I . GENERAL LAND PREPARATION AND IRRIGATION

A- **TILLAGE**

Tillage is the preparation of soil for planting. It is used for the process of keeping the soil loose, porour, to free from weeds during the growth of crops.

The primary objectives of tillage are:-

1. **preparation of a suitable seed bed.**

   A good seed bed is considered to imply finner soil particles at greater fineness soil in the vicinity of seeds. A fine soil structure is desirable to allow rapid infiltration, provide adequate air capacity to exchange with in the soil and to minimize resistant to root penetration.

2. **To control weeds:**

   During tillage different weeds are cut down.

   There stem, up rooting and then mixed into the soil.

   Tillage disturbs the growth process of weeds.

3. **To improve the physical condition of soil.**

   Tillage incorporating to mix crop residue helps for controlling of soil moisture (soil water conservation

Tillage is affected by:-

- **surface crop residue**
- **surface soil roughness**
- **soil porosity**
- **Infiltration & retention capacity of the soil**

Pre- condition of land for plowing

A. clearing:- removal of plants residue from the land or slashing of the plant residues, weeds and preparing the land for tillage.

Types of tillage

1. **Conventional tillage practice**

Conventional tillage practice is traditional way of farming and is different from place to place.

2. Conservation tillage practices

It is a practice where moisture is conserved by tillage.
This tillage reduces soil water losses by leaving crop residue on or above the surface and by making the surface porous.

To maintain the physical condition of the soil the following tillage systems are considered.

a. **Rotary tillage:- In this practice there is no inversion of land, instead there is cultivation only to shallow depth. The Plant residue remain on top of surface of the soil as a result moisture will be conserved . it is widely used in areas were moisture limits crop growth and well wind erosion is high**
b. **Ridge tillage The land is ridged and seeds are planted on the top of the ridge. Ridges are generally used when row crop land is prepared seeded and cultivated by hand.**
c. **Reduced /minimum tillge/- This is based on a reduction in the number of operations used in conventional tillage.**

The major objects are:-

- **To reduce mechanical energy, labour requirements and soil compantion.**
- **To conserve moisture**

d. No/Zero tillage:- All operations in conventional tillage are done at the same time.

Major benefits are:-

- **Lower fuel to machinery cost**
- **Considerably less soil compaction**
- **better run off and soil erosion control.**
- **Impalements that are used to break deeply 6-36 inches**

Helps to get loosen the soil to prepare a suitable seed bed. This includes mold board ploughs (MBP) disc ploughs (DP) heavy duty disc harrows, chisel plough and rotary tiller.

1. Mold board plough (MBP)- can penetrate 7-10 inches.

- **Tractor speed 5.6- 9.6 km/hr. efficiency 70-90% MBP**
- **Is designed to cut narrow strip of soil/furrow slide) completely loose& invert it. Most MBP- are right handed& move the furrow slices to the right as the right as they are inverted.**

***If an operator begins ploughing along the boundaries for making furrow slices to wards the boundaries, two open furrows will exist in the center of area, the field forms dead furrow. This have to be arranged during leveling operation.**

If an operator starts ploughing at the center of the field back furrow will be formed. such two way of plawing avoids the formation of dead /open/ furrow.

2. Disc Plough- a modification of mold board plough.
is concave disc mounted to a frame.

Types of tractor operated disc ploughes

a. mounted disc plough:-

- **attached to the tractor by one /two/three/ point linkage.**
- **Raised/lowered by the tractor of hydraulic system.**

b. Trailed disc plough:-

- **have three wheels for support.**

c. semi- mounted-pulled by the draw bar of the tracter.

The depth of cut influence by:- soil type, crop to be planted and moisture content of the soil.

Disc angle

- **Horizontal disc angle /cutting angle:- the angle between the line of travel of machine to axle line of each disc blade. This affects the width of cut.**
- **vertical /tilling angle:- the angle of disc plough form the vertical affects the penetration of soil.**

Adjustment of cutting angle

The rear truck of wheels are pivoted so that the rear and of the plough beam can be moved to the left. This increases the width of cut.

3. Subsoiler

Is heavy duty implement designed to operate below the normal depth of tillage and to loosen the soil by lifting / displacement.

Mold board and Disc plough penetrates the top soil part.

where as sub soiler penetrates up to the sub soil. sub soiler (heavy plough requires high power

perpose of sub soilers

- **To increase the infestations rates**
- **Increase root penetration**

Types of subsoiler

I. **Mounted type- three point hitch , hydraulic system**

II. **Pulled- to wheele, one- three shanks**

4. **Chisel plough**

Similar in there action with sub soiler but differ mainly in there working depth. this is more dipper that subsoiler

5. **Rotary Tiller**

Is powered from tractor P.T.O

SECONDARY TILLAGE IMPLEMENTS

It follows the primary tillage's used to till the land at shallow depth and pulverizes the furrow slice used to remove weeds, break down big size of soil particle also has an objective of covering the seeds after sown.

1. **Disc. harrow.**

- **Used before and after ploughing un like the two harrows uses I Before ploughing to cut up vegetable matter II Used after ploughing to pulverize the soil and put it in a better reception of a seed .**

III used for cultivation of crops.

IV used to cover seeds when they are sown broad cast.

2 .Cultivators

- **The primary objective of cultivators are:**
  - **Retain moisture**
  - **Allow oxygen to penetrate the soil.**
  - **Controlling of weeds.**

3. Leveling

Leveling is very important for plants that grows by open channel irrigation.

Benefit of leveler

a. to get leveled field

b. helps for uniform distribution of water to crops

c. avoids water logging

d. important to fill dead furrow and to cut back furrow

4. Ridging - After leveling ridging is done.

- **Ridging is done always parallel to the field canal.**
- **Ridging have to be operated in straight line.**
- **Spacing varies according to plants**
- **ridger should have good depth to hold enough water for plants.**

-optimum depth of ridge will be 20-25 cm.

6. Ditching

- **Ditches helps to convey water from the field canal to field furrows.**
- **Ditches are perpendicular to furrow ridges.**
- **Interval b/n diches are baded on the slop of the field & types of crops (Plants)**

If the field is well leveled interval b/n ditches will be maximized while if not well leveled interval b/n ditches will be minimized. Net area of the field influenced by interval b/n ditches.

Planting machinery / equipment/

Planter is device used to place seeds, plant parts on the soil for production of food.

Planting equipment divisions

- **Row crop planters**
- **Seed grain drill**
- **Broad casting**
- **Hill drop planting**
- **Check row planting**

Row crop planters

- **Machine designed to plant seeds in rows far enough apart to permit the passage of tractor wheels.**
- **Planter size is usually indicated by the number of row units and row spacing.**

Function and performance of row crop planter (RCP)

- **The four major functions**

1. **Opens the furrow for seeds**
2. **Select the seed from the seed hopper**
3. **Convey the seed to the furrow opener**
4. **Covers the seed.**

Back furrow, dead furrow and head line tillage

When an operator begins plowing along the boundaries for making furrow slices to wards the boundaries, two open furrows will exist in the center of the field and forms dead furrow.

The existence of dead furrow in the field mean there is depressed area and during irrigation water logging will occur here and water will not move to the adjacent side of the field. So the formed dead furrow (furrow opening) have been reduced by well skilled operation.

Here to minimize number of open furrows / dead furrows/ in the field starting plowing from both edges of the field is advisable based on the area of the field.

To over come this dead furrow formation two-way plough is used. These are bottom right and left alternated at field ends. So no formation of open furrow/ dead furrow by mold board plough.

During tillage there is place remained at both ends of the field at turning point of tractor. So after plowing of the field is completed the mentioned two ends will be ploughed perpendicular to the first plough, five meters to ten meters at both ends.

It is better to start tillage at the side of the field to avoid open furrow.

<u>Factors affecting tillage</u>

-Clearing

- **Soil**
- **Implement**

1. **Clearing- If the land is properly cleared,**
   - **Good tillage**
   - **No repetition**
   - **Good for proceeding operations**

- **Minimize the inoculums of pests**

If the land is not properly cleared,

- **Poor tillage**
- **There is repetition of plowing**
- **Increases cost**
- **Makes the proceeding operations difficult.**

2. **Soil - plowing is affected by types and moisture content of the soil.**

   If the soil is heavy clay and dry, tillage is very difficult. In such condition the soil could be moist. Other wise, there will be a need of second plowing.

3. **<u>Implements.</u>**

   I. **If an implement is in a good working condition proper tillage is obtained.**

   II. **If an implement is in bad working condition, there is improper plowing, dicing, ridging and this leads to additional operation cost.**

   - **Results yield reduction.**

B- **IRRIGATION**

INTRODUCTION

Plants need soil, water, air and light (sunshine) to grow. With out water plants cannot grow. Too much water in not good for many crops. But paddy rice, there are only every few crops which like to grow " with there feet in the water"

The most source of water for plant growth is rainwater. If there is too much water, excess water must be removed. The removal of excess water either from the ground surface or from the root zone is called Drainage. Thus the practice of drainage be it irrigation water or rain fall is necessary to maintain the structure and aeration of the soil for the promotion of healthy root growth and aeration of the soil for the promotion of healthy root growth and allow access to the cultivated fields for cultivation and other purposes.

If there is too little rain, water must be supplied from other sources through artificial method. This practice is called irrigation

The amount of irrigation water that is needed depends not only on the amount of water already available from rain fail, but also on the total amount of water needed by the various crops.

With respect to the need of water distinction can be made among three depending up on climate.

1. **Humid climate:- This represents areas with more than 1200 mm rain fall per year. The amount of rainfall is sufficient to cover the water needs of the various crops. Excess water may cause problems for plant growth and thus drainage is required.**

2. **Sub-humid and semi-arid climates:- This represents areas having rain fall amount ranging between 400-1200 mm per year. The amount of rain fall is important but often not sufficient to cover the water needs of the crops specially in areas. having less than 600 mm rain fall per year. Crop production in dry season is only possible with irrigation, while crop production in the rainy season is possible but unreliable: yields will be less than optional.**
3. **Semi-arid and desert climates:- Represents areas having less than 400 mm of rain per year. Reliable crop production based on rainfall is not possible. Thus in such kind of places irrigation in essential for successful crop production.**

The two major factors which determines the amount of irrigation water needed are:-

a) **The total water need of the crops grown.**
b) **The amount of rainwater, which is available to the crops. So for estimation of irrigation water whether conditions should be known.**

IRRIGATION WATER NEED= Crop water need - available rain fall

Source of Irrigation water

The main source of irrigation water are:-

1. **Surface water:- is found on the surface of the land.**

   These include spring water, River water, lake water, etc. This can be supplied to the field by wier (check dam) by gravity or by using pump.

Check dam /wier/ system is used only when the source of water is from river, or spring water that starts from up stream.

Where the slop of the source of water is greater than the slop of the field to be irrigated.

Pumps are used where the source of water for the field is at down stream (at lower altitude.)

Here mostly centrifugal type pumps are used.

2. Ground water:- Where these is shortage of surface water ground water is used for irrigation. This is supplied only by using pumps.

Determination of amount of water for the field

- **Gravity water (check dam)- The amount of water is determined by the flow of water from up stream and the total water catchments of the dam.**
- **In case of pumps- the amount of water needed for irrigation (water is planned) by the size of the pump.**

There fore the size of the pump is influenced by:-

1.8 its total salt content which is expressed in terms of electrical conductivity

(E. C.) (In million hrs/cm or ppm)

2. **The relative proportion of exchangeable cation of Na+ in comparison with ca++ and Mg ++ ions.**

   This is expressed by sodium absorption ratio (SAR)
3. **The contents of bicarbonates and boron, relation tolerance of plants to Borron in irrigation water.**

<u>Conveyance of water</u>

This is may be classified as:-

1) **pressure (closed conduct) and**

2) **gravity which includes open channel or closed conduit (partial flow)**

Open channels- steady uniform flow.

When velocity exceeds a certain value, particles are dislodged from sides& bottom of channel so erosion caused by attractive forces. And when velocity fall below certain limit sedimentation (salutation) is formed. So there is limitation in construction of canals, these are side slops, free boards, should be considered. Canals- can be lened or unlined.

Since it is economical to construct lined canals unlined canals are widely used.

Advantages of lined canals:

1) **Avoiding excessive loss of water due to seepage.**
2) **To avoid erosion**
3) **To avoid water logging of adjacent lands due to seepage.**
4) **To reduce flow resistance.**
5) **To help in control of weeds aquatic growth.**
6) **To provide needed side slope stability.**

Types of canals are

1. **Main canal**
2. **Secondary canal**
3. **Tertiary canal and**
4. **Field canal**

***These are convenes structures that controls the flow of water from main canal to secondary canal then to Tertiary canal and to field canal.**

These structures are called division boxes.

Handling canals- canals need high investment for construction so it is very important to protect them from any damage.

- **Not to allow water beyond the canal carrying capacity.**
- **Protecting the canal from animal damage.**
- **To grow grass on adjusts side of the canal. This protects damage of canal by wind erosion.**
- **Avoiding taking soil from adjacent side of canals during irrigation.**

METHODS OF IRRIGATIONS

Under gravity irrigation, water is distributed by means of open canals and conducts with out pressure. Gravity irrigation methods are less expensive, but requires more skill and experience to achieve rescannable efficiency. This method also requires that the land to be irrigated should have a flatter slope, other wise the cost of land leveling and preparation at times be come very high. Gravity irrigation method. Includes furrow, boarder, basin, wild- flooding and corrugation.

Furrow irrigation- in this method of surface irrigation, water is applied to the field by furrow which are small canales having a continuous our nearly uniform slope in the direction of irrigation. Water flowing in the furrow into the soil spreads laterally to irrigate the area between furrows.

The rate of lateral spread of water in the soil depends on soil type.i.e. For a given time, water will infiltrate more vertically and less laterally in relatively sandy soils than in clay soil.

Where the land grade is less than 1% in the direction of furrow, striate graded furrows may be adapted.

The grade can be as much as 2 to 3% depending on the soil type and the rainfall intensity, which affects erosion. When field sloped is too steep to align the furrows down the slope, control furrows which run along curved routed may be used.

Spacing of furrows depends on the crop type and the type of machinery used for cultivation and planting.

Length of furrows depends largely on permeability of the soil, the available labor and skill, and experiences of the irrigation.

Flow rates are related to the infiltration to the rate of the soil.

SOIL TEXTURE	AVERAGE RANGE OF INFLITARATION Rate (mm/hr)
Clay	1-5
Clay loam	5-10
Silty loam	10-20
Sandy loam	20-30
Sand	30-100

-Longitudinal slope of furrow depends up on the soil type, especially its errodiability and the velocity of flow.

slope may be related to discharge as follows.

slop%	0.25	0.5	0.75	1.0	1.5	2.0	
Qmax (m^3/hr)	9.0	4.5	3.0	2.2	1.5	1.1	

Boarder- strip Irrigation

The farms are divided into number of strips of 5 to 20 meters wide and 100 to 400 meters long. Parallel earth bunds or levees are provided in order to guide the advancing sheet of water.

Recommended safe limits of longitudinal slope also depends on the soil texture:-

- **- Sandy loam to sandy soils 0.25-0.6%**
- **- Medium loam soils 0.2-0.4%**
- **- Clay to clay loam soils 0.05-0.2%**

Basin irrigation

Large stream of water is applied to almost level and smaller unit of fields which are surrounded by levees or bunds. The applied water is retained in the basin until it filtrates.

Soil type, stream size and irrigation depth are the important factors indeterming the basin area.

Wild flooding- water is applied all over the field especially, before plowing for soil that can't be plowed when dry.

Under closed conduit- there are two types of irrigation

1. **Sprinkler**
2. **Drip irrigation**

1) **<u>Sprinkeler irrigation</u>- is mostly used for young growth, to humid the atmosphere, for soil compaction(specially for sandy loam soils before planting, for land having up and down slope and used to wash out plant leaves especially in dusty area.**

   Advantage- economical to labour & uniform distribution.

2) **<u>Drip irrigation</u>- this is used especially where there is shortage of water.**

   Advantage- No loss. of water because all water drops at root zone.

   - **No water logging and rise of water table at result salinity problems caused by this irrigation type is almost nil.**
   - **Uniform distribution of water.**
   - **Good water management.**
   - **Economical use of lobour.**

Crop water requirement

The irrigation water need is defined, as the crop water need minus the effective rain fall. It is usually expressed in mm/day or mm/month.

When for example, the irrigation water need of a certain crop, grown in a hot, dry climate is 8mm/day, this means that each day the crop needs a water layer of 8 mm over the whole area on, which the crop is grown. This water has to be supplied by means of irrigation.

An irrigation water need of 8mm/day, however, does not mean that this 8 mm has to be supplied by irrigation every day. But it is time and labour consuming soil is preferable to have along irrigation interval. For example it is possible to supply 24 mm every 3 days or 40 mm every 5 days. There fore the irrigation water will be stored in the root zone and gradually be used by the plant.

Three major considerations that influence the time of irrigation and how much water should be applied namely.

- **Water needs of the crop.**
- **Availability of water to irrigate.**
- **Capacity of the root-zone**
- **Soil to store water**

  The amount of irrigation water which can be given during one irrigation application is limited by:-

  a) **<u>Sandy soil-</u> little water can be stored- Irrigation will have to take place frequently little amount of water should be given per application.**
  b) **<u>Loamy soil:-</u> more water can be stored than sandy soil.**

     Irrigation water is applied less frequently and more water is given per application.
  c) **<u>Clay soil:-</u> more water can be stored than in loamy soil.**

     Irrigation water is applied even less frequently and again more water is given per application.

Climate 1: Represents a situation where the reference crop evapo- transpiration ETO = 4-5 mm/day.

Climate 2: Represents an ETO= 6-7 mm/day.

Climate 3: Represents an ETO= 8-9 mm/day.

Amount of moisture content (A.M.C) = Field capacity (F.C)- permanent wilting point (P.W.P)

1. **<u>Field capacity</u> - is the moisture content of a soil when gravitational water has been removed.**

   -is considered as the upper limit of the moisture available to plants and field condition.

2. **<u>Permanent wilting point</u>:- all water at field capacity can not be utilized by plant.**

   - Low range of moisture

3. **Available moisture:- The water which is available to the plants is the difference b/n the moisture at field capacity and at permanent wilting point. This is called available water or maximum storage capacity.**

Ready available moisture- is moisture, which is mostly easily extracted by plants& is approximately 75% to 80% of the available moisture.

How to calculate frequency of irrigation in days.

A.M.C=F.C -P.W.P

<u>eg - given</u>

F.C= 30% **D(root depth)= 80 cm**

P.W.P=12% **(dry density) = 1.3 g/cm3**

Daily consumptive rate= 12mm/day

frequency interval in days (t (days)=?

A.M.C= F.C - P.W.P

= 30-12= 18%=PW

AS= $\frac{\partial S}{\partial W}$ = $\frac{1.3\ g/cm^3}{1\ g/cm^3}$ = 1.3

d= As PWD = 1.3 x $\frac{18}{100}$ x80cm = 18.72 cm

- **Frequency of irrigation (days) = $\frac{\text{depth of moisture (d)}}{\text{Daily consumption use}}$**

  = $\frac{187.2\ mm}{12mm/day}$ = 15.6 days

15.6 days= 15 days 1x hrs 24 min.

So irrigation water will be supplied in interval of 15.6 days.

II- NURSER MANAGEMENT

The main reason for establishing a nursery for horticultural corps, are:-

1. **To apply optimum growing conditions to the various plants during their very early development. i.e improved soil structure and control of soil moisture for better development of seedling protection.**
2. **To economies on seeds, especially expensive hybrid seeds, e.g tomato direct seeded in to the field the seed rate is 0.9 -1.0 kg/ha compared with 0.3-0.4 kg/ha per a transplanted crop.**
3. **To eliminate weak and diseased plants in order to obtain even stand on the field or orchard especially for perennial crops fruit trees.**
4. **To give the seeds better conditions for germination.**
5. **To produce seedlings for transplanting to rain fed fields at the start of the rains.**

Site selection

The success or failure of a true nursery is depending on the selection of a suitable site.

The following points should be considered:-

1. **In a nursery plenty of water is needed all the time the quality of the water should also be considered.**
2. **The area should have a flat or gently sloping surface. The best site for the nursery is a slight slope about 3% to 5% A site on a steeper slope requires terracing to allow successful nursery activities.**

3. **The nursery site should have light to medium soil and should be well drained e.g. for a fruit tree nursery to a depth of at least 1 m.**

If the soil is not of the best quality, it should be improved by application of organic matter. Sometimes it is necessary to sterilize the soil of a nursery site with chemicals to avoid transmission of soil born disease or nematodes to the seedling or cuttings.

4. **The location of nursery site should be**
    - **Separated from the production field.**
    - **On land which was not preciously planted under the same crop, to avoid build up of diseases and nematode population. Established nursery should be rotated after one season's production.**
    - **Out side the range of roots and the shade of trees, hedges and buildings**
    - **In an area not subject to frost**
    - **Near a source of water for irrigation.**
    - **Protected from a strong winds.**

5. **The nursery area should be fenced and should be kept clean from weeds and other plants with in and around the nursery, which may be hosts for virus or other pests and diseases.**

<u>Proper bed lay out</u>

Nursery beds could be 1mx5m or 1m x10m but the first one is easy and manageable. The surrounding paths should have a width of 40 cm. Each bed should be carefully leveled and surrounded with an earth ridge 10cm high. This is to enable the beds to be flood irrigated after the initial period of hand watering or sprinkler irrigation. If the nursery area is on sloping land, the beds should be arranged on the contour.

There are two types of beds

a) Raised beds b) sunken beds

In area where floods occur, beds must be raised above the ground in order to avoid water logging. In dry areas where water harvesting is important beds can be laid below ground level in creating sunken beds, it is essential to have a drainage system, which can be opened and closed, to avoid water logging during heavy rains.

Method of irrigation

Method of watering nursery stock depends on the size of the nursery and the financial resources available. In small nurseries watering cane are sufficient, but in larger nurseries pipe lines and hosepipes save a lot of work.

Flood irrigation, where water is led into the nursery and nursery beds by gravity, is common method. Flood irrigation is always be combined with cane watering because flood irrigation is needed after the plant germinated and grow well.

The quantity of water required can fluctuate, depending on local climatic condition, the stage of the seedlings, the species, the soil type and other factors.

Nursery practices

Good seedbeds help germination and are important in the production of good quality seedlings. It is important to select a row spacing and plant density that will provide room for good healthy growth combined with economy and convenience in working.

Well rotten organic manure or inorganic fertilizer such as Dap and Urea maybe incorporated into the soil. The application of fertilizer depends the type of species and soil.

An important factor in seed germination is planting at the right depth. Generally, a seed should no be planted deeper than one, or at most two times its diameter. Regulating the density of planting is also an important factor. The optimum density depends on the species.

During early stages of development, seedling must be protected against drying, heat and cold by applying mulch. Shade should be provided only when necessary. Sprinkling the seed bed with water on early morning and late after noon is useful for the growth of the seedling, After germination the time to take off mulching material should be on late after noon.

Seedling should be transplanted from the seedbeds to an open transplant nursery bed or into the field when they have reached the proper size.

Before transplanting to the field seedlings must hardened up.

Important points to be considered before translating.

1. **Water the seedbed or nursery bed before transplanting.**
2. **Never handle the seedlings by the collar (stem) instead, hold the seedling by the tip of a leaf.**
3. **The young taproot should be cut about 1/3 of its length.**
4. **Lift only a few seedlings from the seedbed at a time.**
5. **Only strong and healthy seedlings should be transplanted.**
6. **Place the seedlings in a container with moist soil or water.**
7. **Ensure the seedlings' are well " firmed" in the soil up on transplanting.**
8. **Water the seedlings immediately after transplanting.**
   pre- irrigate the land before transplanting.
9. **The uniformity of the seedling must be maintained**

<u>Nursery materials.</u>

Shovel, digging hoe, Rake, Measuring tape, watering cane, sickle, Mulching material, measuring balance stake ect.

