**DEBREMARKOS UNIVERSITY**

**COLLEGE OF AGRICULTURE AND NATURAL RESOURCES**

**DEPARTMENT OF HORTICULTURE**

 

HAND OUT FOR

ROOT AND TIBER CROPS PRODUCTION AND MANAGEMENT (HORT 2112)

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**CHAPTER ONE**

1. **Introduction to Root and Tuber Crops Production**

**Learning objectives**

At the end of this chapter students should be able to:

* **Differentiate** between Roots, Tubers and Corms
* **List** the importance of root & tuber crops
* **State** the roles of Root and Tuber Crops in Food Security
* **Identify** the distinguishing features of Root and Tuber Crops
* **Pin point** problems/challenges of and Tuber Crops Production in Ethiopia
* **Give explanation** on the prospects of Root and Tuber Crops Production

**Content**

* 1. Definition of Roots, Tubers and Corms
	2. Importance of Root and Tuber Crops
	3. Roles of Root and Tuber Crops in Food Security
	4. General Characteristics of Root and Tuber Crops
	5. Problems/challenges of and Tuber Crops Production
	6. Prospects of Root and Tuber Crops Production
1. **Introduction**

Root and tuber crops provide a substantial part of the world's food supply, and are also an important source of animal feed and industrial products. On a global basis, approximately 45% of root and tuber crop production is consumed as food, with the remainder used as animal feed or for industrial processing for products such as starch, distilled spirits, and a range of minor products.

The pattern of root and tuber crop utilization varies considerably among countries. In the developing countries (with the exception of China and Brazil), relatively small amounts (less than 20%) are fed to livestock. Most of the remainder is used locally as food. The relatively high cost of transportation, processing, and storage, as well as the considerable time needed in food preparation, frequently makes unprocessed root and tuber crops less attractive to urban consumers. Root and tuber crops are widely produced in Latin America, Asia West Africa and Caribbean countries.

* 1. **Definition of Roots, Tubers and Corms**

**Activity 1.1. Make a distinction between roots, tubers and corms**

1. **Roots:** - are underground vegetative organ of plants which is responsible for anchorage, absorption of water and minerals. The tuberous root includes several types of structures with thickened tuberous growth that functions as storage organs. Botanically, these differ from true tubers, although common horticultural usage sometimes utilizes the term “tuber” for all of them.
2. **Tubers**: - are enlarged storage organs which are found underground. The distinguishing factor of a tuber is the presence of nodes or ‘eyes’ on the organ. A classic example is the potato.
3. **Corms**: - is the swollen base of a stem axis enclosed by the dry, scale-like leaves. In contrast to the bulb, which is predominantly leaf scales, a corm is a solid stem structure with distinct node and internodes.
	1. **Importance of Root and Tuber Crops**

**Activity 1.2. Why do we produce roots & tubers crops?**

Roots and tubers were critical components in the diet during the early evolution of mankind (~5 million years ago). Roots and tubers comprised significant components of the diet and had the advantage for hunter-gatherer societies in that they were available over extended periods of time due to their ability to be left *in situ* until needed. With the advent of agriculture, cultivated root and tuber crops became increasingly critical sources of food with the potato, cassava and sweet potato representing the 3rd, 6th and 7th most important sources of food for humans worldwide today.

1. **Food use**
2. **Main dishes**

Root and tuber crops are effectively serves as main dishes in many situations. About 20% of Ethiopian population depends on Enset for food and feed.

1. **Side dish: -** Many root and tubers such as carrot, yam, beet root and Anchote are traditional side dishes that are steamed, boiled, baked, or fired. A potato dish is a common side dish in many meals from the home cooked meal to the
2. **Dessert: -** sweet food served after the main part of meal. Sweet potatoes, potatoes, tannia, taro and yams are used to make biscuits, bread, muffins, pies, custard, cookies and cakes.
3. **Medicinal uses**
4. **Vitamins**

Root and tuber crops are excellent source of essential minerals and vitamins (A, C and B-complex)

**Vitamin C** (ascorbic acid):- increase body resistance to colds, coughs, wound healing, allergic reactions and respiratory diseases. Foods rich in vitamin C are: - potatoes, sweet potatoes, taro and tannia.

**Vitamin A**: - essential for vision, growth, bone development, immune system and reproduction. Good sources are carrot and sweet potato.

