multiple resistances. Understanding multiple resistances is of fundamental and practical interest to plant biologists, entomologists, pathologists, and breeders to reduce loss levels to pests. The overall losses in food have been further aggravated by losses in feed and fodders of animals. Such losses could be due to mycotoxin contaminations that request for immediate solutions. Accordingly, the major research priority projects with major research components are identified by **Crop Protection Research Area**.

a. **Assessment of Crops Yield Loss and Sustainable Management of Plant-Parasitic Nematodes in eastern Ethiopia**

- Sustainable Management of Plant-Parasitic Nematodes on Tomato, Pepper, Potato and Sweet Potato Crops in Eastern Ethiopia;
- Damage Assessment, Identification and Characterization of Cereal Nematodes in Eastern Ethiopia;
- Investigating Diseases Complexes Involving Plant-Parasitic Nematodes and Soil-Borne Fungal Pathogens on Root, Tuber and Vegetable Crops;
- The Potential of Entomopathogenic Nematodes to Manage Economically Important Insect Pests of Major Crops in Eastern Ethiopia.

b. **Assessment of Mycotoxin-Producing Fungi Distribution and Mycotoxin Contamination in Foods, Feeds and Fodders in Eastern Ethiopia**

- Analyses of Mycotoxin Contamination in Foods, Feeds and Fodders in Eastern Ethiopia;
- Importance and Distribution of Mycotoxin-Producing Fungi and Their Management in Major Crops (especially Focusing on Legumes) in Eastern Ethiopia.

c. **Assessment of Crops Yield Loss due to Insect Pests, identification and Management of Emerging and Re-Emerging Diseases, Insect Pests and Invasive Weeds of Major Crops in Eastern Ethiopia**

- Plant Diseases, Insect Pests and Parasitic Weeds Monitoring on Major Crops in Eastern Ethiopia (Regular Survey);
- Importance and Distribution of Emerging and Re-Emerging Diseases, Insect Pests and Invasive Weeds of Major Crops in Eastern Ethiopia;
- Pinning Out the Association of Production Systems and Disease Epidemics and Insect Pest Outbreaks on Major Crops in Eastern Ethiopia;
- White Mango scale (*Aulacaspustubercularis*), the newly Emerging Pest to Ethiopia

2.4. Indigenous Trees/Shrubs, Aromatic and Medicinal Plants Research Area

The important role played by indigenous trees and shrubs in natural forest, wood land, and agroforestry system in east Hararghe and their benefit to the environment, livelihoods of the local communities and sustainable

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development is not well assessed and documented. Medicinal plants play an important role in pharmacology and pharmaceutical chemistry because of their high essential oil content in their different parts. In herbal medicine, they are used for their antiseptic properties against infectious diseases of fungal and bacterial origin. However, little information is available about the medicinal plants in eastern Ethiopia. Therefore, the research project needs to be designed and executed focusing on evaluation of the status of indigenous trees, shrubs and analyses of chemical composition and antimicrobial effects of extracts from different parts of medicinal plants in Eastern Ethiopia.

a. Assessing the Status of Indigenous Trees and Shrubs, Determination of Medicinal Values of Herbs and Medicinal Plants in eastern Hararghe

- Status and future prospects of indigenous trees and shrubs in eastern Hararghe
- Phytochemical and pharmacological investigations of extracts of different parts of selected herbs and medicinal plants in eastern Hararghe

2.5. Germplasm Maintenance and Enhancement Research Area

a. Germplasm Maintenance and Enhancement of Crops and Seed Multiplication of Crop Varieties

Haramaya University has been contributing a lot to the country in developing crop varieties since its establishment as Agriculture College. The germplasm collected by the University has been the basis for the establishment of national gene bank and thousands of collections were conserved as world wealth at different gene banks. However, the University has failed to maintain its own varieties, collections and introduced crop genotypes. The seed production of crop varieties in the University is not under strict supervision of breeders. Therefore, the following activities are proposed to be implemented every year. Some of the activities related to this research area are:

- Maintenance of Enhancement of Potato and Sweet potato Collections and Seed Tubers and Cutting Multiplication of Commercial Varieties;
- Maintenance of Inbred Lines and Old Maize Varieties, and Seed Multiplication of Commercial Varieties;
- Maintenance of Cereal Crops Germplasm and Seed Multiplication of Commercial Varieties;
- Maintenance of Common Pulse Crops Collections and Seed Multiplication of Commercial Varieties;
- Maintenance of Collections and Seed Multiplication of Commercial Varieties of Oil Crops.