III. FRUIT PRODUCTION

1. CITRUS

Citrus is the number one fruit crops both at world and sub tropics. In order to produce fruit of high quality, it is essential to plant each variety with in its range of climatic a adaptation. The principal factor which affects fruit quality in Ethiopia is temperature and this can be roughly corrected with altitude. Citrus includes: Orange / Citrus sinensis / Mandarin /Citrus reticulata /, Grape fruit/ Citrus paradis/, Lemon/ citrus lemon/and lime/ citrus autrantifalia/

oranges varieties

1. Valencia

- **It has a wide range of climatic adaptability.**
- **Fruit of high quality is expected on altitude range of 1000 to 1600m above sea level.**
- **It is selected for both table and processing purpose.**
- **They are late verities, take about 9-10 months. From blooming to harvest.**
- **Their fruits are juicy and hold on the tree from 45-60 days after maturity.**
- **The fruits have good shelf life.**
- **The most recommended variety to be grown.**

2. Washington navel .

- **This group has the narrowest range of climatic adaptability. It is recommended for cooler areas, usually to higher altitudes than lower altitudes.**

- **It grows well up to 1800 meter above sea level.**
- **The variety is seedless but with lower Juice content, hence not suitable for processing.**
- **It is selected for table because of its excellent palatability and peel ability**
- **Fruits are big and rough at the earlier stage of the tree.**

3. <u>Hamlin</u>

- **It is early maturing variety, 6-7 months from blooming to harvest.**
- **Seedless fruit with low juice content.**
- **The fruits are easily peeled and are palatable.**
- **Prefers low land area with hot climates.**

4. <u>Pineapple Orange</u>

-Adaptable to low areas.

- **It takes 7-8 months to mature often blooming.**
- **Fruits are seeds and naturally juicy with a higher content of sugar.**
- **The fruits are selected for processing and for table.**
- **The fruit size ranges from medium to large with smooth peel surface.**

<u>Mandarin varieties</u>

Mandarin have a wide range of adaptation than most of the sweet oranges.

Varieties of mandarins are - Satsuma, Fairchild, Fremont, Dancy , Tangelo and others

Grape fruit Varieties

- **Grape fruits are vigorous citrus trees with a big size fruits.**
- **It is well adapted to hot lowlands.**
- **Only marsh, a seedless white fleshed and ruby red (red blush) varieties are recommended for Ethiopia.**
- **Both varieties mature in the same season.**
- **They can be stayed on the tree for a longer period of time.**

Lemon Varieties

The demand of lemon is not so great as for orange and mandarin. Eureka and Lisbon lemons are the common varieties, which can be grown in the tropics for processing. They can be successfully grown in the hot low hands of Ethiopia. However, they need much more pruning than other citrus. Lemons are juicy and have reasonable acidity up to 6-7%.

Lime varieties

Mexican and West Indian varieties are the common verities of lime.

It has greenish flesh with high citric acid content (7-8%)Root stock

For commercial production the scion verities, with the exception of Mexican lime, are always budded on to a rootstock. The kind of rootstock used can have profound effect on the results obtained through out the life of the plantation. The choice of rootstock is, therefore highly critical, and a number of factors particularly disease situation and soil conditions, have to be considered. Recommended root stocks for citrus propagation:

1. Sour Orange

It is selected for citrus owing to its vigor, hardiness, deep root system, resistant to phytophtora gummosis disease the high quality smooth, thin-skinned, and juicy fruits

Produced by cultivars on it. However, it lacks resistance to tristeze. It is good root stock for oranges, lemon and grape fruit cultivars. Highly recommended root stock in Ethiopia and well adapted to heavy soils.

2. Rough lemon

- **Resistant to tristeze**
- **Low tolerance to phytophtora.**

- **Well adapted to sandy loam soil.**
- **Drought resistant due to its extensive root system.**
- **Cultivar grafted on rough lemon give the highest production.**
- **The quality of the fruit is very poor.**

3. Citrages (Trifoliate orange x sweet orange)

-Troyer and carizo citrages are the known rootstocks for oranges, tangelos, lemons and grape fruits.

-The yield is better than sour orange but sensitive to saline soils.

4. Cleopatra

- **Trees on this rootstock show good yield with high quality.**
- **The fruit size is smaller than the average.**

- **Very slow to come in to bearing & susceptible to phytophtora parasitica root rot.**
- **Resistant to tristeza, exocortis & xyloprosis.**
- **Tolerant to saline soils.**

5. <u>Macrophylia</u>

- **Good rootstock for lime and lemon varites.**
- **grows rapidly in nurseries.**
- **Resistant to tristeza and exocortis, but suscep table to tristeza when sweet orange scion is budded on it.**
- **Resistant to phytophtora gummosis.**

<u>selection and handling of scion wood</u>

1. **The scion wood should be one year old. very old or very succulent scions fail union to take place.**
2. **Healthy and well developed vegetative buds should be present. avoid wood with flower buds. Usually vegetative buds are pointed and narrow where as flower buds are round and plump.**

3. **Hardened shoots from the upper part of the tree are taken. High production of scion material can be promoted by pruning.**

4. **The best scion material are obtained from the center portion or from the basal two- thirds of the shoots. The terminal sections are too succulent and low in their carbohydrate content.**

5. **Take scion wood from bearing plants where the production history is known.**

Propagation

There are two types of propagation in citrus.

1. **Production of citrus trees from seed.**
2. **Propagation by budding and grafting.**

<u>Production of citrus trees from seed</u>

The planting of seedling citurs trees, that is trees grown from seed without budding, is practiced where citrus is to be grown for home use without irrigation. A disadvantage of seedling trees is that they may take about two years longer than budded trees to come into bearing, but they can be expected to have a much longer life.

<u>The propagation of grafted citrus trees</u>

1. **<u>seed bed preparation</u>**

The seed bed shall be with a size of 1x5m 40cms foot path. It should be level to protect erosion and irrigation run off. It should be level to protect erosion and irrigation run off. The bed is harrower in to a finetilth. seed bed soils should be

fertile, tree from racks, slightly acid, low insoluble salts and vergin to citrus. Apply DAP 20 g/m^2 before sowing.

2. Planting the seed

seeds are planted when the soil is warm or when the night temperature is above 13^{o}c for better germination. The normal temperature required is 26.6-32.2 ^{o}c. It takes 3-4 weeks for

Germination in some countries but in our county it takes 10-20 days to germinate. In order not to delay germination, the soil cover after planting seeds should be between 1-1.5 cm. It should be mulched with clean, dry seedless grass.

3. Agronomic practices

3-1 Irrigation

The seed bed has to be moist but not to wet in order not to loss seeds by rotting.

3-2 Fertilizing seedlings

seedlings in seed beds should be fertilized with nitrogen fertilizers like urea, apply 200 gms/seed bed in six months time.

3-3 Weeding& cultivation

The seedling should be free of weeds and were aerated by frequent hand weeding and shallow cultivation.

3-4 selecting seedlings

select seedlings to eliminate weak, off types and diseased seedlings.

3-5 Digging, selecting and handling seedling

Citurs seedlings are ready to transplant in to nursery when they are 20-30 cm high, or when they are 4-6 months old (in the rift valley zones of Ethiopia) Before digging seedling, pince the leaves to reduce transpiration and irrigation the root

zone up to 45cm depth. pinch the tap-root with pruning shear. Discard seedlings with diseased or deformed roots.

3-6 Nursery land preparation

The selected land should be ploughed disked, and leveled to better to better tilth. Then planting ridges are made in 90 cm distance. There should be ditch for irrigation and drainage after every 30 meters. The land has to be free from weed remnants, rocks, etc.

4. Planting in the nursery

The best time to plant is just before the rainy season.

The planting spacing should be 30 cm between plants.

Planting is done after pre irrigated the field. After planting, roots should be covered with soil firmly so that to avoid root drying and losses of seedlings.

Seedling care in the Nursery

weeding and cultivation, disease and insect control, pruning and discoursing, irrigation and fertilization are the major practices to be under taken in the nursery.

Budding

Budding is rapid method of grafting, which is used on wide range of climatic condition- It is a sort of lateral grafting with a single bud eye. The bud is removed with small amount of surrounding tissues from the plant of desired flowering and fruiting behavior and inserted in the rootstock.

Root stocks are ready for budding when the single stem attains a diameter of 10 mm at a height of 300 mm above soil level.

Speed is essential in budding, otherwise the cut surface will dry out before the operation of is completed and the bud will die.

In our country budding can be carried out at any time of the year, however periods of heavy rain and very hot dry periods should be avoided. The most favorable period is considered to be from October to December.

'T' budding or inverted 'T" budding is the usual and recommended method for citrus.

1. **'T' or shield budding**

   This type of budding is quick and common used by nursery men.

A mature and rounded, scion is selected. The leaf at the base of the bud to be taken out is cut off leaving the leaf petiole to serve as handle. On the root stock, at first a vertical cut is given, (just through the bark and not more) of about 2-4 cm, and then horizontal cut (1-5cm) is made on the top of the first cut, shaping "T" letter. The two flags are opened with a spatula (attached on other end of budding knife). only one bud is taken being cut from the bottom up ward and cut horizontally at the top to take the bud piece off. Which shapes a shield. The bud is inserted into the T cut on the root stock. If the bud is too long, the top should be cut to fit in very well. The bud after insertion is wrapped immediately with plastic tape. Buds that remain green and become active after someday indicate that the union has taken place. One should not forget to irrigate the rootstock seedlings sufficiently so that the bark is slipping easily.

The ties should remain in place for two to three weeks, after which they should be removed and the bud examined. buds which are still green will have formed a union with the stock and the top of the stock should be broken half way through at about 25cm above the bud. This will tend to force the bud into growth. should the flags of rind at the top of the force the bud into growth. should the flags of rind at the top of the cut start to open out, union is not complete and retying is necessary. Stocks on which the buds have died should be rebudded at once with the same variety. Frequent desuckering of the scion is needed.

When the shoot from the bud has growth, the frees may be given a dressing of urea at the rate of 50 kg/ha. This may be repeated

After 4 months. The trees may be allowed to grow to a height of 160cm from soil level as a single anabranches stem. Generally from seed sowing to transplanting to orchard takes 9 to 16 month/s.

2. Inverted t- budding

This method is almost the same as T- budding Different points are that T is inverted in the root stock and the bud is cut from the top down ward.

Planting and layout of an orchard land preparation

After the land has been cleared off. it should be well ploughed. Harrowed and disked. a rough grading can then be carried not to remove local irregularities of slope. The next operation is to lay out on the ground the irrigation system.

At each planting position, a hole of 0.5-0.6 meter cube should be dug, the topsoil and subsoil being thrown out on opposite sides of the hole. The hole should be left open for several months to weather and be filled in about a month before planting. Fill with topsoil only and trample down well mark the center of the hole with a peg. One K.G of DAP may be mixed with the soil when the hole is being refilled. Alternately the soil may be subsoil chisel ploughed to a depth of 60cm. In this case the holes dug at each planting position need to be large enough only to accumulate the root system of the nursery tree.

The spacing now recommended for different varieties of citrus in our case are as follows:

1. **Orange** **7x7m or7x6 or 7x8**
2. **Grape fruit** **7x7m**
3. **Mandarin** **6x6m or 6x7**

4. **Lemon** **8x8m**
5. **Lime** **5.5 x5.5m**

Depending on attitude

Planting

Most of the time plant is best carried out during the period July to September, at this time weather conditions are conductive to success in establishing tree crops A hole large enough to accommodate the roots of the nursery is dug at the previously prepared planting position. spread the roots carefully in the hole and fill in and firm the soil gradually until level with the surface. Form a basin of 20 cm high and 1 m diameter. Irrigate the basin as soon as possible after planting.

Basin Making

In citrus double ring should be formed. The inner ring is formed about half meter away from the trunk. The formation of the outer ring is depend on the canopy of the plant. When the canopy increases the outer ring should be increased.

Regular inspection of the circular ridge which protects the trunk from contact with irrigation water must be made.

Weeding and cultivation

weeding and cultivation of citrus is necessary for the removal of weed. in a mature orchard, the tree canopy will cover most of the area and very little weeding will be necessary. The area with in the tree must be weeded by hand.

Fertilizer application

Supply of adequate quantities of nutrients is very essential for obtaining high yields as well as high quality fruits.

The application of fertilizer depends on the stage of the plant, fertility of the soil and density of the plant.

Ago- wise application of nitrogen and phosphorus to citrus

TREE AGE (IN YEARS)	RATES OF NUTRIENTS PER TREE (IN G)	
	N (NITROGEN)	P_2O_5 (PHOSPHATE)
1	300	150
2	600	300
3	900	450
4	1200	600
5	1500	600

In fully matured orchards fertilizer generally recommended

Dap - 200- 300 Kg per hectare

UREA-600- 1000 Kg per hectare

Nitrogen should be applied in 3-4 split doses in young plantations depending up on the soil conditions and plant growth. In case of bearing orchards, two split doses are applied. The first being applied at the time when the main growth flush is starting and the second about three months after flowering, when the fruit is swilling

Irrigation

The irrigation interval for newly planted trees is up to seven days and basins should be filled to a depth of about 10 cm. after one year the interval may be increased. It

depends on the type of soil and available soil moisture in root Zone. Wastage of irrigation water through miss- application and over application should be removed.

Lack of adequate soil moisture during blooming; reduce fruit set and causes shedding of flowers and newly set fruits. During fruit development and maturity, insufficient soil moisture causes fruit shedding and reduce the fruit size, juice content and quality of the fruit.

Pruning and training

Ever though these are different types of pruning and training, an open center type one's practically advisable. In open center type, the tree has no main or central branch but a series of well space 'coordinate' lateral branches. These laterals are given the same dominance by cutting them back equally each year.

The main advantages of this tree form are that light penetration becomes sufficient for the fruiting of inner branches and that a low headed tree develops, which facilitates pruning.

Spraying, and picking operations.

Pruning is removal of sucker growth, dead and diseased wood. in vigour, productivity and become crowded with branches. The purpose of pruning is mainly to remove diseased and dead twigs. Further the low hunging branches, water suckers and misplaced brances are also removed. Heavy pruning is necessary when the trees decline in vigour, yield and fruit size.

Harvesting

Citrus fruit should not be harvested until it is mature because immature fruit will not ripen after harvesting. Maturity is indicated by the colour of the skin which, except in very hot climates, should be yellow /orange. Fruits with green skin colour should not be harvested. Selective harvesting is essential in order to achieve uniform quality. After four years from planting, the first production will be harvested.

Estimated yield of orange for the first eight years ofter planting

YEARS	YIELD Q/HA

1	**-**
2	**-**
3	**-**
4	**30**
5	**60**
6	**120**
7	**240**
8	**300**

Generally the estimated yield of properly managed a fully mature citrus is as follow

Orange = 250-300 Q/ha

Mandarin = 300-350 Q/ha

Grape fruit =250-300 Q/ha

Lemon = 400-500 Q/ha

Lime =150-200 Q/ha

GRAPE VINE (VITIS VINIFERA)

Growing condition

In Ethiopian condition grape vine is grawing at altitude 100 m-2000 mts above sea level. There are different kind of varieties interoduced in the county. From these varities some are well suit in production is variable according to the chages of altitiudes. In pracduction low land area have two cropping season. Such as merti and Zwai farms. When it goes higher alititude above 1800 mts ives one cropping per anmim. Optimal temperature of growing areas is from 19c0. If growing is a higher alitiued low flowering and poor yield will be obtained.

Soil Condition

Sandy loam, red clay and alluvial solis are suitable for growing grape vine. Black cottony solis are hard and they have sticky character, because of that at the end of

rainy season it is better to cultivate and breake top part of the soli for preservation moisture during production season.

Moisuture reauirement

At higher places if annual rainfall reachs 800 mm, here is possiblty to grow grape vine without supply of irrigation water.

Grape vine cultivars

The grape vine is categorized according to their use

1. **For technology purpose xuch like wine production and liquad.**
2. **For table use(descert)**
3. **Resein production.**

Grape vine is brought(interoduced) to our country through Europians. Commonly used cultivaers are Red vine, Black,Dube and Shulc etc. There are known varieties in Merti collection Block which were recorded.

propagation

Grape vine is propagated by vagatabive method . In Europe of other countries propagation is by grafting budding or other methods which needs root stock and scion. In Europe there is common pest which attacks root Zone, this post is phyloxera. In our condition we are producing the cancas planting material.

Preparation of plant material.

After late production canes are developing bused at period of physiological rest . And theb cut the canes with three eyes to produce standard cuttings. When you cut the cane the top part should be cut in stabted shape the bottom part should be round and at the time of planting in the nursery you can differentiate the position.

After prepartion of land for nussery between rows 75-80 cms, then prepare the bed where you can lay cuttings the cuttings should be laid at 8-10 cm differemnce between plants. Production of seedling operation takes 8-10 moths for development of rooted seedlings.

When the seeding is ready for transplanting prune the side branches and remain with strong one branch, again prune to two buds bach prepare the seedling for transplanting permanent field where holes are prepared.

Population

Population depends accourding to its design or spacing. The spacing is designed according to your operation practice. If operation is manual you reduce spacing bet ween rows 2 mtx2.5mts 3mtsx2ms-for easily manuplation. Plan the material at prepared hole at depth of 30 cms-40 cm. When you plan keep the straightness of hiagonally and horizontally plant the stake for remarking

Planted place.

After planting in permanent place/field/ there is initiation of bud at the time of growing have temporary support and traine until the bud mature and then cut back to two buds to develop healty stronh stem. The selected strong stem has grown to stage that can be for structurning countries. From these we are applied some systems that are overead system and in big plantation bilateral crdon system. This is applied, in merti and Zwai also in Guder farm. This system is selected for mechanical cultivation.

- **By laterall cordon system needs some construction materials.**
    1. **Wooden post**
    2. **Conctete pole**
    3. **Galvanized wire with thickness 2.8 mr 3.0 m**

Planting of poles of poles or posts and threllesing wire

The aim of planting poles and threllesing wire is to support. stems with not to fall on the ground. Grape is vine crop that is why support is needed. Threllsing the first wire is direct lined to corden system. The next is at interval of 40 cms the other two lines at 30-35 cms interval alined.

Cultural practiceAfter formation of cordons bilateral pruning system arranged according to variatal character and potential of the plant. The remaining cane number and eye buds depend upon the plant. character this operation is happened after 4 years when the production starts.

The pruning practice for cropping per annum depends upon the climate.

The places where in low land condition such as merti, Zwai pruning may takes place twice a year. At high altitudes such like Dukam, and Guder it is once a year

Cultivation

Hoeing and cultivation is very important to remove weeds away not to compit neutrients and preserve moisture. If cropping is twice a year cultivation must be also two times . If cropping is one time one cultimation is enough.

Fertilizer

Like other horticultural crops fertilizing is essential

The rate of fertlizer per plant is according to the need or response of the plant.

The practice we use:-

DAP-300 -400 Kg/ha -split application incorporating in moisten period with cultivation.

Irrigation

In low land areas 3-4 irregation is enough in one cropping

If it is high land areas where annual rainfall is higher than 800 m with supporting cultivation moister caresile be irrigation water available, One irrigation is enough at time of fruit setting.

60-8-% of yield can be attained in Ethiopian condition

Different year yield data of zwai farm.

PRODUCTION YEAR	AREA IN HA	PRODUCTIVITY
1981/82	67	48
1982/83	67	36

3.BANANA (MUSA SAPIENTU AND MUSA PARADISICA I.)

DISTRIBUTION

Banana is growing in all tropical and subtropical regions. it is originated south east asia. From East Africa our country has potential for commercial production.

Growing Condition (Ecological characteristics)

Banana is thermopiles plant, it vegetables at temperature 24^{o}c -29^{o}c through out the year. Low temperature causes a delay in the emergence of leaves and reduce leaf size. Temperature below 20^{o}c delay shooting whilst temperature below 8^{o}c for long periods causes serious structural damage to the crop. Temperature above 35-38^{o}cleads to sun scorching of the fruit making them unmarketable. Banana are day neutral in their response to day light.

Growing period - banana is pernial crop but has and average fruit growing period of 240-365 days depending on environmental conditions, a banana tree can produce for up to 50 years sending suckers from its rhizome.

Banana poorly with stand droughts and are compeletely irrest and to flooding uncontrollable condition. It is light demanding plant, however higher, solar radiation is undesirable for young banana plants

snail conditions

supending in the development of root system banana develops usually in the surface soil layer (to p soil) Banana prefers minimum textured soils with high humus content and good drainage. Banana have a shallow root system although rooting depth of over 75 cm is perfumed. A soil depth as little as 25 cm still have restricted suitability.

cultivation techniques

In practice banana verities can be divided into two group sweet banana varieties and plantains.

-Sweet banana varieties mainly grown for export.

- **Plantains are mainly utilized home needs.**

Among the sweet banana varies the most popular one are

1. **Gross Michel (ladies finger) plants of these varieties may grow to height of 5 meters. It provided high yields of sweet and aromatic fruits, which are easy to transport. The clusters are large 35 Kgs each, Raving fruit up to 23 cm long. This cultivars is not resistant to fearer expounds.**

2. **Dwarf Cavendish (chins cultivars) is short saturated about two meters high, early ripening high yielding and it may be cultivated both tropics and subtropics. The composite fruit of dwarf Cavendish from 6-12 clusters each**

weighing 25 kg. The cultivars is resistant to fusionism disease. The fruits are sweet and aromatic. but travel badly.

3. **Joint Cavendish defers from previous cultivars by its higher false aerial up stem up to 3 meters with large fruits and the composite fruits (clusters) weigh up to 30 kgs. It is resistant to wiles lately another fusarium immune cultivars / the poyo/ has become very popular and it given high yield and quality fruit.**

Land preparation and characteristics of propagation land preparation canal system.

Propagation

Banana is propagated only by vegetative system using suckers and rhizomes as planting stock. It is better to select banana suckers when the parent plant is in fruit bearing in subtropics, 4 to 7 months old suckers are usually chosen for planting when they reach 1-1.5 meters height, rhizomes are dugout from plantation and cut out into sepatrate pieces with two buds. Each treated with fungicide. suckers or rhizomes are planted into especially prepared pits (hole) up to 60 cms.

Population of banana plants greatiy varies

No.	VARIETIES	SPACING IN MTS
1	Dwarf	2.5mx2.5mts
2	Cavendish	3mtx2.5mts
3	Joint caver dish	3.5mtx3.0mts
4	poye	5.0x4.0 mts
	Gross Michael	

Management practice

Different methods of agronomic practice is applied. bare fallow ,mulching, use of cover crop etc

- **Bare fallowing: regular loosening of raw spaces with cultivation.**
- **mulching: manure and organic remaine are needed.**
- **Cover crops are growing in banana row spaces during rainy season.**

During vegetation the rhizome of parent plant omite upto 10 or 12 daughter suckers. Atleast 3-5 daughters should be remaind for prduction. In practice some of these suckers use them as planting stock.

Irrigation

Banana requires a larger amount of water if grown under rainfed conditions it requires at least 1500 ml of uniform distribution of rainfall per annum.

In the dry tropics and subtropics banana are grow only under irrigation.

The irrigation rates very depending on the length of dry season; the soil texture and variety feature.

Heavy texture soil- 8-15 days
Light texture soil- 5-10 days

Irrigation rate vary from 600-1000 cubic meter per hectare (Dumanov 1974)

Fertilizers

The length of productive life span of banana plantation is with in 3 to 10 years. During such length of period considerable quantities of nutrients would be drawn. Each

ton of banana fruit contains about 2 kgs N,0.9 Kgs p2 o5 7 Kgs k2o. a yield of 30 tons of fruits a respective amount stalks,leaves,and suckers per 1 hectare usually removes 278 kgs of nitrogen,70 of p2o5 and 623 Kgs k20 (Bofie 1948)

In practice-

Dap 150 kg- /ha.
Urea 400-600 kg/ha. with split application, the rate depends according to deficiency symptom of the crop.
In our country potassium application is not practical.
Harvesting

Banana fruit harvesting is usually manual, Banana clusters or whole bunch cut with special knifes and packed into boxes or bage and transported to store houses or they are laid on special straw mats. Ripe fruits are not transportable. The yield differs according to varites. The average yield per hectare is from 200 quintal to wards 600 quintal extendingly the lowest yield is 13 tons.

The green fruits usually transported as a whole composite or bunch at temperature strictly maintained for each variety (11co-13oc) and at high air humidity. Temperature in ripening room should be 19co-24co. Ripeness indicated by change in the colour of the fruit from green to yellow, Ripening may be accelerated by interducing ethylene gas into the ripening room.

4.PAPAYE (CARICA PAPAY)

Distribution

papaya is widly distributed in south America countries as East Indies, panama, Guba Hawaii and Etc.

In Ethiopia papaya is widely distributed in Rift Valley Places. Eastern Ethiopia, Southern Ethipia and south west Ethiopia. At present Northeren part of the country, Amara Region is trying to grow in some parts of the region.

This days papaya is known in the country for juice purpose and as variety of human food. Most of its market is mainly in Addis Ababa as well as big cities of the country.