**Vitamin B complex** [(Vitamin B1 (thiamine), B2 (riboflavin), B6 (pyridoxine), B12 (cyanobalamin) and niacin (nicotinic acid). The B vitamins are necessary for the utilization of carbohydrates and protein and in the prevention of anemia. The tannia and taro contain a reasonable amount for of vitamin B1, B2 and niacin.

1. **Fiber or as a source of roughage**

Root and tuber crops are very important, especially in developed countries where a low fiber diet is consumed. It is the component of vegetables (Root and tuber crops) that assist moving food through the alimentary canal by aiding the muscular action of the intestines, thus preventing constipation. It also helps to satisfy the appetite.

The beneficial effect of fiber on blood cholesterol level and consequently high blood pressure and heart disease, in preventing gall stones and cancer of the colon has received increasing attention in recent years. Its large bulk and low energy values make it also useful in preventing and treating obesity (fatness). Its role in the effective control of diabetes is significant.

1. **Root and tuber crops as source of energy**

Potatoes, sweet potatoes, yam, taro, enset and tannia are rich in carbohydrates and thus are capable of providing energy.

1. **Ornamental uses**

Various types of Root and tuber crops are also used for decorative purposes Enset, taro, tannia and sweet potatoes are grown for their attractive foliage as ornamental plants in some parts of the country. Having a field that partially encompasses the homestead is considered aesthetically desirable by enset-based societies; enset beautifies the Ethiopian landscape by its thick, dark green foliage.

1. **Economic uses**

Root and tuber crops are important sources of income for both the grower and the country. It is good potential for export market and thereby to earn foreign currency. Production of Root and tuber crops creates a number of job opportunities in the rural and sub-urban areas and in the complementary fields of business that arise, such as marketing, processing and transportation. Root and tuber crops growers tend to learn earn higher income than other farmers because of the relatively higher yield and value of the crops.

1. **Social role**

Root and tuber crops for special occasions: Among the root vegetables, anchote (*Coccinia abysinica*) holds a very special place in the traditions and customs of the Ethiopian (Oromo) people. Also a most yam producing African countries, extra large yams are required for ceremonial purposes, “Yam festival”.

1. **Animal feed**

Cassava, yam, sweet potato and potato is used worldwide for animal feed.

1. **Fuel and alcohol production**

In many countries, significant research has begun to evaluate the use of cassava as an ethanol bio-fuel.

* 1. **Roles of Root and Tuber Crops in Food Security**

The majority of the Ethiopian population depends mainly on cereal crops as food source. The food potential of horticultural crops, particularly that of root and tuber crops, has not yet been fully exploited and utilized despite their significant contributions towards food security, income generation, provision of food energy and resource base conservation. The low agricultural productivity, recurrent drought and socio-political factors have greatly contributed to critical food shortages in Ethiopia. These in turn have resulted in food insecurity, which is characterized by inability of the people at all times to have a physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life. Consequently, there is evidence of a reduced capacity to cope with expected setbacks in their economic or natural environments due to food shortages to maintain appropriate and sustainable food security systems.

Among the different approaches in achieving food security, integration of root and tuber crops into the food system of the people should be given a serious attention. Because, these crops are often thought as starchy staples, that provide low cost energy to the human diet. In addition, they are known to contain appreciable amounts of proteins, essential vitamins and minerals. On average, cooked potatoes, and yams have about 2-3% protein. Cassava, potatoes and sweet potatoes also contain the important amino acids like lysine; which are missing in most cereal crops. Moreover, the leaves of sweet potatoes, cassava, taro, tannia and anchote are known to provide good amount of vitamin A, on the other hand, is a very good source of quality starch and fiber for agro-industries.

The food and non-food products of Enset are steadily becoming popular in non-enset producing areas of central and northern Ethiopia, and fiber products manufactures are increasingly using enset fiber as a raw material.

The main reasons for the growing importance of the crop are its high yielding ability and the fact that its production and processing activities are environmentally friendly.

Root and tuber crops are most important in south, southwest, eastern and northwest parts of Ethiopia in terms of production area, distribution and consumption. They are also grown almost all over the nation. Small-scale subsistence farmers grow the crop, under resource poor conditions. In general, root and tuber crops are parts of traditional food of Ethiopia. Their contribution to family food self-sufficiency, income generation and soil based resource conservation is indispensible. The principal root and tuber crops grown in Ethiopia are Enset (*Ensete veantricosum*), potato (*Solanum tuberosum L.*), taro (*Colocasia esculenta* schott), cassava (*Manihot esculantum*), yam (*Dioscorea species*), anchote (*Coccinia abyssinica*), ‘Ethiopian dinich’ (*Coleusedulis*), tannia (*Xanthsoma species*) and Sweet potato (*Ipomoea batatus*). Among these ‘Ethiopian dinich’ and Enset are believed to be indigenous to Ethiopia.