Varieties

- **Local variety which has separate flower location . Their fertilization is cross pollination.**
- **solo type- are hermaphrodite form, bearing can be distinguished by single large flower which is home in axil of each leaf.**

Growing condition

It is possible to grow papaya at range 800 mts to 1800 mts. above sea level- Export varities can grown 1450mts- 1650mts in Rift valley around Nazareth and towareds Zwai areas.

Soil condition

Papaya grows well where soil is textured sandy soil. Where water logging is available papaya is very susceptible to fungus disease so with free drainage minimize the damage.

<u>Propagation</u>

papaya is propagated by seed but there is difficulty in sex of socal papaya, because of that to determine seedlings is difficult until it produce flower. It is necessary to establish several seedling at each planting hole when flowering etarts the excess male

plants are removed and leaving one tree at each planting in the proportion 1 to 25 females.

Seedling of "solo" varities should be raised by sowing in plastic potts. If the seeds are original, They are very expensive so that more than two seeds should not be sown in each pot. only one seedling should be transplanted to each planting hole (position).

Cultural Practice

Where the land is well prepared at the same time the irrigation structure should be designed.
If cultivation is mechanical the spacing should be 3 mts x 3mts or also if it by manual it is possible to have spacing 2mtx2.5 mts.

Planting seeds

If it common / Local/ papaya it is possible to seed direct sowing with depth 2-3 cm and marking the planted place.
If it is potted, The seedlings should be planted out in the field when they are 10-15 cm high plastic pots should be slit or perforated before planting.

Consumption or original seed is essential.

Fertilizer application

In many part of the world, good results have been obtained from the use of organic manures and nitrogenous fertilizers.

Rate of application or commercial fertilizer

Dap- 0.5 kg-1.0kg/per plant

Urea-400-600 kg/ha- depends at the 400 kg per hectar symptom of nitrogen deficiency.

Irrigation

Papaya can grow at high altitudes without irrigation where there is annual rainfall above 800 mm furrow irrigation system is recommended for commercial production. Irrigation interval depends on soil structure an temperature. It should be irrigated within 8 days innerved weeding and cultivation

- **cultivation should be shallow not to destruct the roots:- Using mulch we can suppress weeds.**

Harvest and post harvest

The papaya fruit is ready for harvesting as soon as it starts to develop some pole green or yellow colour. At this stage transporting is easy without damaging the fruit. After a few days the fruit softens and then ripe for eating.

Papaya fruit is damaged very easily and must always be handled with great care. A very bad practice is knock the fruit of very tall trees with long stick. The result is a high proportion of damaged fruit.

The economic cropping life is 2-3 years, after this the trees would be too fall to be harvested.

Papaya intended for export should be carefully packed in padded or devided cartons and cool stored as soon as possible after harvest at 7oc. Approximate cool storage life is Reported to be 2-3 weeks maxiumum.

Yield expecting from planting is depends according to climate condition.

- **Melkasa research station 10-11 months after plantion**
- **In Zwai cause Yield expectation is after 12 months**
- **Yeild of papaya fruit under normal conduction can be above 20 tons/ha.**

4- APPLE- MALES DOMESTICA

The apple is a major decidous- tree fruits of North America and of the world. The apple probably originated in region south of Caucasus where appears to be indigenous. By 1968 the apple had becomes established from coast to coast.

Propagation of Nursery stock

Apples produce themselves by means of seeds but their off spring differ widly; thus they must maintained by means of budding or grafting, two distinct parts/namely, the root system and the stem and branch system/which may have very diverse characterstics are made to grow together as a single plant.

Nursery site selection

The area to be selected for nursery should fulfill the following requirements:

- **Accessibility of area for frequent inspection.**
- **Dependable water supply for irrigation.**
- **Natural protection against wild.**
- **The area should have flat or gently slopping surface for water and airdrainage.**
- **The land should not be planted with the same crop during the previors year.**
- **It should be outside of the range of roots and shade of trees, hedged and buildings.**
- **The nursery area should be fenced and should be kept clean from weeds and other plants**

Nursery land preparation

The selected land should be cleared of tree roots and weeds and deeply ploughed, disked and leveled.

Deep fertile medium textured soil with good surface and sub surface drainage gives best result. To promote better root growth,

Thoroughly incorporate about sufficient amount of well decomposed compost manure.

Seedling root stocks

Root stock - The lower portion of the graft, Which develops into root system of the graft plant.

- **Root stock are raised either from seed or by vegetative.**

Propagation seeds from delicious, Yellow Newton, wealthy and Rome gives good germination and vigorous seedlings. seeds from triploid cultivars eg. Rhade island green, and Grave stain is unsets factory for root stock production.

Producing Nursery seedlings

- **For root stock production established collection block in order to get disease free sucker as compared to the minified.**
- **Detach the suckers with roots from the rootstock of the plant from the collection block with care of known verities which is free from disease.**
- **Remove the leaves of the sucker and back prune 10-15 cm.**
- **Plant the sucker immutably b/n plant 30 cm and b/n rows 90cm.**

- **In planting the sucker, firm the earth around the root but take care to avoid injury to the roots.**
- **Land should be irrigated one day before planting and immediately after planting again.**
- **It reaches for grafting 7-8 months.**

Irrigation - The soil has to be moist but not too wet.

Initially irrigated 3-4 days depends up on the soil type and climatic condition. After a good establishement of seedlings, it can be extended 7 days interval.

TOOLS AND MATERIAL FOR BUDDING

Weeding and cultivation - The seedling should be free of weeds and well aerated by frequent hand weeding and shallow cultivation.

Pruning and desuckering - Allow to grow only one seedling which is straight, remove all side branches and initiated suckers.

1. **Budding Knives- Made of high quality steel, the blade is 50-60mm/ long, atapered bone handle or blunt protuber once on the back of the blade is provided for lifting the back of the root stock**

   Knives must be kept clean and very sharp.

2. **Sharpening stones- Stones of rectangular shape and of fine grade must provided for sharpening the knives.**
3. **Pruning shears- The scissor type if recommended it makes a cleaner cut than the anvil type.**

4. **Protective cloths- Is repuired to wrap bud wood during the budding operation. The cloths are kept wet with clean water and protect the bud wood against srying out and over heating.**
5. **Tying materials- polyethylene, the plastic strips of 200 or 300 gauge and 15 mm width are most efficient for tying buds particularly under conditions of low atmospheric humidity.**
   A length of 30cm is usually sufficient for tying one bud.

Techniques of vegetative propagation

Budding and grafting

Budding -Is the usual method of propagating fruit trees in the nursery. Normally only one bud is inserted on each root stock.

Grafting- is the art of connecting two piecies of living plant tissues together in such way that unit subsequently grow and develop one plant.

When to bud

Budding is done when buds are well formed and the bark slips well. When the rootstock grow as thick as pencil. Budding should be done 8 months after planting the seedling. Budding should be done better early morning up to 4:00 o'clock.

Bud sticks- these shoots, which carry the buds for budding.

Primary, Emphasize is on the use of virus free bud wood sources. Use buds from the best producing, true to type, disease free trees for propagation are selected.

To check loss of moisture by evaporation from the leaves after the bud stick has been cut from the parent tree property remove leave and keep the bud stick moist. Leaving a short portion of the petiole in place as a "handle" wrap the bud sticks in moist cloth, in plastic bags or place them with the basal end in water containers but it is better to use them soon after cutting use the well developed plump and hard buds from the mid-portion of the shoot, discarding the soft tip buds and basal buds. Then bud sticks carries vegetative bud and avoid flower buds. select one year old bud sticks.

Tow types of bud

1. **Vegetative bud- usually pointed and narrow.**
2. **Flower bud- are round and plump.**

method of budding

1. **T- budding - at budding time make t-cut in the vary of the root stock 30 cm above the grounding in our condition make the cut through the bark to cambium depth/ not in to wood/ make the transverse cut first, about 1/3 around the stock.**

They them make a vertical cut up wards to meet transverse cut. As it reaches the transverse cut, the knife blade is twisted to raised the edge of the bark just enough, with out

tearing, so that the buds may be easily inserted. other budders prefers to make the upward cut first, then transverse cut.

2. **Inverted T. budding- This method is almost the same as T. budding . Different points are that T is inverted on the rootstock and the bud is cut from the top down wards.**

Cutting the bud

- **Cut the bud with a shield of bark by holding the bud stick by the toped, with the lower end away from the body. Place the knife 1.5 cm below the first suitable bud and by a shallow slicing movement pass the knife beneath the bud approaching the surface 2.5 cm above it. (T.budding)**

Inserting the bud

After cutting, hold the bud by the petiole between finger and thumb and insert the bud in to T- shaped inclusion. Fast budder slip the on their knife directly to the T-cut Aproperly inserted bud is at least 2 cm (2/4in) in below the transverse cut.

Buds are usually placed on the same side of stack along the row so that they be readily inspected and manipulated the following season. The side from which prevailing wind come is the preferable to prevant subsequent breakage. care should be taken the inserted buds not inverted.

Tying:- After inserting the bud wrap it snugly. Besure to leave the bud exposed. Wrapping may be done either down or up ward.

When parenchema call of both stock and bud are locked, a new or "bridge" cambium is produced which begins typical cabium activity and start formation of new xylem and phloem.

Care after budding

In successful budding the bud usually will have grow to the stock In 2-3 weeks If the budding failses a new buds may be inserted in a new postion on the root stock. Buds properly united with stock cut off rootstocks immediately above the grafted bud Rub off all suckers that appear on the root stock.

Maintain healthy foliage and good growth by weed and pest control, fertilizer and if necessary by irrigation.

Apple trees reaches 160 cm head back to 0.6 0.9 meter measured from the ground level.

Method of grafting

Whip-and tongue graft.

In this method use 1- year-old wood seedling that is smooths straight and free from branches. The diameters of the stock and scion should match. Rootstocks is cut in across way first, then a second cut is made to half the cut. A scion is cut from both side to

shape a wedge. The scion and stock then inter locked so that the cambium layers make as mach contact as possible. secure the graft with grafting type or waxed string. waxing is not necessary but is helpful.

Care after grafting

- **In successful grafting the scion bud usually will have grow 1-2 weeks**
- **Run off all suckers and leaves that appears on the rootstock.**
- **Deflower when the scion bud it flowers.**
- **Waterd aday before grafting and after grafting.**
- **Maintain healthy folage and good growth by weed and pest control .fertilization and if necessary by irrigation.**

Apple trees reaches 160 cm head back to 0.6-0.9 meter measured from the ground level.

CHOICE OF LOCATION AND SITE

The commercial life of an apple orchards may be 30-50 yrs. careful planning and preparation is time well spent and result in greater returns in the years to follow.

Altitude- In generally grown at elevations 2200 m- 2800m. select the site at elevations a little higher than surrounding land so as to ensure good air drainage through and away from the orchard. This location not only lessens the risk from late firsts but also helps avoid rapid of fugues disease.

Soil- The soil PH should maintained between 5.5-6.5 The nature of subsoil on the proposed site may be even more important than the kind and quality of surface soil. The sub-soil should be well drained, so that tree roots at no time stand in water and it should be loose enough to let the roots an extended growth.

- **Avoide sites on heavy clay or compact sub-soil and hard pan formation that are near the surface.**

Wind break- This protection reduce moisture loss from evaporation reduces damage to the fruit and to the trees during wind storms. set the wind break 22 meter from the nearest row of orchard trees.

Land preparation

The area selected for planting apple trees should be cleaned prior to any operations. the removal of any residues and root remains of trees of past crops is the second essentiality ape ration. after the land has been cleared of all trees and stumps, it should be well ploughed to a minimum depth of 50-60 cm . it is better to second plough different direction of the first plough- then disked- and leveled. Grading is necessary to remove local irregulaties .

or slope . The next operation is to lay out on the ground so the irrigation systems furrows etc. can be lined.

Preparation of planting holes

Holes are dug depending on the recommended spacing b/n plant and rows for each crop and variety and variety. Hole size should be 50x50x50 cm. The top soil being put on one side and subsoil also the other side. It should be open at least for a month time then filled with topsosil, organic soil, before planting. The center of the hole should be marked with pegs. In each hole 1 kg of dap be applied and mixed the soil in the hole before planting.

Planting- Planting to rows 4 meter a part, plants 3 meter apart in the row. plant the tree with root bolls 2.5-3 cm deeper than they stood in the nursery. In planting the trees, firm the earth around the roots by tramping but take care to avoid injury to the roots. Use moist surface soil to fill in around the roots. Do not let the young trees dry out before or during planting.

Cultivation - The first few years in the life of the apple tree are very important, make every effort to get young tree established quickly and to have it make gook growth. For this reason it is generally wise to follow a system of limited cultivation for first 4-6 years after planting.

Basin Making - The size of the basin depends on the canopy of the apple tree.

- **The inner ring should hot be contact to sion.**
- **Innerring helps to potect the irrigation water contact to the root stock.**

Irrigation -The amount of water progressively increasing with the years of trees. /Internal one week-10 days /depends on the soil type& climatic condition

- **If there is the problem of water stress cover the ring by have to 10 cm or grass cover.**

Fertilizers- Apple trees repuire all the minerals elements needed by other fruit trees, but usually only N,P &K must be constantly replaced in normal orchards soil. There is no information avialiable fertilization application under Ethiopian condition.

- **Now practically applied in Tseday farm Dap 3 Quntal /ha& Urea 2 Quntal/ha . These rate need further study.**

Application - During pruning and growth initiation apply dap.

- **Half of Urea applied early fruit set.**
- **Half of Urea applied at Medium fruit size.**

- **On outside literature- Fertilezer rate Dap 380 gm/tree & Urea 668 gm/tree in the bering apple fruit.**

Pruning- One adjective in pruning bearing trees is to keep the tree reasonable open to admit sun light and ensure good aeration. This, entrain, helps promote glld quality and color in the fruit, aids in the control of disease and facilitates thinning and picking another purpose is to remove from the tree weed-growing wood that never produces fruit of satisfactory size and quality.

- **Pruning should establish a balance between vegetative growth and flower induction and ,along with other erchard practices, maintain good conditions in the trees for growth and fruit production.**

Principles of pruning

1. **Prunning dwarft total growth and delays fruiting.**

The total growth attained by an unprunded tree is always greater than that of a pruned tree regarless of the type and amount of pruning not only reduces the total growth made by the above ground portions but as a consequence total root growth as well with young trees which have not yet flowered. sever purnning delays flower-bud formation.

A heading back out seems to delay flowering more than a thinning-out cut.

2.Reduces yield

To prune bearing trees usually result in reduction in total yield. The effect of pruning however on the yield of mark table fruit the important factor.

2. Stimulates new growth in older trees.

Prunning through its stimulation of more shoots and spurs produces a most positive and benefical effect on older tree.

3. Increases set of fruit

Prunning tends to increase the set of fruit. The elimination of certain growth points indirectly the supplies of water and nutrients available to the remainder.

When to purne

The ideal time for pruning from the stand point of avoiding ill effects on the trees before the bud swell. The usual practice is to start pruning soon after harvest./ September-November/

Prunning one year trees

Head back 1 year old trees at planting time to a good strong bud of a height of about 1.6m. These causes the bud below the cut to elongate and side shoots to form. If the strong branch has developed 0.6-0.9 meter from the ground select it as the bottom scaffold limb 2-3 additional branches spaced at least 15-20 cm a part along the trunk and extending indifferent directions from the trunk. Leave 5-7 branches to form the head of the tree in modified central leader system of training.

Prunning two year trees

Additional branch arise from the leader during the succeeding years and form these select the required number of scaffold limbs to complete the frame work.

Prunning young non bearing trees

Prunne lightly in the third and fourth years, chiefly by thinning out rater than heading back branches. Remove branched that form narrow angled with the truck and crossing and interfering branches.

Prunning bearing trees

On method of opening up the top to facilitate spraying and harvesting and to improve fruit quality by admitting more light. Light to moderate pruning is desirable to bearing trees. The amount of pruning must be repulated by the yield and quality of fruit produced.

Height of head- Rising costs of spraying and picking necessitate establishing the height of tree head about 4.5 meter.

Trainning

- **The selected scaffold branches along the turnk to bend horizontally usually practiced. Which helps to avoid dominance on individual buds and improved uniform bud breaking.**

Pollination and fruit set

Apple cultivars are commercially self -unfruitful. That is they require another apple cultivat for cross pollination in order to set a commercial crop of fruit. cultivars very considerably in their inherent tendancy toward self-fruit fullness where self-pollenation exists the average number of seeds per fruit may be 3-5 or less, and with good cross pollination may be or up to 10. When the crop is fairly heavy fruit with less than three seeds usually abscisses.

Factors affecting fruit fullness

The cause of poor set of fruit may be related to inadequate pollination or conditions existing after pollination has taken place.

a. Defective of pollen

b. Incompatibility

c. Irregular chromosome behavior

d. Climatic condition

e. Vigor in fruiting wood

f. Agent of pollination.

Pollinizer cultivar

Since apple cultivars are generally commercially self unfruitful, it is necessary to provide suitable pollinizer cultivars in the orchard. This should be done when the orchard is planted.

Under Tseday farm Apple orchard there is two cultivars ANA and Inshemer.

Inshemer is pollinizer cultivars. plant eight of the main cultivar.

-set out the orchard so that no tree is more than 24 m from pollinnzer.

Harvesting

When to pick apple fruit the surface color of fruit skin changes from green to red, the ground color also change from a green to yellow and the fruit seed color changes from white to brown color. Regardless of maturity is rather constant from season to season and is more reliable index of maturity than the other factor.

Storage- The longest storage life is obtained at 30o-32oF & RH of 85-90%.

IV.VEGETABLE PRODUCTION

Soil and climatic condition

The recommended soil for onions is well- drained sandy loam with a high content of organic matter. The optimum altitude range for onion production is 1000-2000 m. but it has the possibility to grow on altitude range of 700-22-- c.a.s level. The optimum growing temperature lies between 15oc and 23oc

onion varieties / IAR Melkassa Dec. 2000/

VERIETY	COLOUR	WEIGHT OF ONE HEAD (GM)	DAYS TO MATURITY	PRODUCTIVITY PER HECTAR
1. Adama Red	Dark red	65-80	120-135	350
2. Melkam	red	85-100	130-142	400
3. Red creor	redishj	60-70	130-140	300

4. Mermiru	Brown	75-80	135-145	330
brown	Redish	70-80	135-145	300
5. Bombay red				

Nursery operation

The location of the nursery should be on land which was not previorlsy planted onion to avoid build up on disease.

- **The area should have flat or gently sloping surface.**
- **The site should have light to medium soil and should be well drained.**

Proper bed lay out

Nursery beds should be 1mx5m. The surrounding paths should have a width of 40 cm. Each bed should be carefully leveled and surrounded an earth ridge 10cm high.

The number of bed per hectar is determined by the soil type, the density of the seedling and the viability of the seed.

Comparison of our farms on number of seed bed per hectar.

Farm	No of seed bed per hectar
Errer Gota	120
Ghibe	110-120
Ziway	80-100
Recommendation (but not recent)	112
Our recommendation	70-100

Practically is has observed that by using the seed-bed property and intensively we can use 70-80 seed beds hectar.

The number of lines per bed recommended 33-50. (The distance between lines per bed is 10-15cm)

Seed sowing

Most of seeds delivered are treated with chemicals against seed borne disease. Be careful with these related seeds, keep them safe during transpiration and in the store. The rate of seed sowing should be related to the rate at which seedling can be transplanted in the field.

The quantity of seed per hectar used is 4 k.g., but it depends on the spacing of the plant in the field. There should be proper soil coverage.

As soon as the seed has been sown, the surface of the seed bed should be mulched with dry grass. Apply water immediately through the mulch. Remove the mulch as soon as the seedlings are visible above the ground. It may take 6-10 days from sowing to germination.

Seed bed practice

1. **Over head watering by watering can at easily morning and late after noon up to the stage when the seedlings are about 5 cm high, after this surface irrigation by flooding the bed could also be possible.**
2. **In windy places it is advisable to establish temporary wild breaks at 5m. intervals in the nursery. protection from wind increase the rate of growth and reduce damage to plant.**
3. **In the absence of soil analysis the following standard fertilizer application is made 100 g of DAP before sowing and 200-300 gm UREA two to three split application per bed should be applied.**
4. **Weeding and cultivation must be practice to avoid weed and create good aeration .**
5. **A preventive spraying against thrips, and against damping off, downy mildew and purple blotch is recommended in the nursery.**

Transplanting

Transplanting should be done when seedlings have reached a height of 12-15 cm and must be well organizes to avoid plant losses. Transplanting of large over seedlings may resist in bolting into flower instead of bulb production.

Make flat top ridges with furrows between the ridges plant on the flat ridged 20 cm a part. The spacing between double rows is 40cm. Spacing with in the row is 5 to 7 cm.

Generally the spacing between ridges are 60 cm.)Lift only a few seedlings from a seed bed at atime. Ensure the seedlings are well "friend" in the soil up on transplanting.

Irrigation

The seedling should be irrigated after transplanting.

Irrigation is influenced by the type of soil, The climate and the species, but generally during the dry season onion crop should be irrigated at 5-7 days interval. A longer interval may be necessary on heavy soils- Irrigation should be stopped 15 days before harvesting.

Weeding &Cultivation

Weeding and cultivation mainly practiced for:-

- **Destruction of weeds they're by conserving soil moisture, nutrients and eliminating competition.**
- **Helps increasing aeration there by favoring decomposition and other chemical changes in the soil.**
- **Helps in increasing absorption and retention of soil temperature.**
- **Based on the presence of weeding it can be cultivated 3-4 times**

Fertilization

The amount and method of fertilizer application is very important for the production of vegetable

For one gectar of onion we can use:

DAP 100- 150kg

UREA 100-200kg based on the fertility of the soil.

DAP is incorporated into the soil before ridging.

UREA is applied 12-15 days after planting together with cultivation, and can be splited 3-4 times

Since urea is volatile, the plant should be irrigated after incorporation with cultivation.

As much as possible the soil should be moist and loosen before application of urea.

Harvesting

Harvesting can start when 50 to 80% of the tops have fallen over. Take into consideration the following harvest operations.

1. **Lift the onions with forks.**
2. **Lay onions inwind rows and let them dry in the field for about 5-7 days. care is necessary to prevent sun scorch by covering the bulbs with leaves of the next row.**
3. **Tops should not be removed until necks are dry.**
4. **Incedence of bacterial soft rot may spread rapidly through trimming with infected knives.**
5. **Roots should be trimmed as close as possible to the bulb but tops should be trimmed to a lengh of about 2-3cm.**

- **Onion needs 120-145 days from transplanting to maturity.**

Post harvest handling

Only onions which have been properly dride and cured are suitable for storage. Rapid development of rot diseases and premature sprouting can be expected in improperly cured crops.

Large size bulbs may be expected to have a shorter storage life that smaller once and should there fore be stored separately

The onion store should be sited where there is good air movement and ventilation.

The protective outer skin should not be removed unless it is very loose and broken.

3. **TOMATO (lycopersium esculantum)**

The tomato is one of the most popular and important vegetables for fresh consumption and for processing.

Soil and climatic requirement

The tomato requires a warm and dry climate. The climate. The optimum men day temperature for growth of tomato lies between 24oC and 28 oC Temperature above 32oC during fruit development inhabit the formation of red color. Temperature below 15Co stops flowering of the plant.

Preferably, soils for tomato cultivation is loamy sand or alluvial soil. Good soil drainage is important optimum Ph range is from 5-5 to 7-0

Varieties

There are two different habits of groth of tomato; determinate and indeterminate.

The plant of determinate varieties are compact in growth, and mature their fruit within a relatively short period. The advantages of these varitires compared with indeterminate varitetes are that staking to support. Belonging to this group are such varities as Roma V.F., Napoli and pearson.

The plants of in determinative varieties are high in stature, open in growth and they develop their fruit during a relatively long period. These have high labour requirements for maintenance (staking) . Some well- dnown varieties which have been growth successfully in our country are Marglobe, Money makes& Rutgers

The plant of determinate varieties end- their growth by flowering and fruiting & this enhibit lateral growth but the indeterminate have vegetative end as long as these is moisture.

Now a day some individual invests and state farms use

staking for some determinate types of tomato verities like Roma V.F

Nursery Operation

The operation of nursery like site selection, proper bed lay out, seed sowing, watering, fertilization, weeding& cultivation of tomato is almost similarly to that of onion.

The following points should be considered for seed bed practice of tomato.

1. **The area should have flat or gently sloping surface.**
2. **The site should have light to medium well drained soil.**
3. **Nursery bed should be 1x5m.**
4. **The bed should be carefully leveled and surrounded an earth ridge of 10 cm.**
5. **The number of seed bed per hectar should 35-45.**
6. **The number of line per bed recommended is 33(i.e. the distance between lines per bed is 15cm)**
7. **The quantity of seed the per hactar is 300gm -400gm.**
8. **Preventive spraying with fungicides should be applied with one week interval.**

Sowing and Transplanting

The seed rate for tomato is about 300-400 gm per hectar, but it depends on plant population that will be transplant in one hectar.