Currently most root and tuber crops are grown as security crops against crop failures and/or to bridge the food deficit periods, as they are ready for harvest during “hunger months.” These crops are also tolerant to termites, which might be attributed to their higher moisture content, and thrive well on very poor soils and under moisture stress conditions.

The diverse agro-ecologies that exist in Ethiopia allow the production of different root and tuber crops. But, despite the suitable environment of the country, the cultivation and productivity of root and tuber crops are low as compared to most of the sub-Saharan countries. Ethiopia faces a huge food deficit, which may be due to drought that occurs every other two-three years. Much of the food deficit could be avoided if root and tuber crops were cultivated with adequate agronomic practices, as they have a high productivity potential. Moreover, most of the root and tuber crops are believed to be drought tolerant. The present in adequate use of root and tuber crops could be attributed to many factors, such as low investment in research, extension and training of farmers on utilization of these crops.

* 1. **General Characteristics of Root and Tuber Crops**
1. **Seasonality**

Most root and tuber crops are seasonal. They grow best during certain seasons or in certain places. Demands for certain root and tuber crops are also higher during certain periods of the year. Several species of root and tuber crops can be grown throughout the year, but here are others that can be grown only during certain times of the year. If irrigation is available, many species can be grown throughout the year.

1. **Perishability**

Because of high water content (85-90%) of root and tuber crops, they are perishable and although the shelf life of many root crops may extend over weeks or months.

1. **Bulkiness**

They are bulky in relation to their volume and this is aggravated by the further needs of packing to protect them from damage.

1. **High capital requirements**

Root and tuber crops are intensively cultivated crops. The production, harvest and marketing of root and tuber crops are generally labor intensive. The sheer bulk of root and tuber crops, compared to cereals is an even bigger problem than is their underground harvest. Root and tuber crops can be harvested by means other than simply digging up individual plants (e.g., ploughs, spinners, mechanical harvesters) but the volume to be dealt with (stored or transported) remains a significant labor problem. The processing of traditional consumable products from these crops may also require high labor inputs. In many countries, women are heavily involved in each of these tasks, and thus the role of women is worthy of special attention.

1. **Susceptibility to damage**

Crops only be stored for relatively short period of time. Root and Tuber crops may also suffer from wind damage when grown on exposed sites where some form of protection will be desirable. For example, potatoes are susceptible for such damage.

1. **Diversity**

Considering their diversity nature, a plant may be vegetable (Root and tuber crops) in one country but a weed, an ornamental or a medicinal plant in another country, depending on the crop. Root and tuber crops differ in their growth habit (herbaceous, viny, shrubby or trees), propagation (by seed or vegetatively), disease and pest reaction, growth requirements and genetic systems.

1. **Vegetative propagation**

Similarity of root and tuber crops is the common practice of vegetative propagation. Relative to grain crops, root and tuber crops require sophisticated technologies for their propagation. Moreover, vegetative propagation of crops increases the likelihood of transmitting many different plant pathogens.

1. **Time needed in food preparation: -** High energy cost for food preparation.
	1. **Prospects of Root and Tuber Crops Production**
2. Favorable agro-ecology
3. climate
4. Soil: - favorable for different types of vegetables
5. Ample water supply: - both RF & irrigation

 b. Market: - local & export

c. Cheap and abundant labor force

d. Proximity of the country to fertile markets of Europe and Middle East Asia

* 1. **Problems/challenges of Root and Tuber Crops production**

The major gaps that require research intervention in root and tuber crops production and use can be grouped into the following areas:

1. **Production technologies**
* Adaptable high yielding and good quality varieties
* Improved agronomic packages
* Lack of improved seed sources/plant material and limited research activities, thus poor varieties are resulted into low quality and yield
* Improved soil fertility and water management
* Genetic resource conservation and utilization of indigenous root and tuber crops
* Control of major diseases such as late blight and bacterial wilt of potato, bacterial wilt of Enset, virus in sweet potato
1. **Postharvest, processing and utilization**
* Storage, packaging and processing techniques
* Information and awareness on different recipes
* Appropriate processing equipment
* Inadequate knowledge about the cultural requirement of each crop
* Poor transportation facilities
1. **Marketing and transportation**
* Lack of capital
* Market problem (poor marketing system)
* Market information and distribution system
* Market linkages between producers and consumers
1. **Protection :**Diseases and insect pests

**CHAPTER TWO**

1. **Major tuber Crops grown in Ethiopia**

1. **Chapter learning objectives**

After completing this Chapter students are expected to:

* Identify the origin, botany and environmental preferences of major tuber crops (potato, Sweet potato, Cassava and Yam) grown in Ethiopia
* Be familiar with the production technology of potato, Sweet potato, Yam and Cassava
* Recognize the varieties released so far for major tuber crops
* Identify the major diseases and insect pests of tuber crops and their control measures
* Explain the postharvest handling, processing, marketing and utilization of tuber crops

1. **Contents**
	1. **Potato (*Solanum tuberosum L.*)**
		1. Introduction
		2. Origin
		3. Taxonomy and Botany
		4. Breeding and Genetics
		5. Climatic requirements
		6. Agronomy
		7. Diseases and pests
		8. Postharvest handling and processing
		9. Marketing and utilization
	2. **Sweet Potato (*Ipomoea batatas L.*)**
	3. **Cassava (*Manihot esculenta* Crantz)**
	4. **Yam (*Dioscorea species*)**

**2.1. POTATO (***Solanum tuberosum**L****.)***

1. **Introduction**

The potato is the **fourth** most important food crop in the world after **wheat, maize and rice** with 311 million tones produced from 19 million hectares at an average fresh weight yield of 16.4 t/ha in 2003 (FAO statistics), but with a huge range from 2 to 44 t/ha by country.

As well as being a staple food the potato is grown as a vegetable for table use, is processed into French fries and chips (crisps) and is used for dried products and starch production. Processing is the fastest growing sector of the world potato economy, and today, processors are building factories in countries where the potato is primarily grown as a staple food.

1. **Origin**

Activity 2.1. Why do we study about the origin of vegetables?

Potato has its **origin** in the high **Andes of South America** and was first cultivated approximately **Lake Titicaca** near the present border of Peru and Bolivia. It was introduced to Ethiopia 1858 by the Germen botanist Schimper. Since then, the potato has becomes an important crop in many part of the country.

1. **Botany**

Potato (*Solanum tuberosum L.*) family; *Solanaceae*; genus; *Solanum;* section *Tuberarium* and chromosome number; 2n=48 is one of mankind’s most valuable food crops. There are four diploid species; *Solanum stenotomum, S. phureja, S. goniocalyx* and *S. ajanhurri.* There are also two triploid species; Solanum *chaucha* and *Solanum juzepczukii;* and one pentaploid cultivated species called *S. curtilobum.* There are two sun species of *Solanum tuberosum*; Andean and tuberosum or Chilean. Today, over 99% of all cultivated potato varieties world wide are descendants of the Chilean subspecies. There are about five thousand potato varieties (3 thousands of them are found in the Andes alone, mainly in Peru, Bolivia, Ecudar, Chile and Colombia). Apart from the five thousand cultivated varieties, there are about 200 wild species and subspecies.

The potato is perennial but as crop, it is treated as an annual. It is vegetative propagated by the mean of tuber. The tuber is an enlarged underground stem produced on the end of a stolen and not on the roots proper. These tubers are morphologically stems. The possess eyes that is bud. Many potato cultivars produce flowers and fruits in cultivation.

Potato is a self-pollinated plant. The flower of the potato plants are in terminal cluster. Each flower normally has five stamens, two-celled pistil, five sepals and five petals united for about half their length. Most varieties of potatoes bear infertile pollens and hence fruits or berries are not generally formed. In some of the varieties fruits or berries are formed. One inflorescence can contain variable number of flowers (1 to 40), depending on the cultivar and time of the flowering season. Usually there are more flowers in a cluster but maintained six to eight flowers are recommended. The stigma is receptive for pollination just before the flower buds open, or shortly thereafter older flowers may become self pollinated.