The opimum time for transplanting is when the seedlings have three pairs of true leaves or when they reach a height of 10-12cm.

To prevent of infection of tomato seedlings with fungus diseases the seed should be treated with a chemical seed dressing. Disease and insecticide spray to control pests may be necessary.

Land preparation and lay out

Following ploughing, disking and the elimination of perrenial weeds, the land should be graded to as high a standard as possible with available epuipment.

After leveling the land, raised beds are made by ridger.

The distance between the rows for determinate type is 75 cm and 90-100 cm for the indeterminate ones. Furrows must be on suitable gradient to allow an even flow of irrigation water . the length of furrow which can be irrigated between feeder canals will

depend on how well the land has been graded. optimum length of furrow will also depend on infiltration rate and drainage characteristics of the soil.

On land of variable slope,a contour lay out may have to be a dapted to enable furrows to be of reasonable length.

Planting and plant population

Planting distance

Determinate - 75 a between rows and 20 cm between plants given a plant population of 66000/hecrar.

Indetreminate- 90-100 cm between rews and 20-30 cm between plants.

Tomato should be transplanted about 10 cm from the edge of the bed. Later on the position of the furrows should be changed gradually during cultivation. The planting of rows should be in the middle of the bed at the time of fruit development.

Fertiltizer application.

The rate and kind of fertilized applied should depend on the nutrient status of the soil. However if this information is not available average dressing should be used.

According to nutrient up take from soil and the expected yield the following amount of nutrient should be applied.

DAP 100-150 kg/ha befor transplanting.

UREA 150-200 kg/ha split application.

The application of urea can be splitted three times. That is two to three weeks after transplanting, shortly before flowing and at first fruite setting/

Irrigation

Before planting the crop, the irrigation lay out should always be tested by pre-irrigation inorder to locate and correct any high or low spots which would cause uneven water supply to the plants.

Irrigation frequency will vary according to soil type and weather condition in the range of 4-8 days. When to irrigate should be determined by examination of the soil in the root Zone.

The rate of flow of water into furros should be controlled. Root damage will result if water is standing for morthan 12 hours.

During harvesting irrigation after harvest is advisable.

Cultivation

Cultivaton is for the purpose of remiving weeds which will competd with the crop for water, light and mutrients. To be effective, cultivation must be done timely, i.e. the weeds are still small.

Another function of early cultivations is to move soil to wards plant planted near the edfe of the bed. About three such operation are required to bring the plant rows to the center of the bed bdfore the shoots start to hang into the furrows.

Supporting

Indeterminate varietites of tomato for fresh production requiring a suppert to produce clean, attractive and high quality tomato.

Prunning pinching

Prunning in tomato have advantages & disadvantages but for good production pruning is advisalble.

Advatages 1. earlier maturity due to reduced branching competition.

2. Relatively larer fruits can be produced.

3. Covernient for harvest.

4. Covenient for harvest.

5. Number of marketable fruits per node increases.

Disadvantages 1. Expensive and labour reduced problem of sun scaled on fruits may be observed.

Harvest and post harvest handing

Processing tomates are neary for harvest when they are red ripe. For export and far distant markets the tomatoes should be harvested when the green mature stage is reached,That means the colour of the tomatoes is shiny-green when the colour break is starting.

Proper handing during harvesting and transport is important to reduce damage of the fruits. Aftr harvest tomatoes should be brought as soon as possible from the field to cool and shady place.

grading should be done on the basis of size, shape, stage of maturity and other characterstices such as cleanliness, freedom from diseases, insect or mechanical damage, free of foreign smell or test etc.

By using optimum conditions and proper cultural practices the productivity of tomato could be 400-500 Q per hectar.

PEPPER(caposicum annum)

soile and climatic requirements

Pepper tolerates slightly higher temperature. The optimum growing temperature are 21c0 to 29co hot pepper ans 21c0 24c0 for sweet pepper.

Hot pepper can be grown as a rain fed erop as well as under irrigation. soil for pepper cultivation is liamy sand or auuvial soil which have good structure and good soil drainage. Optimum PH ranges 6.0-7.0.

Varites

There are two important types of peeper.

1. **Hot pepper with a high content of capsicin which makes the fruit very pungent.**
2. **Sweet pepper with a very low content of capsician.**

The fruit if hot pepper are relatively small compared with sweet pepper. Hot pepper is used fresh and varieties frown in out country. The yield for dried hot pepper ranges from 0.8 to 1.5 tons per hectar of dried fruits.

The most popular variety of sweet pepper. Is califorinia wondrer

The Bird's eye chillie /c. frutescens/ is the most pungent of the chillies and has the smallest fruits. The plants are generally perrenial.

Nursery operation.

The operation of the nursery from site selection to transplanting is similar to that of onion.

The number of seed bed per hectar should be 40-50 and the distance between rows (lines per bed is 15 cm.

sowing and transplanting

The seed rate per hectar is 0.6 kg. The seedlings will be transplanted when they have reached a height of 10-12 cm.

To prevent seedling, from infection with bacterial leaf spot spraying at weekly intervals is recommended. White fly or aphids, as virus vectors must be controlled by spraying with a suitable insecticide.

Pepper under irrigation is planted in double rows on flat topped ridges. Spacing between the rows is 75 cm-80cm. The spacing with in the row is 40 cm.

Three to five years must elapse before pepper can be grown on the same land.

Fertilizer application

According to nutrient up take soil and the expected yield, the amount of nutrient applied is similar to tomato.

DAP- 100-150 kg/ha before transplanting

Urea- 150-200 kg/ha splitted three times

Irrigation

Pepper is susceptible to diseases which develop under water logged soil conditions .It is important therefore that the ridges are well constructed and that there are no low spots which can become the focal point for infection seedlings should always be planted on top of the ridge and about 10cm away from the edge. Adequate drainage should be provided at furrow out lits.

Irrigation frequency will very according to the soil type and weather conditions in the range of 4-8 days.

Cultivation

cultivation to control weeds should also be aimed at building up the ridges, Particularly if they become washed down by heavy rain. The first cultivation should

cultivated at 12-15 days after transplanting about 2-3 cultivation should be required for the production of pepper.

Harvest and post harvest handling

Green chillies and sweet pepper is harvested when they fruits have reached full size but are still green. However during the sater stages of the crop, fruit may be breaking clour of be fully red.

Chillies are normally harvested after they have fully or partly dried on the plant. Dried Chillies should be produced by sun-drying on trays or mats at table hight,not on the ground.

By using such cultural practices, The productivity of green chillies could be 120-150 Q.per hectar

BEANS / PHASEOLUS VULGARIS/

DISTRIBUTION

Beans is originated from south America. At present it is distributed through out the world.

Beans have long history in our country. Commonly use/are red wolita, Black dessie and some climbing types and etc its growing habit differs accouding to varietal character. Beans are lnown in most part of the country as source of food. Its growing mithod is according as source of food. Its growing method is according to human need. Therefore, it is used for dry and fresh beans purpose.

In Ethiopia farmesrs for investers are growing for dry and fresh produce purpose. There are varieties commonly used for dry beans purpose, Mexican and Michigan variety. For fresh pupose bobby types such as Nerina and Nerisha are used but at present Zera cultivar is taking place for fresh Export purpose.

Growing Condition

Beans are hot loving crop at temperature of 20oc to 28oc, high teprerature and dry windy condition forces the plant falling flowers. The elecation or height above sea level tends from 1000-2000 meters.

Soil condition

A type of soil suit for frowing beans is medium textured sandy soil, alluvial soil, Fertile loam and other wide range type of soil but with provided drainage. The ph of the soil must be 6.5-7.5

The crop is suceptable to wind damage. causes bent and scarred pods which are not exportable wind damage, causes bent and acarred pods which are not exportable wind damage,carses bent and scarred posd which are not excportable wind breads must be planted around the plots to over come the problem.

preparation of land and layout

After ploughing and harrwing finished the next operation with leveling follows. Grading of the land depends accouding to its position or profile. This work must be carried out attaintvely before irrigation system and ridging set up. seriors attention must be given for ridging furrow irrigation. Literal for beans furrow spacing between rows is from 60-80 cms, but in our condition we are using the average spacing of 75 cms. After this operation finished, sometimes the beds have high or low spots, so that is must be corrected by labour, before preirrigation let.

Planting or sowing

After the land has aridged with recommended space, then the beds has to be corrected before preirrigation. sowing is done by double rows with a space between plants 5-7 cms. It is important to sow the seeds on top of the ridge and not on sides slopping down in to the furrows. Bean seeds requires good aeration in order to grminate. However some varities has to be 2-3 cms according to the seed thickness. However, some varities have high or lower weight, Because of that the rate of seed per hectar varies so the variance of a rate per ha is 70-100 kg.

Cultivation

Cultivation starts early 7 days after emergency it is for the purpose of removing weeds which will compete with the crop for water, light and nutrients. To be effective, cultivation must be timely whilst the weeds are still small. At least 2-3 cultivation is needed per crop season.

Fertilizer application

Fertilizer rate is depends upon availability of nutrients in the soil.

our practice is :-

Dap-100-150 kgs/ha during land preparation before planting.

Urea- 100 kg the practice is split application In moisten soil with cultivation For complete utlization of nutrient irrigation water has to be followed.

Irrigation

Irrigation is adapted with furrow irrigation system. The intervals has to be with the requirement of the crop and the soil moisture condition. In condition of Zwai, the soil is sand textured so that irrgation interval must be more frequent of 3-5 days specially time of flowering on ward.

Harvesting

The first harvest of beans mastly 60 days on ward after planting. Sometimes cool or hot conditions elongated or shortens. verietal differences also shorten or elongate the time of harvesting

Eg. Nerina variety has shorter harvest and early maturation with three picking time.

Zera variety has long harvesting day and more pickings

Time of harvesting

Eg. Bobby beans- Harvest all mature pods from hole production plot every two days interval.

- **Deviation from above scheduale will result reduction of yield and too high a rate of un exportable grades.**

Great care after harvest

- **Prevent the deterioration of the produce after harvest exposure to sun or dry wind.**
- **It is better to construct shade structure with still or evaporative cooler in the field.**

- **Facilities may cary out grading ioerations inside a field evaporative coller.**

Grading and packing'

The produce should be transported to the pack house in the field boxes or trays in which it has been harvested. The labour of grading is reduced if the harvesters arranged the beans in parallel rows in the harvestion containers. Confirmation of beans in Europe is according to Eu, ECE standard.

Class or Grads

- **Of characteristic shape,size, colour of the variety not bent.**
- **Young tender stringless, with cut large seeds.**
- **Free from disease or insect damage and not wilted.**

Export Packing

Beans are packed for export In wooden of fiber board cartons which whould of attractive appearance and strong enough to ensure the arrival of product at the market in good condition.

Bobby beans are packed to a net weight 4 kg per carton. The pods are arranged in paralle rows in the cartons.

Expertable yield is varies in different varities. In some exporting countries of Africa, such like Kenya, Senegal and Egypt yield per he is from 80-120 Quintals per ha. In Ethiopia condition attaining capacity is from 50-70 quintals exportable quality.

Cold storage.

The storage devided precooling and cooling store. The recommended cool store temperature for beans is 7oC at relative humidity 90-95%. After Packing, The cartons should cooled by forced draught cooling or in an ordinary coll store in ventilated stocks.

6. Cabbage- Brassica cleyacea capitata

Abiennal, with sort thickened stem surrounded by series of over lapping expended leaves in whorls which form acompact head.
Head shape may be pointed or round.

Enviromental respose

soil- Cabbage are tolerant a wide range of soils. The lighter ones are perfered for early production. The soil PH should be maintained between 6.5 and 7.0 help suppress club root disease.

Alititude- Generally grown succllfully at elevation of more than 1000m.
Tempratures- sensitive to temperatures, but some forms and cultivar can with stand temperatures in excess of 30oC
Head formation is more likely to occur at temperatures lower than 24 oC and the optimum range is some a reas is in region of 15-20oC.

Land prepartion

After the site has been chosen and all un wanted vegetation should be removed from the area, including trees, bushes and weeds. The land should be deeply ploughed, harrowed, leveled and ridged.

Nursery lay out

The site of the nursery should be chosen with care. It should preferably be on soil which has not previously carried vegetable crops.

The size of the nursery bed is 1mx5m. The surrounding path should have a width of 40cm. The surface of a raised seed bed should be 10-20 cm higher than surrounding path.

-Two type of beds are used:-

1. Raised bed- Is common in the humid places or where is surplus rain fall during growing season

- **On poorly drained soils.**

2. Sunken bed Are used in arid and semi-acid areas, so that the maximum amount of water can be directed to root system where as the sunken beds can be constructed by drawing soil from the center of the bed and condtructing a ridge around the edges of the beds.

Nursery management

seed sowing

The rate of seed sowing should be related to the rate at which seedlings can be transplanted in the field. seed rate per hectore 500gm/8.33gm/bed/. Before sowing the seed it will better to apply Ridomil 5G to control fungus disease. Spacing between the rows 10 cm and with in row 3 cm and the depth of sowing 1-2 cm.

Avoid too thick sowing use two person per bed side by side. the number of seed beds should be 10

As soon as the seed has been sown, The surface of the seed bed should be mulched with 5 cm deep layer of dry grass straw.

Apply water immediately through the mulch. Remove the mulch as soon as the seedlings are visible above the ground. The seds will germinate 7-10 days. After removing of mulch spray fungicide chemicals to control damping off /Docide 101/

Yound seedling should be watered in early morning and late afternoon. It is also a very important that beds do not dry out any time during the germination process.

Irrigation - Hand watering by watering cane followed by surface irrigation after the seedling reach a height of 5 cm frequency of watering will depend on local condution The beds should be examined daily and rewatered as necessary.

Fetilizer application - Refore sowing at the rate of 50gm dap per bed and 30 gm bed with first cultivation 7-10 days after removed the mulch.

- **Second cultivation with UREA after 7-10 days of 1 st cultivation**

Cultivation and weeding - In order to get healthy an strong seedling the bed free from weeds and also the soil must be loose to conserve moisure & to increase aeration . Until to transplant 1-2 frequencey is enough.

Translanting

Cabbage seedling are normally ready for trandplanting when they reach a heighy of 10-12 cm or when 3-4 true leaves formed two weeks prior to transplanting the seedling should be hardened by reducing water. However water should be applied the day before seedlings are lifted to minimize damage to roots. Transplanting should be done preferably in the evening (late afternoon) seedling should be carefully lifted from the

seed bed with fork / hoe-with out damage of the roots. The roots must be protected against drying out roots down in plastic field boxes and cover the box by wet sack.

Spacing- Transplanted to rows 60-75 cm a part, plants 45-60 cm a part in the row-no a commercial scale head size can be regulated by adjustment of planting density.

Ex. Under Tseday farm condution rows 80 cm a part plant 40 cm a part in the row/ double row planting/

Planting- The land should be irrigated one day before transplanting to reach optimum soil moisture. Immediately after transplanting irrigate again. Take care not to bend the root of seedlings in planting holes at nursery depth and farm the soil with out damage of roots. prune the longer roots.

Replanting- After planting due to various reasons some seedling drying out should be replavced by new seedling after five to seven days of planting. These helps to maintain the plant population per hectors The expected number of plant population re hector decreases due to various reasons also directely influence on the ecpected yield.

Irrigation A constant level of soil water should be maintained through out the growing period. Ashortate of water may lead to cracking or splitting of the heads the effective root zone is approximately 60cm Irrigation frequency will vary according to soil type and weather conditions in the range of 5-6 days under Tseday farm condution.

Fertilizer application- The crop resposnds well to high soil fertility and bulky organic matter. The rate of application will depend on soil analysis soil type and perviors management.

- **The rate of fertilizer on out side condution dap 250-300 Kg/hr and Urea 76-100 kg/ha (most 1981)**

- **According to out coundertion used dap 200kg and urea 200 kg.**

Dap applied before planting by broad casting.

Urea in splitt application

- **half 12-15 days after planting.**
- **half before head formation.**

Cultivation and weeding- Is for the purpose of removing weeds which will compete with crop of water. Light and nutrients Facilitates incorporation into soil of organic matter, fertilizer and conserve moisture.

First cultivation applied 10-15 days after planting and second cultivation the sign of head formation with nitrogen fertilizer when the soil at moist condution.

- **It needs 2-3 cultivation though growing period**

Growth peried and harvesting

Normally harvested as soon as the plant head hould be green firm and soild. The internal leaves should be yellow or light green with out seed stalk. Root should be trimmed below the basal leaves and loose the leaves removed.

Delay in harvesting there crops usually results in splitting of outer leave which losses the quality of the crop. Early harvest 80-110 days depending on cultivar characterstics

Yield -The estimated average yield from a well managed field is 30 to 40 tons per hectare.
Quality- Head compact, leaves firmy attached, properly trimmed, slight bruising bruising and crack or outer leaves.
Storage- Heads may be damaged by sever freezing but storage at temperatures of 0-1oC for periods of 90 or more days is possible.

Potato - solamum tuberasum

The crop has alternate leaves, perfect flower up on fertilization produced berries which contais tiny seeds.

Enviromental response

Soil- This crops needs sandy loam and fertile loose soil when potatos grown on heavy clay soil result deformed tubers and secondary growth . The soil PH should be maintained between 5-6.8.

Alititude -is widely grown on the highlands and mid- alititude areas of the country. Generally growth at elevation of 1700-2800 m.

Temperatures- The optimum temptratures for tuberization 15-19oC.

Temperatures from 20Co- 29Co heads to small size more than 29oC tuberization not formed.

Rainfall- About 800 mm is adequate for light soil during growing period and sensitive to drought.

Land preparation

After the site has been chosen and all unwanted vegetable should be removed from the area including trees, bushed, weeds and residual. The land should be deeply ploughed 25-30 cm depth then harrow, leveled and ridged. After ridging the ridge must be shaped.

Seed rate- The seed tuber size 4-6 cm diameter /40-50gm/ are perfered for planting, seed rate per hectare 2000 kg.

The seed rate depends upen the size of the tubrl used for seed.

Planting

Plant the tuber having 2 or more spriut of lengh 0.5 cm- 1cm. Perfered at depth of 8-10cm.

-For ware potato production planted to row 75 a part, plants 30 cm apart in the row for seed potato production.

To rows 60 cm a part, Plants 20 cm a part in the row or to rows 75 cm a part, plat 15 cm a part in the row.

- **Plant the tuber with out- irrigation is possible but better to plant the soil at moist conduction and after planting irrigate immdetely**
- **Care has to be taken during planting the sprout from damage.**

Fertilizer- The rate of application will depend on soil analysis, soil type and perviors mangement.

- **Woleta and similar agro-Ecologies 200 kg DAP and 165 kg of UREA per gectare.**
- **It better to apply total amount of DAP in rows while planting and also apply by broad casting after leveling.**
- **Split application of Urea half applied three weeks / Uniform growth starts/ after planting and the rest applied at a midum vegetative growth / before flowering/ with cultivation when the soil at moist condution.**

Cultivation and weeding- potato is a root crop it needs shallow frquent cultivation to loosen the soil for root developments.

- **-2-3 Cutivation enough the growing period.**

The benefits- destruction of weeds, there by conserving moisutru and nutrients.

-Protects the tuber from greening by covering of adequate soil.

- **Avoids potato tuber moth.**

Irrigation - Potato is shallow rooted crops it needs frequent irrigation. sensitive at the early stage 7-10 days frequency depends up on the soil type and weather condutions

-Comparison of potato production by true potato seed and seed tubers

1. **True potato seed- seed rate per heactore 100-140gm.**
    - **relatively healther seedling tuber can be produced as most viruses and vematode are not transmitted through betenical seed (Jones 1982)**
    - **less expensive**
    - **easy to store and transport**
    - **lack of uniformity**
    - **longer growing period**
    - **Low yield**

2. **Seed tuber- Seed rate per heactare 1500-2000kg**
    - **The best opportunity to propapate disease**
    - **expensive**
    - **difficult to store and transport**
    - **Uniform**
    - **short growing period**
    - **high yield**

Harvesting

The tuber are harvested when they attain right maturity which indicates by change the colour of the leaves from green to yellow. Change of colour can also becaused by some virused hence care should be taken not confuse the isease symptom with stage of maturity.

Crop duration is between 90-100 days harvest by carefull digging up tuber. it is better to harvest by oxen plough than labour.

The stem trail on the ground and bend up at the upex

Removed the folage 7-15 days before harvest this leave to harden the skin tuber and facilitates this harvesting.

- **The harvested tubre not be exposed direct sulight.**
- **The estimated average yield from a well- managed field is 20 to 35 tons per hectare.**

storage

Tuber are stored either for seed purposed or ware. Potato not stored for long period of time for table consumption uless you have cold storage.

For seed Purpose stored for long period under difused light store.

Diffused light store- the most approprate for development conrties These storage well ventilated, dry storage which can allow the entrance of light. Under these storage tuber can be store for 6-8 month with minimu loss.

VERITIES UNDER POTATO PRODUCTION

No.	VARIETIES	YEAR OF REALABLE	GROWING ALITITUDE	MATURITY PERIOD	YIELD QT/KG	
					RESARCH FIELD	FARMER FIELD
1	Chirro/AL-111/	1997/98	---	--	--	--
2	Alemaya 624	1987	1500-2000	90-100	260	200
3	Awasa	1991	1700-2800	90-110	254	205
4	Tolcha	1993	1700-2800	110-115	332	285

5 6	Menagesha Wechecha	1993 1997	2200-3000	110-130	270	220

IV. CEREALE PRODUCTION

1. Wheat - Triticum aestivum

Wheat is one of the important cereals of the world. It is the number one cereals of the world. which are climatiacally very suitable fir its cultivation. Now a days it is also grown on a large scale in the subtropical an tropical regions of the world.

Wheat is one of the various cereal crops largely grown in the highlands of Ethiopia. It is produced largely in the south east, Central and north west part of the country.

Nutritive value

The whole grain of weat contains approximately 70% carbohydrate, 11.5% protein/ varying from 8-15%, 2% fat, 2% fibre, 1.5%ash and 13% water.

Adaptation

Alititudes- most of the wheat is grown at alititudes between 1800-2800m.

Rain fall- Wheat repuires 250-270 mm of annual preciptation

Tempratures- For the proper development of the wheat plant the best temperature range is 20-23oC . At temperature higher than 25Co in the grain development plase the plant dries up prematurely.

Soil - Wheat can be grown successfully under a wide range of soil conditions, But it is best adapted to fertile, Well- drained silt and clay loam soils. Although it often produces satisfactory tields on clay and sandy loams it is poorly suited to these and poorly- draind soils. The soil PH ranges between 6 7.5

Cultivation Cropping systems

- **Wheat can be grown in rotation with one or two crops per year,**

Example - Maize- potato-whaet
-potato-wheat etc.

Land preparation

The site has been chosen and all unwanted vegetation should be removed from the area including trees, bushed,weeds and residual. Recent studies have cleary shown that when adequate attention is given to the control of perennial weeds. Paoughing the land 25-30 cm depth, second ploughing if it is neccassry. harrowing and leveling.

sowing

- **The optimum time for sowing is from June 15- July 15. by rain feeded the seed rate per heactare is 150kg-175kg by broad casting and sowing in rows seed rate per hectare 100 kg.**
- **sowing up to 5-6 cm deep done not have any adverse effect on the emergence percentage. shwing beyond this depth**

however results in a marked reduction in emergence percentage.

- **The seed cover by using harrowing & spring cultivater care has to taken the depth.**

Fertilizer- With modern high yielding cultivars there is almost a resposnse to fertilizer.

- **On red soil DAP applid 125 kg per hectar and 75 kg per hectare of UREA.**
- **On black soil DAP applied 100 kg per hectar and 100 kg per hectar of Urea.**

Method application - The whole amount of DAP and half of the

- **amount of UREA applied at seed sowing by broad costing**
- **The rest amount of UREA applied during tillering by broad casting when the soil at wet condution.**

Weed control

-The only suitable method of controlling weeds by using chemicals.

- **The non -graminaceous annual weeds can be effectidelly controlled by aspray of 2-4-D kg/ha five weeks after sowing. To contol grass weeds 25-30 days after sowing or wheat produce 4-5 leafs spray puma super 75% a1lt/ha**
- **- Weed reduces wheat yields up to 36%**

Harvesting and threasing

- **The wheat crop usually ripens about 120-150 days.The leaves, staks and sprkes begin to lose their green colort and become golden yellow. When completely air-dry the moisture of the grain average about 10-12%**

- **Harvesting may be done by hand with sickles, or by combine harvester. Where the harvest period is dry, the harvesting and threshing of standing crop by combine harvestee is practical where harvesting and threshing are done manually winnowing must be done to separate the grain from the chaff.**

- **The estimated average yield from a well- manged field is 30 to 40 Qt/ha.**

Storage

Drying to 10% moisture content and thorough cleaning of the grain are the first requirements for safe storge insects pests is particularly important.For this storage structures and grain containes including the bags should be well treated with insecticides Fumigation of the grain soon after storing is equally important.

VARITIES UNDER BREAD WHEAT PRODUCTION

No	VARIETY	PLANT HEIGHT /CM/	SEED COLOUR	DAYS TO MATURITY	ALITITUDE	YEAR OF RELEASE	YIELD (QT/HA)	
							RESARCH FIELD	FARMER FIELD
1 2 3 4 5 6 7 8 9 10	SIMBA(HAR-							

11 12								

seed production Technology

1. Maize seed production

Background

Maize (Zea may L) is among the most widely cultivated crops of the would. It is a good crop for may million people, source of animal feed and an important input for many industries The discovery of hybrid vigour in maize is probable the greatest achivement of agriculture this century purposeful breeding for hybrids wascondidered to began in the 1930 S in USA. In Agrica, South African come to realize the value of maize hybrids in the years 1939-1945 . In Ethiopia the first top cross hydrid, BH 140 was released in 1988. Since then other 3 hydride namely BH-660 BH 530 and BH-540 were developed by the national maize research team.

Bh- 660 is the most popusar local hybrid among the released so fare. Prior to the release of these foru local hybrids, ESE used to import f1 seeds of different hybrids from East Agrican neighbouring countries to distribue to the users later on the import was shifted to the parental seeds to produce the hybrids locally. In the mean time pioneer hi-bred seed Inc- started producing and marketing its own hybrids.

1. Cultivars

There are two kinds of improved maize cultivars.

a. Open pollinated varieties

Cultivars of this group are characterized by their broad genetic make up containing several inbred lines, commonly known coposited and synthetics are open pollinated maize varities. Composites are made by random pollination of different inbred lines while synthetics contain

limited number of parents which are allowed to pollinated to the time of their development. Open pollinated varities are used for

Grain production less extensibvely their use in breeding rather outwitht their as seeds for farmes

b. hybrids

Hybrids are those cultivars which utilize the first generation crosses among inbrd lines. The inbread lines are selected to meet the desired charatreristics by the breedt There are several types of hybrid maize cultivars and the most commonly used are the following:

a. Single cross:- The first generation cross resulting from the controlled crossing of two certified inbred lines.eg BH- 140, sc-140

b. Double cross:- The first generation resulting from the controlled crossing of two certified single crosses eg. H-625.

c. Three way cross:- the first generation resusting from the conrolled crossing of a certified single croll & certified inbed line eg. Bh- 660

d. Top cross:- the The first generation resulting from the contolled crossing of a certified inbred line and a certified open pollinated variety, or the firwt generation resuting from the controlled crossing of a certified single cross and a certified open- pollinated variety.

e. Varietal cross:- the first generation resulting from the controlled crossing of two certified open -pollinated varieties. Top crosses and varictal crosses are used less extensively.

Methods of seed production

site selection

Seed production of maize needs a lot of follow up and due inspections and hence the production plots should be accessible to read transport. The plots should be also be safe from wild animals attack. The previors cropping pattern of the plots should be taken into consider ation and hence, as much as possible the plots should not be planted maize cultivars in the previous cropping season.

Isolation

The selected plot shoud be isolated from any maize production farems or plots by at least 400 meters in any direction. Hybred seeds need more isolation distance than composites.Careful time solation can also be used when the area of seed multiplication is not large enough.

Land preparation

Maize seed needs well prepared. drained and aerated seed bed. Heavey and poorly drained soils are not possible proper plowing dicing and leveling is quite necessary if it becomes necessary to plant the seeds in already prepared furrows they should be paraller and clear so as not to confuse the workers on time of detassiling and inspection.

1.3.4

Planting

The plot should be well planned as to how the seed and pollen parents are arranged prior to the actual planting.

In maize seed production the following should be considered.

1. **Female to male ratio arrangement**
    - **Could be 2:1, 4:2, 6:2, 3:1, 10:4 & 12:7 depending on varieties.**

2. **Degree days / heat unit/ - It is the number of degrees F. above an established minimun growing tempratues. For maize it could be 50oF or 10oC**
3. **Spacing**

    a- **Male:- in order to get maximum pollen, it is advisable to have more male plats per unit area. so planting of 19cm-22cm b/n plants and 75 cm b/n rows is recommendable.**

    b- **Female:- Planting of female plants with spacing of 22-24 cm b/n rows is advisable.**

4. **seed rate - The seed rate depends on:**
    - **seed size**
    - **percentage of germination**
    - **Planning of plant population density**

There fore, depending on the above factor it is desirable to sow 15-20% more seeds than calculated to over come the problems.

Irrigation and drainage

Both soil irrigation and drainage conditions are detrimental in maize seed production plots very dry condition during the flowering time away limit the proper stage and usually result in problem of flower synchrony b/n the other pollen and seed parents. Excessive moister& flowering on the other hand can lender the seedling emergence. The problem world be further aggravated if the flooding is associated with poor leveling for the row of male and female furrow lines and seeds may be mixed up prior to germination.

Table-1 Water requirement of maize at different growth stages.

DEVELOPMENT STAGE		WATER REQUIRREMENT IN % OF THE TOTAL AMOUNT
FROM	TO	
Planting	7-8 leaf stage	11-12
7-8 leaf stage	Tasseling	19-20
Tasseling	Silking	22-23
Silking	End of pollination	22-30
End of pollination	harvesting	15-20

Source:- FAO of the UN- Technical guidelines for maize seed technology 1982.

According to the above table maize growers have to take particular care to assure that the field is well supplied with water during the flowering period. The most critical period for maize begins 10 days before teaseling and ends just after fertilization.

Fertilization

As it is needed to get a maximum quality and quantity of seed, seed production plots should be well fertilized. For normal textured soil, it is recommended to plow under the fertilizers for the dressing generally phosphoric fertilizer.

Nitrogenous fertilizer is applied in three split application in the ration of 1:2:1 with cultivation.

Recommendations:-

DAP= 2 Q/ha

UREA= 2 Q/ha

Nitrogenous fertilizers are sometimes used to enhance the vegetative growth and vigour of very weak pollen parents to establish themselves. However, care should be taken to avoid excessive vegetative growth that could rather result in flowering dalliance and lodging

Weeding and cultivation

After maize seed has been planted and has emerged changes occur on the soil surface. This usually involve crust formation and small or large creacks parallel to this weeds may establish and may be aggressive. crust formation is common on irrigated fieds.

Cultivation us there fire necessary to break the crust and control the weeds mechanical cultivators are normally used but cultivation by hand hoeing is also possible when it is not available

Inspection and rouging

It is one of the very important operations after germination of the seeds. The main importance of inspection is:-

- **to avoid off type timely.**
- **to under take corrective measure of any defect.**
- **to under stand the status of the crop.**
- **to avoid suckers**

detasseling

Detasseling is one of the major operations as far as maize seed quality is concerned. It is the removal of the assel from pollen. Every plot should be assessed every day until defasseling is completed.

Harvesting

Maize seed can be harvested as soon as physiological maturity is a checked the grain contain 30-40% of moisture which can be reduced by artificial maize dryers 12-13 percent .Physiological caducity in maize can be determined by splitting the kernels longitudinally and look for a block tough layer. Maize Kernels have completed their growth cycle when a tough block layer has formed above the base which seals off the embryo /germ/ and starchy endosperm.

Cobs of maize can be picked by hand or machine .The cob sorting process can be done either at the farm or at the site of the drier caching cobs are sorted to discard all off type, moldy, damaged or doubtful ears. Only the sorted copy are shelled with appropriate maize Sheller. shelling is usually done when the seed contains 12-14% moisture.

Excessive drying makes the seeds cracked when shelled while prematre shelling will not result in good recovery.
Breakage and damage of the grain during shelling should be less than 5%

ONION

Onion is a biennial crops usually grown as an annuals for bulb but it takes two seasons for seed production. During the first season bulbs are formed. stalks and seeds are developed in the second season it passes from the vegetative phase to reproductive phase for flower stalk development and seed set the development of seed stalk is influenced by storage conditions of the mother bulbs and temperature during the growing period.

Onion cultivars also vary in their susceptibility to flower stalk development depending of climatic conditions and the potential of the cultivars. Onion varieties

are generally maintained in a more complicated manner as they are hardly collections or genitivally similar plants

A. Growth requirement

Temperature greatly influence the flowering activity of onion. cool condition with an adequate moisture supply are most suitable for early growth of onion followed by worm, driver conditions for maturation Low temperature (9 to 17oC) is required for lower stalk development In the upper awash and the lake region during September to February with temperature of 26 to 28co during the day and 11-18c night supplemented with low humidity are good conditions for flower stalk emergency and satisfactory seed set for easy bolting varieties Drier and low humid condition with ample sun shine and the absence of strong wind are suitable for seed maturity ripening and harvesting excessive.

Rainfall and cooler condition during flowering leads to diseases and poor fruit set and ripening and makes the harvesting of seed difficult it also delay seed maturity and result in poor quality seed. a fertile loam soil with PH of 6.0 tro 7.0 is suitable for hight yield pollination

Onion is highly cross pollinated (Tindall 1987). The intensity various between 30 to 94% depending on availability of pollination (oss 1979) This makes self pollination impossible without begging or caging the flowers various insects are involved to carry pollen between floorer the availability of suitable pollinators such as bees which feed on nectar and transfer pollen with in an umbel and between different plants is very important . Honey bee hives could be placed in the farm to effect seed setting.

C Method of production

The two common methods of seed production of onion are describe below.

Bulb to seed Method

The method has the advantage of maintaining seed quality. It allows roughing of color misshapen splits rotten and sprout bulbs several stands are formed per bulb

seed to seed method

This method misses the above advantages but it could be used alternate (every other year) with the other method to speed up the production practiced without affecting the varietal quality. it takes about t to 8 month to produce seeds.

Under Melkasa and other similar climatic condition, in the bulb to seed method, a bulb crop will be grown from February to June and typical mother bulbs will be selected and stored for one to two months the bulbs will be planted in he cooler preiod (early September to October) which is conductive for flower stalk development and subsequent seed sort large and well developed umbels are developed which are favorable for high quality seed production The bulb to

seed method which is the most common one follows a similar practices to bulb production

Cultural practies

Above 3.5 to 4.0 kg of about 92 to 95% germinating seed should be raised on a seed bed and transplanted to the field after 45 days at 40x20x10 cm spacing, (i.e 40cm bed including furrow 20cm between rows on the bed and 5-7 cm between plants) The bulbs will be realy for harvest after four and a half month after transplanting large or medium anther bulbs (5to 6cm) uniform typical size and color free from diseases insects and other injures should be selected and stored for about tow months and

planted the size of the bulb determine the vigor of vegetative phase and number of reproductive shoots which is directly related to the number of seed stalks and seed yield the number of flower stands or bulbs under Melkas condition vary from 1 to 15 and a terminal number of 50 to 200 flower produced per umbel (flower head) depending on the number of shoot axis.

The optimum mother bulb planting time is between August October August , September and October bulb planting can give high number of flower stalks and seed yield due to worm temperature low rainfall and low disease pressure during flowering fruit set and harvesting. Doulble row plantings of 50x30x20 cm with 125,000 bulb per hectar (80 to 90 qha -1) should be used for Melkasa and similar climatic condition.

Isolation

All the flowers in one umbel do not mature at the same time. In addition. The male and female parts of the flowers do not mature at the time, therefore, cross pollination is very common (30 to 94 %)

In order to get pure seed, varieties should be separated by a distance of at least 600 m to 800 m as a barrier to reduce the chances of carrying pollen of one cariety to the other. If there are many varieties,similar to hot pepper, varieties must be covered with insect proof cages to avoid seed contamination. In a commercial production, it would be asvisable to concentrate on one or two varieties;

Harvesting and processing

Since all the umbel in a plant do not mature at the same time, it would be desirable to harvest the field 3 to 4 times before shattering occurs. The seed is ready for harvest when the first formed seed in the head begins to shatter or expose the black seed. The heads are cut by hand using shear with part of the stem attached and left to dry on

canvas In ventilated sheds or in the sun. Though much of the seed fall from the capsule durting drying, the seed could be fully separated by rubbing over canvas or by light pounding with postion and mortar for about 10 to 15 minutes Trashed and poorly developed seeds can be removed or cleaned by immersing seed in clean water for about 15 minutes. Then after seeds should be imidiately transferred to canvas or trays and dried in sun or under shade for 3 to 5 days.

Seed Yield

A great variation was found in seed yield among the promosing open pollinated cultivars. The cultivar, Adama Red, produces the highest seed yield or about 12q ha -1 . The cultivars pusa Red and N-53 also shows a similar trend. Red Creole does not set seed using the standard storage practice. storage of this variety under cool condition in the range of 5 to 10oc for six weeks is effective in flower stalk development and seed set. such practice improved seed yield from 0 to 6 qha-1 The over all onion seed germination varies between 90 and 95% with seed weight of about 3.5 to 4.0 g.

seed storage

Onion seed deteriorates faster than any other vegetable seed. it deteriorates quicker under worm conditions (room temperature) such as at Ziway climatic condition. optimum care must be taken to dry the seed properly and protect it from excessive heat under conventional storage. For temporary storage the seed moisture content should be reduced to about 7 to 9% once the seed dries, it must be sealed in a moist-proof container otherwise it will regain moisture and deteriorates rapidly. Under local conditions it should be better stored in paper or cloth bag under dry an ventilated conditions for at least one year.

TOMATO (lycopersicum esculantum)

The tomato is one of the most popular and important vegetables for fresh consumption and for processing.

Soil and climatic requirement

The tomato requires a warm and dry climate. The optimum men day temperature for growth of tomato lies between 24^{o}C and 28^{o}C Temperature above 32^{o}C during fruit development inhabits the formation of red color. Temperature below 15^{o}C stops flowering of the plant.

Preferably, soils for tomato cultivation is loamy sand or alluvial soil. Good soil drainage is important. Optimum PH range is from 5-5 to 7-0

Varieties.

There are two different habits of growth of tomato; determinate and indeterminate.

The plants of determinate varieties are compact in growth, and mature their fruit within a relatively short period. The advantages of these varieties compared with indeterminate varieties are that staking to support. the plants in not necessary and mechanical harvest is possible. Belonging to this group are such varieties as Roma V.F., Napoli and pearson.

The plants of indeterminate varieties are high in stature, open in growth and they develop their fruit during a relatively long period. These have high labour requirements for maintenance (staking) . Some well- known varieties that have been growth successfully in our country are Marglobe, Money makes& Rutgers

The plants of determinate varieties end- their growth by flowering and fruiting & this inhabit lateral growth but the indeterminate have vegetative end as long as these is moisture.

Now a day some individual invests and state farms use staking for some determinate types of tomato verities like Roma V.F

Nursery Operation

The operation of nursery like site selection, proper bed lay out, seed sowing, watering, fertilization, weeding& cultivation of tomato is almost similarly to that of onion.

The following points should be considered for seed bed practice of tomato.

1. **The area should have flat or gently sloping surface.**
2. **The site should have light to medium well drained soil.**
3. **Nursery bed should be 1x5m.**
4. **The bed should be carefully leveled and surrounded an earth ridge of 10 cm.**
5. **The number of seedbed per hectare should 35-45.**
6. **The number of line per bed recommended is 33(i.e. the distance between lines per bed is 15cm)**
7. **The quantity of seed per hectare is 300gm -400gm.**
8. **Preventive spraying with fungicides should be applied with one-week interval.**

Sowing and Transplanting

The seed rate for tomato is about 300-400 gm per hectare, but it depends on plant population that will be transplant in one hectare.

The optimum time for transplanting is when the seedlings have three pairs of true leaves or when they reach a height of 10-12cm.

To prevent infection of tomato seedlings with fungus diseases the seed should be treated with a chemical seed dressing. Disease and insecticide spray to control pests may be necessary.

Land preparation and lay out

Following plowing, disking and the elimination of perennial weeds, the land should be graded to as high a standard as possible with available equipment.

After leveling the land, raised beds are made by rigger.

The distance between the rows for determinate type is 75 cm and 90-100 cm for the indeterminate ones. Furrows must be on suitable gradient to allow an even flow of irrigation water. The length of furrow that can be irrigated between feeder canals will depend on how well the land has been graded. Optimum length of furrow will also depend on infiltration rate and drainage characteristics of the soil.

On land of variable slope, a contour lay out may have to be adapted to enable furrows to be of reasonable length.

Planting and plant population

Planting distance

Determinate: - 75 cm between rows and 20 cm between plants given a plant population of 66000/hectar.

Indeterminate-: 90-100 cm between rows and 20-30 cm between plants.

Tomato should be transplanted about 10 cm from the edge of the bed. Later on the position of the furrows should be changed gradually during cultivation. The planting of rows should be in the middle of the bed at the time of fruit development.

Fertilizer application.

The rate and kind of fertilizer applied should depend on the nutrient status of the soil. However if this information is not available average dressing should be used.

According to nutrient up take from soil and the expected yield the following amount of nutrient should be applied.

DAP 100-150 kg/ha before transplanting.

UREA 150-200 kg/ha split application.

The application of urea can be splinted three times. That is two to three weeks after transplanting, shortly before flowering and at first fruit setting.

Irrigation

Before planting the crop, the irrigation lay out should always be tested by pre-irrigation in order to locate and correct any high or low spots which would cause uneven water supply to the plants.

Irrigation frequency will vary according to soil type and weather condition in the range of 4-8 days. When to irrigate should be determined by examination of the soil in the root Zone.

The rate of flow of water into furrow should be controlled. Root damage will result if water is standing for more than 12 hours.

Irrigation after each harvesting is advisable and essential for the increment of moisture content of next fruit.

Cultivation

Cultivation is for the purpose of removing weeds, which will compete with the crop for water, light and nutrients. To be effective, cultivation must be done timely, i.e. the weeds are still small.

Another function of early cultivations is to move soil to wards plant planted near the edge of the bed. About three such operations are required to bring the plant rows to the center of the bed before the shoots start to hang into the furrows.

Supporting

Indeterminate varieties of tomato for fresh production requiring a support to produce clean, attractive and high quality tomato.

Pruning /pinching/

Pruning/pinching/ in tomato have advantages & disadvantages but for good production pruning is advisable.

Advantages: - **1. Earlier maturity due to reduced branching competition.**

2. Relatively larger fruits can be produced.

3. Convenient for harvest.

4. Convenient for harvest.

5. Number of marketable fruits per node increases.

Disadvantages:- **1. Expensive and labour consuming.**

2. since the total leaves reduced problems of sun scald on fruit may be observed .

Harvest and post harvest handing

Processing tomatoes are neary for harvest when they are red ripe. For export and far distant markets the tomatoes should be harvested when the green mature stage is reached. That means the color of the tomatoes is shiny-green when the color break is starting.

Proper handling during harvesting and transport is important to reduce damage of the fruits. After harvest tomatoes should be brought as soon as possible from the field to cool and shady place.

Grading should be done on the basis of size, shape, stage of maturity and other characteristics such as cleanliness, freedom from diseases, insect or mechanical damage, free of foreign smell or test etc.

By using optimum conditions and proper cultural practices the productivity of tomato could be 400-500 Q per hectare.

PEPPER(capsicum annum)

Soil and climatic requirements

Pepper tolerates slightly higher temperature. The optimum growing temperatures are 21^{o}C to 29^{o}C hot pepper and 21^{o}C 24^{o}C for sweet pepper.

Hot pepper can be grown as a rain fed crop as well as under irrigation. soil for pepper cultivation is loamy sand or alluvial soil which have good structure and good soil drainage. Optimum PH ranges 6.0-7.0.

Varieties

There are two important types of peeper:-

3. **Hot pepper with a high content of capsaicin, which makes the fruit very pungent.**
4. **Sweet pepper with a very low content of capsaicin.**

The fruit of hot peppers are relatively small compared with sweet pepper. Hot pepper is used fresh and dried as spice. Marako, Fana,bako local and others are varieties frown in out country. The yield for dried hot pepper ranges from 0.8 to 1.5 tons per hectare of dried fruits.

The most popular variety of sweet pepper is California wonder.

The Bird's eye chillie /c. frutescens/ is the most pungent of the chillies and has the smallest fruits. The plants are generally perrenial.

Nursery operation.

The operation of the nursery from site selection to transplanting is similar to that of onion.

The number of seed bed per hectare should be 40-50 and the distance between rows (lines per bed is 15 cm.

sowing and transplanting

The seed rate per hectare is 0.6-0.8 kg. The seedlings will be transplanted when they have reached a height of 10-12 cm.

To prevent seedling, from infection with bacterial leaf spot spraying at weekly intervals is recommended. White fly or aphids, as virus vectors must be controlled by spraying with a suitable insecticide.

Pepper under irrigation is planted in double rows on flat topped ridges. Spacing between the rows is 75 cm-80cm. The spacing with in the row is 40 cm.

Three to five years must elapse before pepper can be grown on the same land.

Fertilizer application

According to nutrient up take soil and the expected yield, the amount of nutrient applied is similar to tomato.

DAP- 100-150 kg/ha before transplanting

Urea- 150-200 kg/ha splitted three times

Irrigation

Pepper is susceptible to diseases which develop under water logged soil conditions .It is important therefore that the ridges are well constructed and that there are no low spots which can become the focal point for infection. Seedlings should always be planted on top of the ridge and about 10cm away from the edge. Adequate drainage should be provided at furrow out lets.

Irrigation frequency will vary according to the soil type and weather conditions in the range of 4-8 days.

Cultivation

Cultivation to control weeds should also be aimed at building up the ridges, particularly if they become washed down by heavy rain.

The first cultivation should cultivated at 12-15 days after transplanting about 2-3 cultivation should be required for the production of pepper.

Harvest and post harvest handling

Green chilies and sweet pepper is harvested when the fruits have reached full size but are still green. However during the later stages of the crop, fruit may be breaking color or be fully red.

Chilies are normally harvested after they have fully or partly dried on the plant. Dried Chilies should be produced by sun-drying on trays or mats at table height, not on the ground.

By using such cultural practices, the productivity of green chilies could be 120-150 Q.per hectares

BEANS / PHASEOLUS VULGARIS/

DISTRIBUTION

Beans is originated from South America. At present it is distributed through out the world.

Beans have long history in our country. Commonly used/ are red wolita, Black dessie and some climbing types and etc. Its growing habit differs according to varietal character. Beans are known in most part of the country as source of food. Its growing method is according to human need. Therefore, it is used for dry and fresh beans purpose.

In Ethiopia farmers or investors are growing for dry and fresh produce purpose. There are varieties commonly used for dry beans purpose, Mexican and Michigan variety. For fresh purpose bobby types such as Nerina and Nerisha are used but at present Zera cultivar is taking place for fresh Export purpose.

Growing Condition

Beans hot love crop at temperature of 20^{o}C to 28^{o}C, high temperature and dry windy condition forces the plant falling flowers. The elevation or height above sea level tends from 1000-2000 meters.

Soil condition

A type of soil suit for growing beans is medium textured sandy soil, alluvial soil, Fertile loam and other wide range type of soil but with provided drainage. The ph of the soil must be 6.5-7.5.

The crop is susceptible to wind damage. Causes bent and scarred pods which are not exportable wind damage, causes bent and scarred pods which are not exportable wind damage, causes bent and scarred pods which are not exportable wind breads must be planted around the plots to over come the problem.

Preparation of land and layout.

After plowing and harrowing finished the next operation with leveling follows. Grading of the land depends according to its position or profile. This work must be carried out attentively before irrigation system and ridging set up. Series attention must be given for ridging furrow irrigation. Literal for beans furrow spacing between rows is from 60-80 cms, but in our condition we are using the average spacing of 75 cms. After this operation finished, sometimes the beds have high or low spots, so that is must be corrected by labour, before pre irrigation let.

Planting or sowing

After the land has ridged with recommended space, then the beds has to be corrected before pre irrigation. Sowing is done by double rows with a space between plants 5-7 cms. It is important to sow the seeds on top of the ridge and not on sides slopping down in to the furrows. A Bean seed requires good aeration in order to germinate. The seed depth has to be 2-3 cms according to the seed thickness. However, some verities have high or lower weight, because of that the rate of seed per hectare varies so the variance of a rate per ha is 70-100 kg.