1. **Economic importance, use and composition**
* Important food & cash crop in Ethiopia (especially on high & mid-altitude area)
* Potatoes are best known for their rich carbohydrate content (starch and fiber). Cheapest source of energy.
* Potatoes contain a number of important Vitamins (Vit. C, Vit B1 (thiamine), Vit B2 (riboflavin) and Vit B6).
* Provides significant amount of proteins with a good amino acid balance.
* Source of minerals (K, P, Ca, Mg, Fe and Zn).
* Potato is rich in antioxidants comprising polyphenols, carotenoids and tocopherols.
* Fresh potatoes are free of fat and cholesterol.
* Staple food in western countries
1. **Production trend, Marketing and Utilization**

**The world potato production had increased from time to time.** Potatoes were grown on 19.6 million hectares of land in 2006 (FAOSTAT), in 149 countries from latitudes 650N to 500S, and at altitudes from sea level to 4000m. Potato production by region is shown in Table 2.1. The four largest potato producers are China (70 million tonnes), the Russian Federation (39 million tonnes), India (24 million tonnes) and the USA (20 million tonnes) with per capita consumption still much larger in Russia than in the other countries.

**Table 2.1. Potato production by region in 2006 (source FAOSTAT)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Harvested area (ha)** | **Quantity (tonnes)** | **Yield (tonnes/ha)** |
| Africa | 1,499,687 | 16,420,729 | **10.95** |
| Asia/Oceania | **9,143,495** | **131,286,181** | **14.36** |
| Europe | 7,348,420 | 126,332,492 | 17.19 |
| Latin America | 951,974 | 15,627,530 | 16.42 |
| North America | 608,131 | 24,708,603 | **40.63** |
| **World** | **19,551,707** | **314,375,535** | **16.08** |
| **China** | **4,901,500** | **70,338,000** | **14.35** |
| Russia | 2,962,420 | 38,572,640 | 13.02 |
| India | 1,400,000 | 23,910,000 | 17.08 |
| USA | 451,430 | 19,712,630 | 43.67 |
| **Ethiopia** | **73,095** | **525,656.8** | **8.03** |

Source: - Singh and Kaur, 2009

**Production trend in Ethiopia**

In the last three decades, the land under potato had increased from 30,000ha in the mid 1970s to 50 thousand in the mid 1980s, and since then there has been a steep rise to about 160,000ha by 2000. The increase in potato production is attributed to different factors. These include:

1. Need for more productive crop. Due to reducing land holding, farmers are forced to move to a labor-intensive, short duration and more productive crops such as potato to meet the growing need for food.
2. The need for cash crop. Cash crops are limited in the highland areas. However, farmers have found potato to be a useful cash crop among other few vegetables to increase their household incomes and improve their livelihoods.
3. Attitude change. In the early times, potato was considered as poor man’s food. This had limited its use and expansion for a long period. However, the increasing awareness of the crop and its utilization through research, technology transfer, media, and urbanization has increased the importance of the crop irrespective of economic classes.
4. Substitution to pulse crops. The increase in price of pulse crops commonly used for stew/*wot*’/ preparation has also increase the utilization of potatoes as a substitute in both urban and rural area.
5. Availability of improved technologies.
6. **Marketing and utilization**

The utilization of potato in Ethiopia has been very conservative. In recent years, however, the consumption of potato in the form of crisps, chips and mixture of salads, stew, porage has dramatically increased. The increase in urban development and improvement in infrastructure such as road has opened a growing opportunity for potato growers to sell their potatoes to nearby towns and distant cities. Some quality of potatoes is also exported to Djibouti from eastern and central parts and to the Sudan from the northwestern part of the country.

1. **Climatic and soil requirements**
2. **Temperature**

In the previous chapter saw that affects the type of growth. High temperatures encourage the growth of the haulm, whereas lower temperatures are more conductive to that of the tubers. The temperature, then, affects the distribution, in one way or the other, of the dry matter formed. For example, temperatures higher than 25 to 30° C are unfavorable for tuber production. It is not only the average temperature that is important; the maxima and minima are even more so. Low night temperature may do a lot to restore the balance. Regions with maxima as high as 30°C and minima of about 15°C are much better for potato growing than regions with temperatures that are fairly constant at around 25°C.

At about 30° C dry-matter production drops to roughly two thirds of what it is at 20°C. At 10° C it is considerably higher of what it is at 30° C. No wonder then that this crop grows best in temperate climates or at high altitudes in the tropics or sub-tropics. Needless to say, the temperature given is that in the crop. This may differ considerably from that measured at a height of 2m (i.e. the air temperature).

1. **Light**

Regions with plenty of sunshine, therefore, have a certain advantage over areas where it is often cloudy. Moreover, an abundance of light tilts the balance of the haulm/tuber growth relationship in favor of the tuber. This is one of the reasons why, in tropical and sub-tropical regions, it is possible to achieve high yields at high altitudes, where there is a high light intensity, even when day temperatures are fairly high, provided that night temperatures are rather low.

1. **Moisture**

Insufficient water supply to the crop reduces foliage growth and the efficiency of, that foliage to use intercepted light by reducing the rate of photosynthesis; moreover. Water deficiency Stimulates maturity and call even cause death of the leaves. Under Conditions prevailing in the Netherlands, shortage of water has a greater effect on the efficiency of the foliage in producing dry matter than it has on total light interception, although on

1. **Soil**

The potato develops best on deep, fertile, sandy to, clay loams with good water retention capacity. Because the potato has a relatively weak, shallow root system, impermeable layers in the soil limit rooting depth, which restricts water availability to the plant in dry periods. Thus soil compaction can greatly reduce potato yields. Aeration of the soil has a great effect on the set and development of tubers.

1. **Agronomy of potato**

Agronomic practices is most of the potato growing areas of Ethiopia leave much to desire for improvement. The agro-ecologies where farmers thrive to grow potato are characterized by diverse conditions. They vary considerably in soil type, moisture and temperature regimes, fertility conditions, and in the on set, intensity and duration of rain. Therefore, crop management operations have to take into account of these differences to ensure high yield levels.

1. **Potato Variety**

Table 2.2. Average yield & some other characteristics of potato varieties released during 1987-2010

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variety | Release year | Area of adaptation | Maturity  | Yield (t/ha) | Releasing research centers or university |
| Altitude (m) | Rainfall (mm) | On station | On farm |
| Alemaya 624 | 1987 | 1000-2000 |  | 90-100 | 25.9 | - | AU |
| Awash  | 1991 | 1500-2000 | >750 | 90-100 | 25.4 | 20.0 | Holetta |
| Tolcha | 1993 | 1700-2000 | >750 |  | 33.1 | 22.5 | Holetta |
| Menagesha | 1993 | >2400 | >750 |  | 27.0 | 25.0 | Holetta |
| Wechecha | 1997 | 1700-2800 | >750 |  | 21.8 | 19.0 | Holetta |
| Chiro | 1998 | 1600-2000 | 700-800 |  | 36.0 | 27.5 | AU |
| Bedassa | 2001 | 1700-2000 | 700-800 |  | 40.5 | - | AU |
| Zemen | 2001 | 1700-2000 | 700-800 |  | 37.2 | - | AU |
| Zengena | 2001 | 2000-2800 | 1000-1500 |  | 30.0 | 23.5 | Adet & Holetta |
| Guassa | 2002 | 2000-2800 | 1000-1500 |  | 22.4 | 23.5 | Adet & Holetta |
| Degemegn | 2002 | 1600-2800 | 750-1000 |  | 46.7 | 35.6 |  Holetta |
| Jalenie | 2002 | 1600-2800 | 750-1000 |  | 44.8 | 29.1 | Holetta |
| Gorebella | 2002 | 2700-3200 | 800-925 |  | 30.1 | 28.0 | Sheno & Holetta |
| Gera | 2003 | 2700-3200 | 800-1000 |  | 25.9 | 20.6 | Sheno & Holetta |
| Bule | 2005 | 1700-2700 | 980-1398 |  | 39.3 | 38.3 | Awassa & Holetta |
| Marachere | 2005 | 1700-2700 | 980-1398 |  | 33.3 | 28.4 | Awassa & Holetta |
| Shenkolla | 2005 | 1700-2700 | 980-1398 |  | 31.5 | 29.1 | Awassa & Holetta |
| Gudenie | 2006 | 1600-2800 | 750-1000 |  | 29.2 | 21.0 | Holetta |
| Belete | 2007 | - | - |  | - | - | Holetta |
| CAESAR | 2009 | - | - | - | - | - | Solagrow plc |
| Mondial | 2009 | - | - | - | - | - | Solagrow plc |
| Red scarlett | 2010 | 1800-2400 | 800-1200 | 70 | 50 | 40 | Solagrow plc |

Source: - MoARD, 2010; EARO, 2004

1. **Propagation**

Planting material can be seed tubers, stem cuttings and botanical seeds (true potato seed).