Cultivation

Cultivation starts early 7 days after emergency it is for the purpose of removing weeds which will compete with the crop for water, light and nutrients. To be effective, cultivation must be timely whilst the weeds are still small.

At least 2-3 cultivation is needed per crop season.

Fertilizer application

Fertilizer rate is depends upon availability of nutrients in the soil.

Our practice is :-

Dap-100-150 kgs/ha during land preparation before planting.

Urea- 100 kg/ha. The practice is split application In moisten soil with cultivation For complete utilization of nutrient irrigation water has to be followed.

Irrigation

Irrigation is adapted with furrow irrigation system. The intervals have to be with the requirement of the crop and the soil moisture condition. In condition of Zwai, the soil is sand textured so that irrigation interval must be more frequent of 3-5 days especially time of flowering on ward.

Harvesting

The first harvest of beans mostly 60 days on ward after planting. Sometimes cool or hot conditions elongated or shorten. Variety differences also shorten or elongate the time of harvesting.

Eg. Nerina variety has shorter harvest day and early maturation with three picking time.

Zera variety has long harvesting day and more pickings.

Time of harvesting

Eg. Bobby beans- Harvest all mature pods from whole production plot every two days interval.

-Deviation from above schedule will result reduction of yield and too high a rate of un exportable grades.

Great care after harvest

-Prevent the deterioration of the produce after harvest exposure to sun or dry wind.

-It is better to construct shade structure with still or evaporative cooler in the field.

-Facilities may carry out grading oprerations inside a field evaporative coller.

Grading and packing

The produce should be transported to the pack house in the field boxes or trays in which it has been harvested. The labour of grading is reduced if the harvesters arranged the beans in parallel rows in the harvesting containers. Confirmation of beans in Europe is according to Eu, ECE standard.

Class or Grads

- **Of characteristic shape, size, color of the variety not bent.**
- **Young tender string less, with cut large seeds.**
- **Free from disease or insect damage and not wilted.**

Export Packing

Beans are packed for export in wooden of fiberboard cartons which should of attractive appearance and strong enough to ensure the arrival of product at the market in good condition.

Bobby beans are packed to a net weight 4 kg per carton. The pods are arranged in parallel rows in the cartons.

Exportable yield is varies in different verities. In some exporting countries of Africa, such like Kenya, Senegal and Egypt yield per he is from 80-120 Quintals per ha. In Ethiopia condition-attaining capacity is from 50-70 quintals exportable quality.

Cold storage.

The storage divided pre cooling and cooling store. The recommended cool store temperature for beans is 7^{o}C at relative humidity 90-95%. After Packing, the cartons should cooled by forced draught cooling or in an ordinary cold store in ventilated stocks.

Cabbage- Brassicacoleracea capitata

Biennial, with sort-thickened stem surrounded by series of over lapping expanded leaves in whorls, which form a compact head. Head shape may be pointed or round.

Environmental response

***Soil*- Cabbage are tolerant a wide range of soils. The lighter ones are preferred for early production. The soil PH should be maintained between 6.5 and 7.0 help suppresses club root disease.**

***Altitude-* Generally grown successfully at elevation of more than 1000m.**

***Temperatures-* sensitive to temperatures, but some forms and cultivars can with stand temperatures in excess of 30^{o}C**

Head formation is more likely to occur at temperatures lower than 24^{o}C and the optimum range is some areas is in region of 15-20^{o}C.

Land preparation

After the site has been chosen and all Un wanted vegetation should be removed from the area, including trees, bushes and weeds. The land should be deeply ploughed, harrowed, leveled and ridged.

Nursery lay out

The site of the nursery should be chosen with care. It should preferably be on soil, which has not previously carried vegetable crops.

The size of the nursery bed is 1mx5m. The surrounding path should have a width of 40cm. The surface of a raised seedbed should be 10-20 cm higher than surrounding path.

-Two type of beds are used: -

1. *Raised bed:*- is common in the humid places or where is surplus rain fall during growing season.

-On poorly drained soils.

2. *Sunken bed:-* Are used in arid and semi-arid areas, so that the maximum amount of water can be directed to root system. where as the sunken beds can be constructed by drawing soil from the center of the bed and constructing a ridge around the edges of the beds.

Nursery management

seed sowing

The rate of seed sowing should be related to the rate at which seedlings can be transplanted in the field. Seed rate per hectare 500gm/8.33gm/bed/. Before sowing the seed it will better to apply Ridomil 5G to control fungus disease. Spacing between the rows 10 cm and with in rows 3 cm and the depth of sowing 1-2 cm.

Avoid too thick sowing use two person per bed side by side. The number of seedbeds should be 60.

As soon as the seed has been sown, the surface of the seedbed should be mulched with 5 cm deep layer of dry grass straw.

Apply water immediately through the mulch. Remove the mulch as soon as the seedlings are visible above the ground. The seeds will germinate 7-10 days. After removing of mulch spray fungicide chemicals to control damping off /kocide 101/

Young seedling should be watered in early morning and late afternoon. It is also a very important that beds do not dry out any time during the germination process.

***Irrigation* - Hand watering by watering cane followed by surface irrigation after the seedling reach a height of 5 cm frequency of watering will depend on local condition the beds should be examined daily and rewatered as necessary.**

***Fertilizer application* - Before sowing at the rate of 50gm Dap per bed and 30 gm Urea/ bed with first cultivation 7-10 days after removed the mulch.**

-Second cultivation with UREA after 7-10 days of 1st cultivation.

Cultivation and weeding **- In order to get healthy and strong seedling the bed free from weeds and also the soil must be loose to conserve moisture & to increase aeration. Until to transplant 1-2 frequency is enough.**

Transplanting

Cabbage seedlings are normally ready for transplanting when they reach a height of 10-12 cm or when 3-4 true leaves formed. Two weeks prior to transplanting the seedling should be hardened by reducing water. However water should be applied the day before seedlings are lifted to minimize damage to roots. Transplanting should be done preferably in the evening (late afternoon). Seedling should be carefully lifted from the seedbed with fork / hoe-with out damage of the roots. The roots must be protected against drying out roots down in plastic field boxes and cover the box by wet sack.

Spacing:- **Transplanted to rows 60-75 cm a part, plants 45-60 cm a part in the row-no a commercial scale head size can be regulated by adjustment of planting density.**

Ex. Under Tseday farm condition rows 80 cm a part plant 40 cm a part in the row/ double row planting/

Planting:- **The land should be irrigated one day before transplanting to reach optimum soil moisture. Immediately after transplanting irrigate again. Take care not to bend the root of seedlings in planting holes at nursery depth and farm the soil with out damage of roots. Prune the longer roots.**

Replanting:- **After planting due to various reasons some seedling drying out should be replaced by new seedling after five to seven days of planting. These helps to maintain the plant population per hectors the expected number of plant population pre hectare decreases due to various reasons also directly influence on the expected yield.**

Irrigation:- **A constant level of soil water should be maintained through out the growing period. A shortage of water may lead to cracking or splitting of the heads. The**

effective root zone is approximately 60cm. Irrigation frequency will vary according to soil type and weather conditions in the range of 5-6 days under Tseday farm condition.

Fertilizer application:- **The crop responds well to high soil fertility and bulky organic matter. The rate of application will depend on soil analysis, soil type, and pervious management.**

- **The rate of fertilizer on out side condition Dap 250-300 Kg/ha and Urea 76-100 kg/ha (most 1981)**

According to our condition used

- **Dap 200kg and Urea 200 kg.**
- **Dap applied before planting by broad casting.**
- **Urea in splitt application**

- **Half 12-15 days after planting.**
- **Half before head formation.**

Cultivation and weeding:- **Is for the purpose of removing weeds, which will compete with crop of water. Light and nutrients facilitates incorporation into soil of organic matter, fertilizer and conserve moisture.**

First cultivation 10-15 days after planting and second cultivation the sign of head formation with nitrogen fertilizer when the soil at moist condition.

- **It needs 2-3 cultivation though growing period**

Growth period and harvesting

Normally harvested as soon as the plant head should be green, firm and solid. The internal leaves should be yellow or light green with out seed stalk. Root should be trimmed below the basal leaves and loose the leaves removed.

Delay in harvesting there crops usually results in splitting of outer leave which losses the quality of the crop. Early harvest well result in lower weight. Growth period may be 80-110 days depending on cultivars characteristics

Yield **-The estimated average yield from a well-managed field is 30 to 40 tons per hectare.**

Quality- **Head compact, leaves firmly attached, properly trimmed, slight bruising and crack or tears in outer leaves.**

Storage **- Heads may be damaged by sever freezing but storage at temperatures of 0-1^{o}C for periods of 90 or more days is possible.**

Potato:- solanum tuberasum

The crop has alternate leaves, perfect flower up on fertilization-produces berries, which contains tiny seeds.

Environmental response

Soil:- **This crops needs sandy loam and fertile loose soil. When potatoes grown on heavy clay soil result deformed tubers and secondary growth . The soil PH should be maintained between 5-6.8.**

Altitude - **is widely grown on the highlands and mid- altitude areas of the country. Generally grown at elevation of 1700-2800 m.**

Temperatures- **The optimum temperatures for tuberization 15-19^{o}C.**

Temperatures from 20^{o}C- 29^{o}C heads to small size more than 29^{o}C tuberization not formed.

Rainfall- **About 800 mm is adequate for light soil during growing period and sensitive to drought.**

Land preparation

After the site has been chosen and all unwanted vegetation should be removed from the area including trees, bushes, weeds and residual. The land should be deeply ploughed 25-30 cm depth then harrow, leveled and ridged. After ridging the ridge must be shaped.

Seed rate:- **the seed tuber size 4-6 cm diameter /40-50gm/ are preferred for planting, seed rate per hectare 2000 kg. The seed rate depends upen the size of the tuber used for seed.**

Planting

Plant the tuber having 2 or more sprout of length 0.5 cm- 1cm. Preferred at depth of 8-10cm.

- **For ware potato production planted to row 75 cm in the row. A part, plants 30 cm apart in the row.**
- **For seed potato production to rows 60 cm a part, Plants 20 cm a part in the row or to rows 75 cm a part, plant 15 cm a part in the row.**

Plant the tuber with out- pre irrigation is possible but its better to plant the soil at moist condition and after planting irrigate immediately

Care has to be taken during planting the sprout from damage.

Fertilizer- **The rate of application will depend on soil analysis, soil type and pervious management.**

- **Woleta and similar agro-Ecologies 200 kg DAP and 165 kg of UREA per hectare.**

- **It better to apply total amount of DAP in rows while planting and also apply by broad casting after leveling.**
- **Split application of Urea half applied three weeks / Uniform growth starts/ after planting and the rest applied at a medium vegetative growth / before flowering/ with cultivation when the soil at moist condition.**

Cultivation and weeding- **potato is a root crop it needs shallow frequent cultivation to loosen the soil for root developments.**

-2-3 Cultivation enough through the growing period.

The benefits of cultivation: *-*

- **Destruction of weeds, there by conserving moisture and nutrients.**
- **Protects the tuber from greening by covering of adequate soil.**
- **Avoids potato tuber moth.**

Irrigation: **- Potato is a shallow rooted crop it needs frequent irrigation. Sensitive at the early stage 7-10 days frequency depends up on the soil type and weather conditions**

Comparison of potato production by true potato seed and seed tubers

True potato seed:-

- **Seed rate per hectare 100-140gm.**
- **Relatively healthier seedling tuber can be produced as most viruses and nematode are not transmitted through botanical seed (Jones 1982)**
- **Less expensive**
- **Easy to store and transport**
- **Lack of uniformity**
- **Longer growing period**

- **Low yield**

Seed tuber:-

- **Seed rate per hectare 1500-2000kg**
- **The best opportunity to propagate disease**
- **Expensive**
- **Difficult to store and transport**
- **Uniform**
- **Short growing period**
- **High yield**

Harvesting

The tubers are harvested when they attain right maturity which indicates by change the color of the leaves from green to yellow. Change of color can also because by some viruses hence care should be taken not to confuse the disease symptom with stage of maturity. The stem trail on the ground and bend up at the apex

Crop duration is between 90-100 days harvest by careful digging up tuber. It is better to harvest by oxen plough than labour.

Removed the foliage 7-15 days before harvest this leave to harden the skin tuber and facilitates this harvesting. The harvested tuber not to exposed direct sunlight.

The estimated average yield from a well- managed field is 20 to 35 tons per hectare.

storage

Tubers are stored either for seed purposes or ware. Potato not stored for long period of time for table consumption unless you have cold storage.

-For seed Purpose stored for long period under diffused light store.

***Diffused light store:-* the most appropriate for developing countries These storage well ventilated, dry storage which can allow the entrance of light. Under these storage tuber can be store for 6-8 month with minimum loss.**

VARITIES UNDER POTATO PRODUCTION

No.	VARIETIES	YEAR OF RELEASE	GROWING ALITITUDE	MATURITY PERIOD	YIELD QT/HA	
					RESARCH FIELD	FARMER FIELD
1	Chirro/AL-111/	1997/98	---	--	--	--
2	Alemaya 624	1987	1500-2000	90-100	260	200
3	Awash	1991	1700-2800	90-110	254	205
4	Tolcha	1993	1700-2800	110-115	332	285
5	Menagesha	1993	2200-3000	110-130	270	220
6	Wechecha	1997				

V. CEREALE PRODUCTION

2. Wheat:- Triticum aestivum L.

Wheat is one of the important cereals of the world. It is the number one cereals of the temperate region of the world. Which are climatically very suitable for its cultivation. Now a day it is also grown on a large scale in the subtropical & tropical regions of the world.

Wheat is one of the various cereal crops largely grown in the highlands of Ethiopia. It is produced largely in the southeast, Central and north west part of the country.

Nutritive value

The whole grain of wheat contains approximately 70% carbohydrate, 11.5% protein/ varying from 8-15%, 2% fat, 2% fiber, 1.5%ash and 13% water.

Adaptation

Altitudes- **most of the wheat is grown at altitudes between 1800-2800m.**

Rain fall:- **Wheat requires 250-750 mm of annual precipitation.**

Temperatures:- **For the proper development of the wheat plant the best temperature range is 20-23^{o}C . At temperature higher than 25^{o}C in the grain development phase the plant dries up prematurely.**

Soil: - **Wheat can be grown successfully under a wide range of soil conditions, but it is best adapted to fertile, Well- drained silt and clay loam soils. Although it often produces satisfactory yields on clay and sandy loams. It is poorly suited to these and poorly-drained soils. The soil PH ranges between 6 -7.5**

Cultivation Cropping systems

- **Wheat can be grown in rotation with one or two crops per year,**

  Example - Maize- potato-wheat

  -Potato-wheat etc.

Land preparation

The site has been chosen and all unwanted vegetation should be removed from the area including trees, bushes, weeds and residual. Recent studies have clearly shown that when adequate attention is given to the control of perennial weeds. Plowing the land 25-30 cm depth, second plowing if it is necessary. Harrowing and leveling.

sowing

- **The optimum time for sowing is from June 15- July 15. By rain feed. The seed rate per hectare is 150kg-175kg by broad casting and sowing in rows seed rate per hectare 100 kg.**
- **Sowing up to 5-6 cm deep does not have any adverse effect on the emergence percentage. Sowing beyond this depth however results in a marked reduction in emergence percentage.**
- **The seed cover by using harrowing & spring cultivator care has to taken the depth.**

Fertilize:- **With modern high yielding cultivars there is almost a response to fertilizer.**

- **On red soil DAP applied 125 kg per hectare and 75 kg per hectare of UREA.**
- **On black soil DAP applied 100 kg per hectare and 100 kg per hectare of Urea.**

Method application **:- The whole amount of DAP and half of the amount of UREA applied at seed sowing by broad costing**

The rest amount of UREA applied at tillering by broad casting when the soil at wet condition.

Weed control:- **The only suitable method of controlling weeds by using chemicals. The non -graminaceous annual weeds can be effectively controlled by spray of 2-4-D1 kg/ha five weeks after sowing. To control grass weeds 25-30 days after sowing or wheat produce 4-5 leafs spray puma super 75% 1lt/ha. Weed reduces wheat yields up to 36%.**

Harvesting and threshing

The wheat crop usually ripens about 120-150 days. The leaves, stalks and spikes begin to lose their green color and become golden yellow. When completely air-dry the moisture of the grain average about 10-12%.

Harvester may do harvesting by hand with sickles, or. Combine harvester Where the harvest period is dry, the harvesting and threshing of standing crop by combine harvester is practical where harvesting and threshing are done manually winnowing must be done to separate the grain from the chaff.

- **The estimated average yield from a well- managed field is 30 to 40 Qt/ha.**

Storage

Drying to 10% moisture content and thorough cleaning of the grain are the first requirements for safe storage of wheat in the tropics. Protection from storage insects pests is particularly important. For this storage structures and grain contains including

the bags should be well treated with insecticides Fumigation of the grain soon after storing is equally important.

VARITIES UNDER BREAD WHEAT PRODUCTION

No	VARIETY	PLANT HEIGHT /CM/	SEED COLOUR	DAYS TO MATURITY	ALITITUDE	YEAR OF RELEASE	YIELD (QT/HA)	
							RESARCH FIELD	FARMER FIELD
1	SIMBA(HAR-2536)	85-100	White	100-160		1999/00	40-65	20-55
2	Wetera (HAR-1920)	75-85	White	130-140	2000-2500	1999/00	35-50	15-28
3	Hawi (HAR-2501)	80-100	White	105-128	1600-2400	1999/00	20-45	22-41
4	Madda walabu (HAR-1480	95	White	136	2200-2600	1999/00	42.71	31.35
5	Sofumar (HAR-1889	97	Brown to red	134	2200-2600	1999/00	37.95	
6	Shina (HAR-1868)					1998/99		
7	Katar (HAR-1899)					1998/99		
8	Tura (HAR-1775)					1998/99		
9	K 6295-4A	108	Red	131	1800-2400	1980	35-55	30-40
10	Dereselgne					1974		
11	ET- 13 A2	118	White	138	1850-2900	1981	40-60	30-40
12	Dashen	95	White	143	2200-2900	1984	45-65	30-40
13	Pavon 76	95	White	113		1982	30-40	20-30
14	HAR 416					1987		
15	HAR 1685	114	White	131	1850-2800	1995	45-60	30-45
16	HAR 1705	104	White	135	1850-2800	1994	45-55	30-40
17	HAR 604	90	White	135	2200-2700	1995	45-65	
18	Tuse (HAR 1407)		White	127	2000-2500	1997		
19	Abola (HAR 1522)		White	130	2000-2700	1997		
20	K 6290 bulk	93	red	126	1850-2150	1977	40-60	30-40
21	Wabe (HAR 710)	104	White	130	1850-2800	1995	45-55	25-35

VI. Seed production Technology

2. Maize seed production

Background

Maize (Zea Mays L) is among the most widely cultivated crops of the world. It is a food crop for many million people, source of animal feed and an important input for many industries. The discovery of hybrid vigor in maize is probable the greatest achievement of agriculture. This century purposeful breeding for hybrids was considered to began in the 1930 S in USA. In Africa, South Africans come to realize the value of maize hybrids in the years 1939-1945 . In Ethiopia the first top cross hybrid, BH 140 was released in 1988. Since then other 3 hydride namely BH- 660, BH 530 and BH-540 were developed by the national maize research team.

BH- 660 is the most popular local hybrid among the released so far. Prior to the release of these four local hybrids, ESE used to import F1 seeds of different hybrids from East African neighboring countries to distribute to the users later on the import was shifted to the parental seeds to produce the hybrids locally. In the mean time pioneer Hi-bred seed Inc- started producing and marketing its own hybrids.

Cultivars

There are two kinds of improved maize cultivars.

a. Open pollinated varieties

Cultivars of this group are characterized by their broad genetic make up containing several inbred lines, commonly known composites and synthetics are open pollinated maize verities. Composites are made by random pollination of different inbred lines while synthetics contain limited number of parents, which are allowed to pollinate to the time of their development. Open pollinated verities are used for grain production less extensively. Their use in breeding rather out might theirs as seeds for farmers.

B- ***Hybrid***

Hybrids are those cultivars that utilize the first generation crosses among inbred lines. The inbreed lines are selected to meet the desired characteristics by the breeder. There are several types of hybrid maize cultivars and the most commonly used are the following:

- **f. Single cross:- The first generation cross resulting from the controlled crossing of two certified inbred lines. eg BH- 140, SC-140**
- **g. Double cross:- The first generation resulting from the controlled crossing of two certified single crosses eg. H-625.**
- **h. Three way cross:- the first generation resulting from the controlled crossing of a certified single cross & certified inbreed line eg. BH- 660.**
- **i. Top cross:- The first generation resulting from the controlled crossing of a certified inbred line and a certified open pollinated variety, or the first generation resulting from the controlled crossing of a certified single cross and a certified open- pollinated variety.**
- **j. Varietal cross:- the first generation resulting from the controlled crossing of two certified open -pollinated varieties. Top crosses and varietal crosses are used less extensively.**

METHODS OF SEED PRODUCTION

site selection

Seed production of maize needs a lot of follow up and due inspections and hence the production plots should be accessible to road transport. The plots should be also be safe from wild animals attack. The previous cropping pattern of the plots ,should be taken into consideration and hence, as much as possible the plots should not be planted maize cultivars in the previous cropping season.

Isolation

The selected plot should be isolated from any maize production farms or plots by at least 400 meters in any direction. Hybrid seeds need more isolation distance than composites. Careful time isolation can also be used when the area of seed multiplication is not large enough.

Land preparation

Maize seed needs well prepare, drained and aerated seedbed. Heavy and poorly drained soils are not possible proper plowing dicing and leveling is quite necessary. If it becomes necessary to plant the seeds in already prepared furrows they should be parallel and clear so as not to confuse the workers on time of detasseling and inspection.

1.3.4 Planting

The plot should be well planned as to how the seed and pollen parents are arranged prior to the actual planting.

In maize seed production the following should be considered:-

5. **Female to male ratio arrangement**
   Could be 2:1, 4:2, 6:2, 3:1, 10:4 & 12:7 depending on varieties.
6. **Degree-days / heat unit/ - It is the number of degrees F. above an established minimum growing temperatures. For maize it could be 50^{o}F or 10^{o}C**
7. **Spacing**

a- Male: - in order to get maximum pollen, it is advisable to have more male plats per unit area. So planting of 19cm-22cm b/n plants and 75 cm b/n rows is recommendable.

b- Female: - Planting of female plants with spacing of 22-24 cm b/n plants and 75 cm b/n rows is advisable.

4. Seed rate: - The seed rate depends on:

Seed size

Percentage of germination

Planning of plant population density

There fore, depending on the above factor it is desirable to sow 15-20% more seeds than calculated to over come the problems.

1.3.5 *Irrigation and drainage*

Both soil irrigation and drainage conditions are detrimental in maize seed production plots very dry condition during the flowering time may limit the proper stage and usually result in problem of flower synchrony b/n the pollen and seed parents. Excessive moisture & flooding on the other hand can lender the seedling emergence. The problem would be further aggravated if the flooding is associated with poor leveling for the rows of male and female furrow lines and seeds may be mixed up prior to germination.

Table-1 Water requirement of maize at different growth stages.

DEVELOPMENT STAGE		WATER REQUIRREMENT IN % OF THE TOTAL AMOUNT
FROM	TO	
Planting	7-8 leaf stage	11-12
7-8 leaf stage	Tasseling	19-20

Tasseling	**Silking**	**22-23**
Silking	**End of pollination**	**22-30**
End of pollination	**harvesting**	**15-20**

Source:- FAO of the UN- Technical guidelines for maize seed technology 1982.

According to the above table maize growers have to take particular care to assure that the field is well supplied with water during the flowering period. The most critical period for maize begins 10 days before tasseling and ends just after fertilization.

1.3.6 Fertilization

As it is needed to get a maximum quality and quantity of seed, seed production plots should be well fertilized. For normal textured soil, it is recommended to plow under the fertilizers for the dressing generally phosphoric fertilizer.

Nitrogenous fertilizer is applied in three split application in the ration of 1:2:1 with cultivation.

Recommendations:-

DAP= 2 Q/ha

UREA= 2 Q/ha

Nitrogenous fertilizers are sometimes used to enhance the vegetative growth and vigor of very weak pollen parents to establish themselves. However, care should be taken to avoid excessive vegetative growth that could rather result in flowering dalliance and lodging .