1. Botanical seeds (true potato seed):- widely used in other countries to reduce the incidence of virus disease.
2. **Seed tubers**
* Most commonly used
* Potato tubers have dormancy period (8-10 weeks)
* Should be planted after the dormancy period is over & when tuber starts to sprout
* Tubers has to be free of viral disease
* Can be planted whole or cut in to pieces

**To overcome dormancy**

* Dip the tubers in 1ppm solution of Gibberelic acid (GA3)
* Treat the tubers with potassium triocyanate
1. **Stem cutting**

Need hormones for sprout initiation

Table 2.3. Comparison of true potato seeds (TSP) and potato seed tuber

|  |  |
| --- | --- |
| **True potato seeds (TSP)** | **Potato seed tuber**  |
| Amount required is small (200g/ha) | Amount required is large (18-20q/ha) |
| Free from diseases | Infected materials may be planted |
| Require much labor (extra time to rise seedlings) | Require less labor |
| Take long time to maturity | The tubers are almost uniform (suitable for processing) |
| Difference in tuber size, shape (lack uniformity) | Mature early |
| Low cost of transportation and storage | High cost of transportation and storage |

**Dormant period**

Under normal conditions the eyes of a potato will not sprout during the first few -weeks after harvest, even if temperatures are favorable. This is called the dormant period. Normally it is defined as that between harvesting and the time when, at normal temperatures, the eyes begin to sprout in earnest.

The length of the period depends on:

1. **Variety**

2. **Degree of maturity when harvested**: - Potatoes harvested immature have a rather longer dormant period, but it must be remembered that such tubers have usually been lifted earlier and will in consequence start to sprout at an earlier date than those harvested when fully mature.

3. **Temperatures during the growing season**: - Potatoes start to sprout earlier after a warm summer than after a cool summer. Variations due to this factor can be observed even in a small country like the Netherlands. Day length may also affect dormancy; a short day during the growing season shortens the dormant period. Warm storage speeds up the physiological processes in the tuber and shortens the dormant period but with some varieties a fluctuating temperature or a low temperature for some weeks after harvesting has an even more marked effect in this direction. It follows from the foregoing that the dormant period is far shorter in hot countries than in cooler climates.

4. **Temperature during storage**

5. **The presence of tuber injury** caused mechanically (deliberate cutting or accidental damage) or disease (e.g. blight).

1. **Planting**
* **Planting method: -** ridge & furrow method is most popular.The seed tubers should not come in contact with fertilizer.
* **Planting time: -** for the main/rainy season (June to September) . Planting time is early June. For off-season/irrigation (October-February). Planting time is early October. But planting can be done any time when there is no frost problem.
* **Planting depth: -** depends on soil moisture and soil temperature. Widely used planting depth for potato is 10-15cm deep.
1. **Spacing**
* Ware potato: - 75cmX 30cm (between rows and between plants, respectively).
* Seed potato: - 60cmX20cm (between rows and between plants, respectively).
1. **Fertility management**

Urea 165 Kg/ha (split: half at planting and the rest during flowering), DAP 195 Kg/ha Side dressing at the time of planting.

1. **Irrigation**

Soil moisture determine yield. Irrigation is essential especially at critical stages; such as sprout formation and establishment, stolon formation, tuber initiation and tuber development. Potato requires uniform moisture throughout the growing season. Erratic soil moisture results in: development of misshapen tubers, bitter taste tuber and rough skin texture tubers. Irrigation frequency must be reduced after tuberization to avoid rooting of tubers.

1. **Earthing up (ridge) cultivation**

Ridging refers tothe practice of hilling or earthing up the soil around the potato plant; it is a normal practice in potato production areas. Proper ridging increase tuber yield by creating favorable conditions for tuber initiation and development and also reduce yield loss. Frequency and optimum of ridging may depend on variety, soil structure and workable soil depth. As compared to non-ridging of the crop at least twice during the growing period may increase yield by 10-20%. First round ridging maybe done in 2-3 weeks after emergence

Have the following benefits;

* Means of wed Control mechanism
* Prevent greening of tubers when exposed to sun by covering with sufficient layer of soil
* To control PTM (potato tuber moth) because larva will be exposed to sun
* To increase tuberization (by increasing aeration**).**
1. **Harvesting**

The size of the tuber increases until the vines become dry. In developed countries, potatoes are harvested by mechanical harvesters. In Ethiopia, they are manually harvested by digging up the ridges with a spade. Care must be taken that tubers are not injured during the process. After harvesting, the crop should be kept in the

shade.