1.3.7 *WEEDING AND CULTIVATION*

After maize seed has been planted and has emerged changes occur on the soil surface. These usually involve crust formation and small or large cracks. Parallel to

these weeds may establish and may be aggressive. Crust formation is common on irrigated fields. Cultivation is there for necessary to break the crust and control the weeds. Mechanical cultivators are normally used but cultivation by hand hoeing is also possible when it is not available.

1.3.8 INSPECTION AND ROUGING

It is one of the very important operations after germination of the seeds. The main importance of inspection is:-

- **To avoid off type timely.**
- **To under take corrective measure of any defect.**
- **To under stand the status of the crop.**
- **to avoid suckers**

1.3.9 *Detasseling*

Detasseling is one of the major operations as far as maize seed quality is concerned. It is the removal of the tassel from the seed patent (female plant) before shedding of the pollen. Every plot should be assessed every day until detasseling is completed.

1.3.10 *Harvesting*

Maize seed can be harvested as soon as physiological maturity is achieved. The grains contain 30-40% of moisture, which can be reduced by artificial maize dryers 12-13 percent. Physiological maturity in maize can be determined by splitting the kernels longitudinally and look for a black tough layer. Maize Kernals have completed their growth cycle when a tough black layer has formed above the base which seals off the embryo /germ/ and starchy endosperm.

Cobs of maize can be picked by hand or machine .The cob sorting process can be done either at the farm or at the site of the drier machine. Cobs are sorted to discard

all off type, moldy, damaged or doubtful ears. Only the sorted cobs are shelled with appropriate maize Sheller. Shelling is usually done when the seed contains 12-14% moisture.

Excessive drying makes the seeds cracked when shelled while premature shelling will not result in good recovery. Breakage and damage of the grain during shelling should be less than 5%

2. ONION

Onion is a biennial crop usually grown as an annual for bulb, but it takes two seasons for seed production. During the first season bulbs are formed, stalks and seeds are developed in the second season. It passes from the vegetative phase to reproductive phase for flower stalk development and seed set. The development of seed stalk is influenced by storage conditions of the mother bulbs and temperature during the growing period.

Onion cultivars also vary in their susceptibility to flower stalk development, depending of climatic conditions and the potential of the cultivars. Onion varieties are generally maintained in a more complicated manner, as they are hardly collections or genetically similar plants

a. Growth requirement

Temperatures greatly influence the flowering activity of onion. Cool condition with an adequate moisture supply are most suitable for early growth of onion followed by worm, drier conditions for maturation Low temperature (9 to 17^{o}C) is required for flower stalk

development In the upper awash and the lake region, during September to February with temperature of 26°C to 28°C during the day and 11-18°C night supplemented with low humidity are good conditions for flower stalk emergency and satisfactory seed set for easy bolting varieties. Drier and low humid condition with ample sun shine and the absence of strong wind are suitable for seed maturity, ripening and harvesting. Excessive rainfall and cooler condition during flowering leads to diseases and poor fruit set and ripening and makes the harvesting of seed difficult. It also delay seed maturity and result in poor quality seed. A fertile loam soil with PH of 6.0 to 7.0 is suitable for higher yield.

b. ***Pollination***

Onion is highly cross pollinated (Tindall 1987). The intensity various between 30 to 94% depending on availability of pollination (voss 1979).The pollen usually sheds before the female part is receptive (protandry). This makes self-pollination impossible without bagging or caging the flowers. Various insects are involved to carry pollen between floorer the availability of suitable pollinators such as bees, which feed on nectar and transfer pollen with in an umbel and between different plants is very important. Honeybee hives could be placed in the farm to effect seed setting.

C. ***Method of production***

The two common methods of seed production of onion are described below.

Bulb to seed Method :- **The method has the advantage of maintaining seed quality. It allows roughing of color, misshapen, splits rotten and sprout bulbs several stalks are formed per bulb.**

seed to seed method:- **This method misses the above advantages but it could be used alternate (every other year) with the other method to speed up the production practice without affecting the varietal quality. It takes about 7 to 8 month to produce seeds.**

Under Melkasa and other similar climatic condition, in the bulb to seed method, a bulb crop will be grown from February to June and typical mother bulbs will be selected and stored for one to two months the bulbs will be planted in he cooler period (early September to October) which is conductive for flower stalk development and subsequent seed set. large and well developed umbels are developed which are favorable for high quality seed production The bulb to seed method which is the most common one follows a similar practices to bulb production

d. *Cultural practices*

Above 3.5 to 4.0 kg of about 92 to 95% germinating seed should be raised on a seed bed and transplanted to the field after 45 days at 40x20x5-7 cm spacing, (i.e. 40cm bed including furrow 20cm between rows on the bed and 5-7 cm between plants). The bulbs will be ready for harvest after four and a half month after transplanting large or medium mother bulbs (5to 6cm) uniform, typical size and color, free from diseases, insects and other injures should be selected and stored for about two months and planted. the size of the bulb determine the vigor of vegetative phase and number of reproductive shoots which is directly related to the number of seed stalks and seed yield. The number of flower stalks or bulbs under Melkasa condition vary from 1 to 15 and a terminal number of 50 to 200 flower produced per umbel (flower head) depending on the number of shoot axis.

The optimum mother bulb planting time is between August& October. August, September and October bulb planting can give high number of flower stalks and seed yield due to worm temperature, low rainfall and low disease pressure during flowering, fruit set and harvesting. Double row plantings of 50x30x20 cm with 125,000 bulb per hectar (80 to 90qha -1) should be used for Melkasa and similar climatic condition.

e. Isolation

All the flowers in one umbel do not opened mature at the same time. In addition, the male and female parts of the flowers do not mature at the time; therefore, cross-pollination is very common (30 to 94 %).

In order to get pure seed, varieties should be separated by a distance of at least 600 m to 800 m as a barrier to reduce the chances of carrying pollen of one variety to the other. If there are many varieties, similar to hot pepper, varieties must be covered with insect proof cages to avoid seed contamination. In a commercial production, it would be advisable to concentrate on one or two varieties;

f. Harvesting and processing

Since all the umbel in a plant do not mature at the same time, it would be desirable to harvest the field 3 to 4 times before shattering occurs. The seed is ready for harvest when the first formed seed in the head begins to shatter or expose the black seed. The heads are cut by hand using shear with part of the stem attached and left to dry on canvas in ventilated sheds or in the sun. Though much of the seed fall from the capsule during drying, the seed could be fully separated by rubbing over canvas or by light pounding with piston and mortar for about 10 to 15 minutes Trashes and poorly developed seeds can be removed or cleaned by immersing seed in clean water for about 15 minutes. Then after seeds should be immediately transferred to canvas or trays and dried in sun or under shade for 3 to 5 days.

g. Seed Yield

A great variation was found in seed yield among the promising open pollinated cultivars. The cultivars, Adama Red, produces the highest seed yield or about 12qt ha -1 . The cultivars pusa Red and N-53 also shows a similar trend. Red Creole does not set seed using the standard storage practice. Storage of this variety under cool condition in the range of 5 to 10^{o}C for six weeks is effective in flower stalk development and seed set. Such practice improves seed yield from 0 to 6 qha-1 the over all onion seed germination varies between 90 and 95% with seed weight of about 3.5 to 4.0 g.

h. Seed storage

Onion seed deteriorates faster than any other vegetable seed. It deteriorates quicker under worm conditions (room temperature) such as at Ziway climatic condition. Optimum

care must be taken to dry the seed properly and protect it from excessive heat under conventional storage.

For temporary storage the seed moisture content should be reduced to about 7 to 9% once the seed dries, it must be sealed in a moist-proof container otherwise it will regain moisture and deteriorates rapidly. Under local conditions it should be better stored in paper or cloth bag under dry an ventilated conditions for at least one year.

3. TOMATOES

Different types of tomato varieties are produced in the country. These include the tall set (Indeterminate), erect and bushy types with fairly thin or thick stem, and the short set (determinate) with strong or weak stem. The determinate types produce more flowers with in a given length of vine within short period than the indeterminate ones, which produce fruits and higher yield for long time. Tomato seed production requires a special attention, because seeds are wet at time of harvest. The seed production could be either a commercial operation or an additional production during industrial processing of tomato.

A. *Cultural practices*

The field culture of tomatoes for seed production is identical whether they are grown for fresh market or processing. It is grown under irrigation in the dry season. Rain fed production is not preferred due to heavy disease incidence and poor seed set. About 300-400 g of seed is raised on nursery bed and good once be transplanted to the field at 3 to 4 true leaf stages, i,e,. 28 to 35 days after emergence at spacing of 100 cm between rows and 30 cm between plants.

Tomatoes should be grown on the same field ones every 2 to3 Years. Related crops such as potatoes and hot pepper should not be used in the years rotation to avoid

diseases build up. Frequent watering, weeding, frequent cultivation, disease control and pest incidence are essential for good seed yield.

Diseases affecting tomatoes occur in large number at one time. For common leaf disease randomly MZ 63% (3.5 kg/ha -1) or Mancozeb (3.5 kg/ha-1) and for insect as African boll worm karate or cypermethrin (100 g a.i.ha-1) can be applied.

Staking is important for tall set varieties to facilitate management practices and to produce high quality seed, whereas short set cultivars could be grown with out support. Depending on cultivars high quality fruits could be harvested from 90 to 120 days after transplanting for about 4 to 5 times for short set and about 6 to 7 times for tall set cultivars.

B. Rouging and isolation

Careful removing of off type plants before flowering is important for seed production. Plants should be thoroughly examined for vegetative growth and fruit characteristics. Plant affected by diseases must be eradicated immediately. Though tomatoes are self pollinated, Therefore it would be important to isolate different varieties so be able to prevent varietal mixes and avoid the extent of cross pollination that may occur, especially where pollinators such as bees are present.

C. Harvesting processing and drying

Good fruits selected from healthy and true to typical plants should be collected for seed extraction. The fruits must be free from disease, any physical damage and must be typical to the variety in color, size, shape the etc. The fruit should be red ripen as seed extract from unripe green fruits will have low germination percentages and the

seed will be not easily separated from the pulp, rejected fruits should not be used for seed.

Since tomato seeds are embodied in a jelly like substance their extraction requires special care Different extraction methods can be used depending on availability of facility technology and the amount of seed to be extracted.

Under commercial seed production, extraction will be economical if it combines fruit processing operation. The seed could be separated from the pulp at the different processing steps; however, seeds must not be exposed to heat when boiling the fruit, since heat has significant effect on seed quality. Under small- scale farmers, i.e. when seed is obtained without making use of the juice, fruits can either be crushed or squeezed or the fruits are cut with a knife and the seed will be separated from the pulp by fermentation processes. In this processes, the mass of the fruits are squeezed and crushed in a container such as bucket. It is then stirred at least 3 times daily to maintain uniformity of fermentation in the container and to avoid discoloration of the seed as well as prevent fungus growth . The process of fermentation could be for two days (36to 48 hours) under room temperature (24 to 27^{o}C). If it is cooler, the process can continue for one more day, i.e, for a total of 72 hours, but it has to be continuously monitored for unwanted seed germination, which eventually affect seed quality. Germination is about completed. The seed is then washed 2 to 3 times with tap water until it is free from pulps. During the process, the seed will sink to the bottom and clean seed will be collected after the pulp is drained off. Then the seed should be spread on suitable tray or mat or nylon net or cloth bags and dried in the sun or under shade for about two days to bring down the moisture content between 7 and 9%. The seed should be put in Plastic bags. So that it will not absorb moisture from the air. The fermentation processes is effective in controlling seed borne disease such as bacterial canker.

Fruit can also be squeezed in a container such as tray and directly dried with out fermentation. However such practice will not control seed borne diseases.

D. Seed yield

Temperature, rainfall, cultural practices and characteristics of cultivars which include number of fruits per plant and number of seeds per fruit affect seed yield of tomatoes, small limited varieties produce about 8 to 10 fruits, while large fruited produce 3 to 4 fruits per cluster. This makes difference in the amount of seed yield In addition, practices like shaking or disturbing the plant when the anther has dehisced helps pollen transfer to the stigma which will eventually increases seed set. Besides the yield of tomato seed also vary considerably with varieties. The ratio of fruit to seed yield could vary from about 200 to 300 to a and even less for some. Seed yield can be between 90 tp 125 kg/ha -1.The 1000 seed weigh is about 2.3 to 2.7 g, with 92 to 97 germination percent and a germination rate of about 6 to 8 days.

E. Seed storage

Under local conditions, the dried seed can be stored in plastic or cloth bags under cooler conduction or hanged in shade in open air until the new planting season. Under commercial production, tomato seeds could be better stored in a sealed container. The seed can retain full viability for about 3 to 4 years when stored at room temperature at low moisture content of about 7 to 9% and relative humidity up to 70 percent.

VII - CROP PROTECTION

I.SOCIAL ASPECTS OF CROP PROTECTION

Crop protection has a social aspect. An individual can not take effective measures against pests which range over a large territory. Here, it is wrath considering joint action even with neibours of the surrounding.

Crop protection can not consist in only one specific measure, but requires a suitable combination of methods depending on crop, climate and region. A knowledge of these factors must play an important role in the way all individuals participating in the production practices should communicate and decide jointly to safe guard their crops.

i. CROP INSPECTION

A regular inspection of crops is very essential, not only to examine status of pest but also to assess plant development. Monitoring pest levels in this way is often referred to as, scouting.

Scouting:- **It is particularly, important in areas where the severity of pest attack may vary considerably from one year to another or where the period of infestation varies from year to year.**

On most crops sampling of eggs or early larval instars is recommended where pest populations can build-up rapidly, and action has to be taken before serious damage occurs. In order to reach such action the following should be considered.

1. ***Information***:- **since it is a tools for making decisions, different in formations, should be obtained.(Back cropping pattern, the surrounding condition, planting date, feed back on status of controlling etc)**
2. ***Programming:***- **there has to be a program for inspection of a particular crop. Otherwise if it is now and then, the inspection given a chance for a sudden attack of pests.**
3. ***Weather forecast:***- **One who involve in this activities could able to identify the weather condition that favors pest development.**
4. ***symptmatological knowledge:***- **there should be a good practical knowledge on symptoms identification of different pest attack.**
5. ***Creditability:***- **people involved on these activities should be relevant. Since the activities are very sensitive there should not be any gap.(on information, Operation, etc)**
6. ***Designing of good sampling method:***- **it is impractical to assess each plants in a field and hence, estimating the population by sample mean is very important here. The different approach of sampling is attached on annex I.**
7. ***There should be a clear:-*** **understanding on the deferent level of infestation.**

The different levels are:-

1. ***Equilibrium position*: The average population density of a pest over along period of time, unaffected by a temporary intervention of pest control.**

2. ***Economic injury level (EIL):-*****The population that produces incremental damage equal to the cost of preventive damage i.e the lowest pest population which will cause economic damage.**

3. ***Economic threshold level (ET):-*****Is the population density at which control measures should be determined to prevent an increasing pest population from reaching the EIL.**

III. DESEASES

Plant disease can be grouped into two categories i.e infections (Biotic land non infections/a biotic).

A. Infections (biotic)

These diseases are transmissible from diseased plant to healthy plants and they are caused by causative agents The agents are bacteria, fungi, virus and others.

B. Non infectious (a biotic)

These diseases are not transmissible from diseased plants to healthy plants. The following disease are some of the examples which are caused by a biotic agents:-

- **The two extremes of watering /under and over irrigation/**
- **Too low or too high amount of fertilization.**
- **In appropriate method of application of fertilizer.**
- **Improper cultural practices**
- **Too low or too high a temperature.**
- **Nutrient deficiencies**
- **Pesticide toxicity.**
- **Others**

When the word disease come in mind people gives due emphasis for the biotic but less for a biotic one.

However the damage caused by a biotic agent is not less than that caused by biotic agent and even some times it could be much more on the other hand. If we observe the controlling mechanism a biotic one is much more easy doesn't cost too much and the controlling method is in the hands of every ones of us.

1. Disease development

For a biotic disease to be occurred there has to be:

1. **Susceptible host (especially the age of the plant)**
2. **Favorable environment for the pathogens.**
3. **Virulent pathogens.**

2. Disease cycle:-

The primary events in disease cycle are inoculation, Penetration establishment of infection, colonization /growth and reproduction of the pathogens/ dissemination and survival of the pathogen in the absence of the host. These events are described as follows.

a*) Inoculation*:- is the coming in contact of pathogen with plant. The part of the pathogen that comes in contact with the plant could be spores, mycelium, sclerotic, and others. The source of the pathogen could be from plant residues, plant debris, soils , seeds, tubers, weeds, volunteer plants and others. Pathogen (s) are carried to their hosts by wind, water and insects. Some pathogens in the soil are attracted to the hosts by sugar and amino acids secreted out of the roots.

b) *Penetration:-* After coming in contact, the pathogen has to enter into the plant. In the case of fungi the entrance could be by direct penetration of the host surface, through natural openings, or through wounds, made by insect and animals while feeding bacterial enters mostly through wounds and less frequently through natural. Openings and never directly. Viruses enter through wounds made by vectors; parasitic higher plants enter by direct penetration Nematodes enter mostly by direct penetration.

C) *Infection:-* the pathogen establish contact with the host plant and obtain nutrients from it. Visible symptoms may appear on the infected plant.

d) *Growth and reproduction (colonization):* - The pathogens grow and reproduces and colonize more parts of the plant. Fungi colonize their hosts by producing more bacteria and parasitic higher plants produce more seeds so that they can colonize spores. Bacterial colonize their hosts by producing more bacteria and parasitic higher plants produce more seeds so that they can colonize more plants. Viruses multiply in living cells of their hosts Female nematodes lay eggs and increase their numbers depending on climatic conditions.

e) *Dissemination:-* Spread of pathogen (S) from one area to another area or from one plant to another plant could happen in many ways including spread by wind, water, insects, human and animals.

1. SPREAD BY WIND

Fungal spores are carried by wind from one area to another area. Insects carrying pathogen may be favored the wind to fly long distances spread to pathogens (S) by contact is assisted by wind when plants rub each other.

2. SPREAD BY WATER

Some pathogens that survive in the soil are disseminated by rain or through irrigation water can also wash down pathogens from plant surfaces or splash them in all directions plant pathogens that are present in the air are washed down ward where some of them may land on susceptible plants.

3. SPREAD BY INSECTS

Insects transmit pathogens during feeding. Some viruses are carried from diseased plants to healthy plants by aphids and by other insects. Insects can carry pathogens externally from plant to and deposit them on the surface or in the wounds they make on the plant during feeding. In case of viral diseases on vegetables and on other crops, their spread is vector dependent

4. SPREAD BY HUMANS

Humans help dissemination of pathogens through tools contaminated when used on diseased plants and then carried to healthy plants Humans also disseminate pathogens by transporting contaminated soil on their feed or equipment, and on infected transplants, seed, nursery stock and on contaminated containers Human also help spread through import of food or planting material that may carry pathogens.

5. SPREAD BY ANIMALS

Animals spread pathogens through feeding disused plants and then to healthy plants. Pathogens can adhere on to the feet or the body of the animals from diseased fields to healthy crop fields.

f*) Survival:-* How pathogens survive when their hosts are not growing in the field Depending on the type of crop and the type of pathogen under consideration pathogens survive in infected, tissues, on fallen infected leaves or fruits, in the soil,

in or an seeds and other propagative organs, such as tubers, on volunteer plants and others.

IV. INTEGRATED PEST MANAGEMENT (IPM)

In agricultural systems particularly, commercial producers has to use a series of direct and in direct measures to safe guard their crops from the ravages of enemies. In this sense integrated pest management (IPM) has long been an integral component of good farming practices and hence, the details of which is as follows.

1. Components of IPM

1.1 Agro Technical Methods

Refers to the modification of management practices that are used to make the environment less favorable to pest(S). These includes:-

Optimal growth condition:- A healthy plant growing vigorously has good natural tolerance to pests and it can give more yield. If a plant is under stress due to water shortage unfavorable temperature, or other factors its growth will be poor and it will be liable to pest attack easily.

Time of sowing:- by sowing early (or sometimes late) it may be possible to avoid the egg lying period of a pest or else the susceptible stage in plant growth may have passed by the time the insect numbers have reached pest populations planting the same crop at the same time over wider area may help to reduce build up of pest populations, Successive plantings may help increase in pest population because of the availability of feed continuously.

-Elimination of secondary hosts:- Most pests are polyphagus and they live on other plants in addition to the crop. In many cases bests build up their numbers on wild hosts

and then invade the crop. Hence elimination of alternate hosts helps to reduce pest population.

- **Trap crops:- These crops can be planted at the edge of a field or else inter planted . If there is need to spray pesticide it is possible to apply it on to the trap crop where the pest is found.**
- **Sanitation**
- **Destruction of damaged or diseased plants**
- **Destruction of crop debris, fallen leaves, branches, dead trunks, weeds, fallen fruits, etc. Some pests will continue to develop in the fallen plant part.**

1.2 *MECHANICAL AND PHYSICAL METHODS: -*

Used to destroy pests or make the environment less favorable for the pests to live in.

Mechanical - Hand destruction, exclusion by barriers and screens .

physical method- The use of temperature (high or low) sound.

1.3 *HOST PLANT RESISTANCE:-*

Manipulation of the genetic make up of host plant so that it is resistant to pest attack.

1.4 *BIOLOGICAL METHODS*:-

This is the deliberate introduction of predators, parasites, and or pathogens into the pest/ crop agro ecosystem, and is designed to reduce the pest population to level at which damage is not serious.

1.5 *GENETIC METHODS*- The sterile- male technique is included here. Mass rearing and release of sterile males of the pest insect. The sterile males are released to compete with the natural population of males in mating with the females.

1.6 REGULATORY METHODS:-

Quarantine- is legal enforced procedure through which plant pests are intercepted at points of entry into geographical and political subdivisions.

1.7 CHEMICAL METHODS:-

Attractants, repellents, sterilants, growth in hibitors and pesticides are include. However, pesticides are used very often in most pest control activities. The use of pesticides should be considered as the last option in pest management programs.

Advantages of pesticides for pest management

- **The only practical control measure for some pests.**
- **Rapid in preventing economic damage on crops**
- **wide range of properties, uses and methods of application to pest situation (fumigant, contact…….)**
- **Benefit / cost ratios are generally favorable**

Limitations of pesticides for pest management.

- **Resurgences, outbreaks of secondary pests.**
- **Adverse effects on non-target species- Natural enemies, fish, honeybees and other pollinators may be affected adversely.**
- **Hazards of pesticide residues and direct hazard from pesticide use.**

These are hazard from chemical residue in food and other products, and the hazard on human directly as a result of using pesticides.

Whenever the need raises for the application of pesticides, any pest management has to select a pesticide on the basis of its overall safety to humans, animals non- target organisms and its effectiveness against target species. It is also important to restrict highly toxic pesticides from pest management program.

V. ACHIEVEMENTS OF BEST RESULTS FROM CHEMICAL APPLICATION

- **The re commanded pesticide at the right amount should be reached to the target pest.**
- **Pesticides should be applied safely (safe to the crop sprayer, and environment)**

- **Pesticides should be applied economically**

Causes of poor results of pesticide after application

a*) Application on in correct dosage*

i) If pesticide is applied at too high dosage

- **costs of pesticide and man power will be too much**
- **Crops will be damaged due to phytotoxic effect**
- **Speed up resistance development**
- **Causes excessive chemical pollution**
  - **increases residual effect in soil and crop**
  - **increases environmental contamination and human health risk**

ii) If pesticide is applied at too low dosage:-

- **The pest will not be controlled as a result**
- **There will be economic loss due to pest damage**
- **Require re- spraying there by increase production costs**
- **Speed up resistance**

b) *Use of sprayers which are contaminated or in bad working condition*

i) Contaminated sprayers damage crops

ii) Bad working condition

Under / lower distribution:-

- **Damage crop**
- **Poor result**

Leaking sprayers:-

- **Damage crop**
- **Contaminate operators**

There fore, accurate matching of chemicals, and spray technique is very important to under take, Economical, effective and safe control operations.

VI. ***SAFE USE AND HANDLING OF CHEMICALS***

In any pest management program pesticide should be considered as the last option how ever for the management of some pest pesticide remain the only immediate weapons for controlling of pests since pesticide is toxic to humans plant, animals and to the environment, appropriate safety is required in handling and using them.