Early potatoes may be harvested before maturity when the skin may flake off readily. Potatoes for storage should be allowed to mature and develop a thick skin and a layer of suberin to reduce moisture loss. Top die down as the tubers mature. Maturity may be hastened by killing the tops with chemicals. Commercial harvest is accomplished by mechanical diggers which dig one or more rows at a time and may deliver the crop direct to trucks driven alongside. Storage is in well-insulated and ventilated storage houses where, after a preliminary curing period, the temperature may be held at about 40°F. Lower temperature will result in starch in the tubers being changed to sugar. The reaction is a reversible one, and so tubers which become sweet from chilling should be held at 40 to 50°F for about two weeks before marketing.

1. **Potato postharvest management**

Postharvest management in potato is a set of operations and functions between crop production and consumption. Potato in inherently perishable. During the process of harvesting, storage, distribution and marketing substantial losses are incurred which range from a slight loss of quality to substantial spoilage. Postharvest losses may occur at any point in the marketing process, from the initial harvest through assembly and distribution to the consumer. The causes of losses are many: physical damage, physiological decay, water loss. The tuber, once harvested, is susceptible to environmental influences and requires proper handling and processing in to value added products that have long shelf life.

**Major postharvest losses**

* Physical, biochemical and physiologically
* Respiration
* Loss of moisture
* Loss in dry matter content
* Sprouting
* Pathogenic losses

**Storage methods**

1. **Cold storage**
* Most effective to maintain tubers in good condition
* Rarely used in most tropical countries
* Temperature and relative humidity should be adjusted to 2-40C and 75-80%, respectively.
* Temperature below 00C cause: internal tissue break down due to chilling injury and sugar formation which reduce quality.
1. **Sack/gunny storage: -** sprouting and rotting is a problem.
2. **Diffused light storage:-**
* Unlike cold storage it is very economical
* Recommended in most potato growing areas
* It avoids direct light and potato can be stored for quit long time in such storage.
1. **Pit storage**

Dig an area that is cool and under shade to 75cm depth, 2.5m long and 1m wide. After storage cover the surface with leaves or dry grass and provide ventilation by providing tubes of bamboo.

1. **Field storage**: - leave the matured tubers in the field un-harvested for some times.

Drawbacks

* Risk of rain
* Amount of tubers are not known
* Difficulty in harvesting if extremely dry weather
* Total weight of tuber will decrease especially if the soil is dry
1. **Protection of Potato**
2. **Potato Disease Management**

Both early and late blight are major fungus diseases. Fusarium wilt, ring rot, scab, rhizoctonia, and virus diseases such as leaf roll and mosaic may be troublesome. Aphis, wireworms, leaf hoppers, and Colorado potato beetles are insect pests. A complete spray program is usually required.

Late blight (LB) and tuber moth are the most significant disease and pest among the others which constraint the production of potato across the major production areas of the country.

**N.B.** Currently, among some constraints the absence of improved seed tuber production and its delivery system have resulted in the wide spread use of disease susceptibility, low yielding and poor quality of seed tubers country.

1. **Potato Pest Management**

Potato tuber moth (PTM):- the young caterpillars mine the leaves producing brown blotches. If infected tubers are planted there will be serious problem in the field. It attacks stem and tuber.

Other pests: cutworms, leafhopper, Aphid, ants.

APPENDIX



2.2. sweet potato

**2.3. Cassava**

1. **Introduction**

Cassava (*Manihot esculenta* Crantz, Euphorbiaceae, Dicotyledons) is the sixth most important crop after wheat, rice, maize, potato and barley and is the primary staple for more than 800 million people in the world, mostly in the poorest tropical countries. The term cassava is most likely derived from the Arawak word for bread, *casavi* or *cazabi*, and the term manioc from the Tupi word *maniot*, which French explorers converted to manioc. Cassava plays an essential food security role because its matured edible roots can be left in the ground for up to 36 months. The crop therefore represents a household food bank that can be drawn on when adverse climatic conditions limit the availability of other foods. The variety of foods that are made from the roots and the nutritious leaves are reasons why cassava cultivation is expanding worldwide.

1. **Origin**
2. **Taxonomy and Botany**
3. **Breeding and Genetics**
4. **Climatic requirements**
5. **Agronomy**
6. **Diseases and pests**
7. **Postharvest handling and processing**
8. **Marketing and utilization**

**CHAPTER THREE**

1. **Common Root Crops grown in Ethiopia**

**Unit learning objectives**

**Content**

* 1. Anchote (*Coccinia abyssinica*)
	2. Carrot (*Daucus carota*)
	3. Beet root (*Beta vulgaris*)

Reading Assignment