General instruction before chemicals application

1. **know the pest and how much damage is really being done.**
2. **Use pesticide only when needed**
3. **Seek advice on the proper method of control.**
4. **Use only the recommended pesticide for the problem. If several pesticide is recommended choose the least toxic to mammal and if possible the least persistent.**
5. **Read the label, including the small print.**
6. **Make sure the appropriate protective device is available and is used and that all concerned with application also understand the recommendations and are fully trained in how to apply pesticide.**
7. **Check that pesticide is in a dry and safe place. Avoid in haling pesticide dust or mist.**
8. **Check application equipment for leaks, calibrate with water and ensure that it is in proper working conditions.**

Instructions when mixing and during applications

- **Don't allow children to apply pesticide.**
- **Wear appropriate protective clothing if it is contaminated, remove and replace them.**
- **Always mix and fill out doors.**
- **Never work alone while handling most toxic pesticide.**
- **Open pesticide containers with extreme care.**

- **Avoid contamination of the skin, especially eyes and mouth.**
- **Never at drink or smoke when mixing or applying pesticide.**
- **Always plenty of water should be available for washing.**
- **Make sure that pesticide is mixed in the correct quantities.**
- **Never put your finger in your ears, eyes, mouth or nose.**
- **Always wash immediately after application.**
- **Start spraying near the down wind edge of field and proceed up wind so that operators into unsprayed areas**
- **Never blow out clogged nozzles or hoses with your mouth.**
- **Never leave pesticide unattended in the field.**

Safety after use

- **All treated plots should be clearly noticed:**
  - **-The type of chemical treated**
  - **-Dates of treatment**
  - **-The date of re- entry**
- **Return un used pesticide to the store**
- **Safely dispose all empty containers. It is absolutely impossible to clean out a container sufficiently well to make it safe for use for storage of food water or as a cooking utensil.**

- **Never leave pesticide in application equipment. Clean equipment and keep it in a safe place.**
- **Remove and clean protective clothing.**
- **Wash well and put on clean clothing.**
- **Keep a record of the use of pesticide.**

VII.*SOME IMPORTANT PEST ON MAJOR*

Yields of most horticultural crops highly influenced by pests. The discussion of such major pests is as follows.

i. Onion (Allium cepa)

a. ***Damping off:*- In the nursery seedling is attacked by this disease**

causal organism:- Phythium Spp.

Remedies:- **formation of proper seed bed**

-Controlled irrigation practices

-Seed dressing with appropriate chemicals

b. ***Purple blotch***

Causal organisms: Alternaria porri

Favorable condition wet and cloudy weather condition.

symptoms.

Whitish sunken spots appear on the leaves.

The spots in large, becomes donated and girdle the leaf or the stem

The sunken lesions becomes purple in color

The leaves turn to yellow and fall down

Semi-watery rot develops at the neck. Tissues of a diseased bulb become dry and papery.

Remedies

- **Avoid too much moisture**
- **There should be proper crop rotation**
- **Previous crop residue should be avoided from planting fields**
- **A boarder effect should be avoided**
- **There should be a proper sanitation**
- **The vigouresity of the crop should be maintained**
- **There should be regular inspection**
- **There should be a good weather fore cast before planting.**

- **Avoid dense population of plants**
- **Spraying of recommended fungicide as the last option**

C.Downy mildew

Causal organism; pernospora distracter

Symptoms

- **Necrotic lesion occurs at the leaf tips.**
- **Affected leaves gradually become pare green and later yellow and diseased parts such as leaf tips, fold over and collapse.**

Remedies

- **All the remedies stated for purple blotch should also be applied here.**

d) *Trhips (Trips tabaci)*

Thrips spp. Fam. Thrips dae

The onion thrips is mostly widely distributed and is found every were.

Life cycle

Onion trips eggs are laid down in incisions in the epidermis of the leaves and stems of young plants. They are white and hatch in 4-10 days. Both the larvae (nymphs) and the adult insects pierce the epidermis of the leaves and imbibe the sap pupation takes place in the ground. The emerging insects are very small, only about 1 mm long, yellow brown with dark cross stripes on the body. The entire life cycle lasts only three weeks or so and there fore 5-10 generations a year can result.

Symptoms

The typical symptom is silvery-flecked leaf surface which in severe cases turns brown. Onion leaves often become deformed and die. A further sign of thrips infestation are small black spots on the leaves, the excrements of the insect.

Remedies / control measure/

-Mulching reduces thrips considerably.

-Deep ploughing after harvest to burry the pupae.

-Stubble and other harvest remains should be burnt to reduce future populations.

-Use of crop rotation.

-Spraying of recommended chemicals.

2 Tomato (lycopersicon esculentum)

A. Damping off

-Caused by pythium, Rhizoctonia, verticilium spp.

***Injury:-*germination is slow and in places young plants do not grow at all- or fall over and die shortly after emergence.**

Control /Remedies/

-All points mentioned for onion should also be applied here.

B. *Early blight / Alternation solani/*

Symptoms

- **Occurs on stem, foliage and fruits.**
- **Small brownish black lesions first occurred on older foliage.**
- **When spotting is abundant the whole leaf may become yellow.**
- **The tissue surrounding a spot may become yellow**
- **The spots enlarge rapidly and concentric rings may be distinguished in the dark brownish portion of the spot.**
- **Affected plants become defoliated exposing the fruit to suns called.**
- **Stem lesions on seedlings are small, dark, and slightly sunken.**
- **If infected seedlings are set in the field the plant may die this phase of disease is called collar rot**

Control / remedies/

- **The seeds should be treated**

- **There should be proper field sanitation to eradicate crop derbis and volunteer host plants.**
- **Diseased seedlings should not be transplanted**
- **Don't plant young crops next to older crops.**
- **There should be proper crop rotation.**
- **Spray recommended chemicals.**

C. ***Late blight (phytophtora blight)***

Causal organism: phytophthora infestance

The fungi attacks all above ground parts and also tubers in the case of potatoes.

Symptoms

-Brown to black round lesions, with yellow green margins first appear at the tips of the leaves and it can eventually cover the whole leaf and petiole.

-In moist weather the undersides or lesions may be coverd with a gray to white moldy growth.

-Infected foliage becomes brown, shrivels and soon dies.

- **Brown elongated lesions occur on the stems**
- **Fruits are infected at the stem end and become covered with whitish growth**

Control / Remedies/

-All the possibilities indicated for early blight should also be applied here.

D. ***American boll worm and potato tuber moth***

As far as the insect pest concerned, the A.B.W and P.T.M is the most predominant insect pest on Tomato.

Control measures

-Intensification of a good cultural practices.

-There should be a good field hygiene.

-Spraying of a recommended insecticide

3 *CABBAGE*

A. Diamond back moth

Causal organism - plutella xylostella

Symptom

-The eggs are tiny whitish

-The newly hatched caterpillar move to the underside of the leaf and enter into epidermis.

-The later instars feed on the underside of the leaf and makes holes on the leaf.

Control

Apply recommended insecticides. / Karate 5% at a rate 0.4Lt/ha, Diazinon at a rate 4 Lt/ha etc.

B. Aphids

Symptom

When aphids become abundant on a plant the leaves may wilt, curl or become discolored and uneventfully the plant will be stunted or even die.

Control

- **Keeping the fields free of weeds or other plants.**
- **By natural enemies, such as ladybird beetles, lacewing flies, or parasitic wasps.**
- **By using a strong spray of water directly on the insects, or they can be killed in small area of cultivation by washing with the figers.**
- **Apply recommended insecticides. / cymbush, Karate, deltante/**

C. *Club roots of crucifers*

Causal organism- plasmodiephora brassicae

Symptoms

- **The infected plant may have pale green to yellowish leaves.**
- **The leaves may show flagging and wilting in the middle of hot days but may recover during night**

- **Plants become stunted.**
- **The main symptoms appear on the roots. smaller large a spindle like spherical, knobby, or club- shaped swellings on the roots and rootlest.**

Control

Plant in a well- drained fields with PH slightly above neutral. The spores of the fungus germination poorly or not at all in alkaline media.

Crop rotation a minimum of 3 years .

-Use of seedlings free from infection and infestation of the causal organisms

Soil fumigation

-Not a single plant should transplanted into clean field from a field with history of club roots.

4. POTATO

A. *Late blight / phytophthora infestant/*

The fungus cause sever defoliation and Avery destructive rot of the plants. The first symptoms are irregular , greenish black and water soaked spots on the leaves. These spots enlarge rapidly in moist weather and some times show white, downy growth on the surfaces.

Control measures

-Use clean tuber for planting

-Rouging of infected plant

-Spray recommended fungicides. ex. Redomil MZ 63.5 at a rate 2.5 kg/ ha mancozed 80% at a rate 3kg/ ha kocide 101 at rate 2 kg/ha etc.

B. *Early blight / Alternaria solani/*

Is a fungus disease, on the leaved, The fungus develops spots that may partly defoliate the plants and reduce the yield. These spots develop on the older leaves and

are small at first but gradually enlarge until they are 0.5 to 1.0 cm in diameter on stem the disease appears as dark. Slightly sunken areas that enlarge to form circular or elongated spot with light centers.

Control measures

-Use clean tubers for planting

-Rouging of infected plant

-Spray recommended fungicides. The same as to late blight.

C. Bacterial wilt /peudomons solanacearum/

The organism that causes the disease is a soil- borne bacterium that may survive in the soil on crop residues for many years. It has a wide host range including tomato pepper, eggplant, tobacco and numerous weeds. It causes serious damage in most potato growing areas. Wilting will be observed on the leaves of the infected plant and later the plant will die.

Control measures

-Develop resistant verities

-Crop rotation

-Rouging the infected plant

-Planting clean seeds

D. Virus

-There are different symptoms of affected plants, yellow spots on the leaves, dwarf growth, poor tubers, setting, extremely mall formed leaves etc,

-The virus is transmitted by tubers, sucking insects and by labours during transplanting etc. The virus has many host plants from the same family and others.

Control

-Sanitation to prevent infection.

-Destruction of host plants near to the fields as well as destruction of infected plant.

-Collect and burn infected plants.

-Use viruses free tuber seed.

-Controls the insect vectors of virus

-Every effort should be made to prevent the spread of virus from infected to healthy plant in planting, cultivating & other cultural practices.

E. Aphids

These are several kinds of aphids that feed on the potato plant. The winged aphids lay eggs on the plant that hatch out into wingless aphids and number increases rapidly during warm dry weather. they can survive as eggs on various perennial host plants by young stems.

Control

Spraying paration or malathion or deltanate at the rate 1.5L/ha at weekly interval starting from the appearance until the danger of damage has passed.

F. Potato tuber moth / Phthorimaea operculealla/

-The caterpillars have brown head and a triangular brown pattern behind the head. Young caterpillars mine the leaves, producing brown blotches. The destruction caused by this insect is not limited to stems and tubers in the fields but it will also destroy the tubers on store by boring. Hence the yield and the quality of the potato tuber will be reduced to great extent.

Control

- **Spray endosulfan at a rate of 0.2% & other insect ides**
- **Using clean seed.**
- **deep ploughiing**
- **Spray cymbush 5% or other chemical during storage**
- **frequent visit to the stored planting material**

5. BEANS

(By million Asfaw)

Beans grown in the tropics are affected by many plant diseases caused by fungi, bacteria, viruses and nematodes and insect pests.

A larger number of plant pathogens exist and infect beans grown in the tropics than in temperate zones of the world. Beans which attack by many insect pests cause defoliation, pod and seed losses on the plant , and storage losses.

In tropical areas, beans seriously attacked by fungal diseases, such as Rust, anthracnose, powdery mildew, bacterial blights, ascochyta, and insect pests such as, cut

worms, cater pillars, leaf hoppers, mites and aphids sometimes causes a serious damage reach up to 70% from the total expected yield

In Ethiopia, Bean rust, anthracnose, blights, ascochyta, caterpillars and aphids are the known pests which sometimes cause a sever and wide spread damage.

But like other bean growing countries here also beans have a relatively short growing season, which usually enables the plants to escapes insignificant damage and yield loss before insect populations reach serious levels

In Ethiopia the major disease and insect pests which attack bean plants and their protective measures are as follows:-

1. ***BEANS RUST*:- / uromyces phaseoli/**

Bean rust is a wide spread disease through out the country where there is a moderate temperatures and high relative humidity or free moisture. A temperature from 17^{o}c up to 27 ^{o} C. Relative humidity above 95% and mostly trace rain fall favors the spread of the disease. The disease is an obligate parasite, which spores are primarily transmitted by local and prevailing wind currents. Sever yield losses can result if infection occurs early in the season before flowering. Leaf signs and symptoms may consist of chlorotic or white spots which develop into reddish -brown pustules on the lower and upper leaf surface. Severe infection may cause premature defoliation at this time pod infection may also occur.

In some regions of the country, if the infestation is severe, all the green parts of the plant infected and die.

Control measures include:

- **destruction of old plant debris:**
- **3-4 years crop rotation**
- **Planting resistant or tolerant varieties**

- Application of chemicals (Oxycaboxin at the rate of 0.1% a.I mancozeb 80% 3kg/ ha.Triadimefon (Bayleton 0.05% a.i) .

2. *Anthracnose (colletorichum lindemuthianum)*

Bean anthracnose is prevalent through out the world, especially at elevation above 1000m. Infection and development by this pathogen are favored by cool temperature which ranges from 14^{o}c to 18^{o}c and high humidity or free moisture. Spore are disseminated by wind and rain or movement through fields by man, animals and insects. Leaf symptoms, initially appear on lower leaf surface and consist of dark brick- red to black lesions along the leaf veins. These lesion may also appear on the leaf petioles, branch, cotylodon, stem or pod. Pod infection generally appears as pink or rust colored to black spots which develop into sunken cankers containing pinkish masses of spores. The fungus can become seed born and cause severe yield losses. Anthracnose symptoms may be confused with ascochyta symptoms, how ever, their differences are apparent and close supervision and identification measured have to take.

Control ceasures:-

- **Planting fungus- free seed**
- **Crop rotation (at least 3 years) maize, sunflower. Beans**
- **Deep plowing**

- **Seed treatment**
- **Destruction of old plant debris**
- **application of chemicals (difolaton,benlate, Kocide 101 etc)**

3.*Blights*

a) *Common bacteria blight (* xanthomonas phaseoli)

These bacteria causes severe yield losses, especially in regions with moderate to high temperatures and moisture Initial infection by this common blight bacteria appears as water soaked spots on the underside of leaves or leaf lets. These spots subsequently enlarge irregularly and adjacent lesions may coalessee Infected regions lately become brown and necrotic. Yellow droplet of bacterial ooze or exudates may be visible on and around lesions. Pod infection provides seed discoloration and subsequent seed transmission of the bacteria.

b) ***Halo bliqht*** **(pseudomonas phaseslicola)**

These bacteria can be a serious problem in region with cool to moderate temperatures less than 28^{o}C. Around Zwai and Nuraera where there is cool temperature and relative humidity is high, Amboy and Nerina varieties are seriously infected by this disease and losses their pod quality.

Initial symptoms of the disease appear 3-5 days after infection as small, water soaked spots generally on the lower leaf surface. Ahalo of greenish - Yellow tissue later appears around these water- soaked areas. Systemic plant chlorosis with leaf yellowing and malformation may develop with the appearance of much external infections stems and infected and pods also cause subsequent seed transmission of the bacteria.

Control measures

-Crop rotation

-Planting bacteria free seed

-Planting resistant or tolerant varieties

-Using chemicals like copper hydroxide (Kocide 101, Kocide 202)

4. Caterpillars

Several species of cater pillars such as bollworms (Heliothis) cause defoliation of bean plants. Yields are usually greatly reduced when defoliation is severe due to larval feeding.

Flowers, leaves and pods some times green stems are eaten by larvae. Pods which are attacked by the larvae become deformed and sometimes may fall. Larvae of this species pass through 5-7 instars and reaches up to 40mm. The eggs of these larvae has spherical shiny yellow wish then darken to brown colors.

Control

The plants should be regularly examined for eggs daily

When eggs appear control measures should be taken by applying pesticides- such as- karate 5% Decis 2.5%, cymbush 25%, Ripcord, Methomyl etc according to the recommended rates.

Red spidermites / Tetranychus/, Aphids (Aphid gossipii); cut worms (Agrotis); and some others have less economic importance in bean growing areas of the country.

(By Million Asfaw)

6. Grape vine

The most trouble some diseases of grape vine in Ethiopia are downey mildew and powdery mildew.

1. Downey mildew (plasmopara viticola)

It is the wide spread disease in the country during rainy season. It affects all green parts of the plant and fruit. A temperature between 18-24^{o}C and high humidity above 95% and water on the leaves favours the disease incidence. Leaf symptoms, initially

appear in the lower surfaces and consist of oily- Yellowish- green patch's then turns to brown lesion along the leaf veins Flowers which attack by the disease become brown and with in a short time die. Attacked fruits have dark chocolate colors.

The disease over winters in the old plant debris. Spores of the diseases in the plant tissue grows above 7.9^{o}C and appear on the green parts of the plant after finishing its incubation period which has a of 61^{o} C

Control

Planting resistant or tolerant varieties

Collect and burn old plant debris

Deep plowing between rows

Pinching unnecessary branches and leaves to penetrate air and spraying chemicals

Chemicals application: Dithane M- 45; Kocide 101; Ridomil MZ 63.5, Ridomil Gold etc. according to the recommended rates. polyram combi and mancozeb are also recommended for controlling.

2. *powdery mildew / Uncinula nectar/:-*

Like Downey mildew this disease also affects all the green parts of the plant and fruit. The disease attacks late season just before the fruit is beginning to color. Abudant sporulation first occurred on the green rubbins of unfertilized flowers or on the small short berries. Damage is most severe in the inner and shaded parts of the canopy. On the attacked upper part the leaves appear white or gray powder like spores which easily rubbed by hands. In Zwai and Nura Era areas, the white varieties are more susceptible. Affected clusters are completely converse with mycelium and berries shattered from the cluster, as well as splitting open and exposing the inner seeds. Despite this less affected fruits losses its quality and the suger content become less. To minimize the infection; leaf

thinning around the clusters to admit air and light is recommended. Over head trellising system that develops too heavy a canopy and shade the fruit makes the problem worse .

Control

-Planting resistant or tolerant varieties

-Admit leaf thinning around the cluster

-Apply systemic chemicals like Bayleton 25% WP. 1st application before flowering, 2nd after 14 days of 1st application.

7.Citurus **(by million Asfaw)**

1. ***California red scales*** ***(aonidiella aurantii)***

It is one of the most destructive pests of citrus widely occurring in Ethiopia. It is a polyphagous insect. It's phenology shows that the pest is reproduced sexually. The embryo develops in the body and females gives birth to crawlers. The crawlers are the mobile stage of the scale and they can transferred to new trees by wind and they do not drawn in water and spread to new locations by floating on irrigation water.

The pest becomes in active stage, first generation in spring, during this generation more crawlers are produced. Crawlers move to the apical portion of branches and invade all young shoots of the tree. Young and matured fruits are attacked and quality is reduced. Braches and twigs are dying back due to the pest attack. As observed in the trial the insect development on a fruit is faster than on leaves.

Control

- **Scales are transferred by wild; water, man, bees, ants, birds and other mechanical ways. So care must be taken the transference of infested parts of the tree to normal ones.**
- **Collect and destroy regularly the infested and fallen off leaves and fruits.**
- **Cut off and burn the infested and dried twinges.**

- Regularly prune leaves and twigs touching the ground.

- Apply recommended chemicals such as Medopaz oil suprathion with Medopaz oil Diazinon with medopaz oil etc. according to the recommended rates.

2. *Fruit and leaf disease:-* / Phaeoramularia or cercospora angolensis/

The diseases was reported in Angola and Mozambique in 1952; in Ethiopia in 1988 around sidamo regions; and in Ghibe state farms in 1995.

The disease is spread by air borne conidia, infected fruits, infected citrus planting material, wet weather and moderately cool temperatures (22-24^{o}C) favor disease development. The disease affects all citrus species including grape fruits, Orange, mandarin, Lemon and lime. Grape fruit, Orange and tangerine mandarin are very susceptible while lemon less and lime the least.

On leaves the fungus produces circular, sometimes coalescing up to 10 mm diameter, with a light brown or grayish center. The spots are usually surrounded by a prominent yellow halo.

On fruit, the spots are circular to irregular, discrete or coalescent, most measuring up to 8mm in diameter and surrounded by a yellow halo. On young fruit symptoms often commence with nipple- like swellings with out a yellow halo. Severely infected fruit lets turn into mummies. Spots on mature fruit are normally flat and often a dark brown to black sunken margin of anthracnose around the spots is observed.

The most devastating effect of the disease is the development of fruit spots, which render the crop unmarketable. A yield loss of 50-100% is not uncommon in most the disease affected ares.

Control -

-Planting of wind breaks around the citrus orchards to reduce the impact of wind.

-Collect and burn or bury the newly affected fruits

-Timely and care must be taken to the spread of the spores.

-Fungicides trial is under going to minimize disease spread with in the orchards.

3. LEAF MINER (PHYLLOCNITIS CITRELLA)

The citrus leaf miner infects citrus plants mostly in all citrus growing areas in the would. In Ethiopia also it is wilily distributed in citrus growing areas. Occasional local out breaks were common and recorded in the past few years. But a serious damage has not been observed unit recently. The pest is more serious on grape fruit and lime. Tangerine and sour orange are also susceptible to the pest.

Damage is caused by larval stage, which mines mostly the axial leaf surfaces and causes the characteristic twisted Galleries and a silvery film appearance on the epidermis; this results in necrotic tissue, leaf curling and abscission of the infested tissue. Occasional injury can also occur on young stems and fruits The biology of the citrus leaf miner since the larva is protected inside the leaf and not exposed to pesticide spray it is hard to achieved an adequate control with insecticide sprays. But sometimes with some recommended pesticides using highly pressurized hydraulic sprayers, provide a temporary solution to control the pest. Scientist working on the citrus leaf miner agree that integrated pest management (IPM) based on the use of good cultural practice and biological control offer a good opportunity to manage this pest. Chemicals control measures are on going in different citrus growing areas of the country.

Citrus bud mite (Aceria sheldoni) ; fruit fly (ceratitis capitata), psorosis, Tristeza, and phytophtora sp. are also known citrus pests which attack citrus plants and different growing stages at different economic levels.

4. Citrus bud mite **:-develops in flowers and leaf buds, and is the cause of dwarfing twigs, malformation of leaves and flowers and of monistrous fruits. Spray with systemic acaricides like metac can decrease the infestation, but to purne the malformed shoots and leaves give better results with minimum expense.**

5. Psorosis:- **is a serious disease which observes on old orchards This disease generally does not exhibit damaging symptoms unit 15 years of age or older. It is transmitted by using infected scion materials for psorosis doesn't kill trees like Trestaze but it is severly damages large limbs and tree truck, there by greatly reducing yields Hence care must be taken that it shouldn't take scion materials from the infected old orchard trees.**

6. Tristeza virus disease **is transmitted by a vector aphid called toxoptera citricida. The field diagnostic symptoms are, clearing of viens, stem putting on the trunk of attacked plants and dieback. Citrus plants grafted on sour orange rootstock are susceptible to tristeza but resistant to phytophtora spp. On the other hand citurs tree grafted on sweet orange are resistant to tristeza while they are severely lost by phytophtora spp Eradication of affected plants minimizing aphids population and quarantine are the leading controlling methods.**

7.Phytophtora sp.:- **(foot rot, root rot) and often called gummosis is a serious problem in citrus growing regions of Ethiopia It is a problem in areas with heavy clay soils, and where surface and sub surface drainage is limited.**

To control this disease care has to be taken during irrigation, through proper basin making and drainage. Plants which are grafted on sour orange are tolerant to this disease.

8.APPLE

The most serious insect pests and disease in apple fruit

1. ***Codling moth*** **/ Lasperyresia pomonella/**

Symptom

-The larvae feed briefly beneath the fruit surface or tunnel directly to the center of the fruit.

-The larvae deliberately feed on the seeds of the fruit.

Control

Apply recommended insecticides mostly organophorus chemicals are recommended.

2. ***Wolly apple aphids*** **/ Erioaoma Lsnigerum/**

Spmptom

- **Cottony- white aerial colonies are found most frequently on succulent tissue such as current season growth, water sprouts ,unhealed pruning wounds or cankers.**
- **Heavy mold on the fruit and galls on the plat part.**
- **Under ground colonies may be found through out the year on the root system.**

Control

-High volume application of recommended insecticides may be necessary to penetrate the wax, Aphelinus malia wasp which penetrate the wax.

-Use resistant root stock / MM - 106 MM-111/

3. Appply scab / Venturia Inheqalis/

Symptom

-Leaves, green flower parts, and young fruits become infected.

-The dark hard and cracked lesions on the fruit

-Enlargement of the young fruit is restricted in the infected area and resulting fruit is knobby and malformed when mature.

Control

According to our condition around Holleta, after defoliation of old leaves manually, frequent spraying with protect ant fungicides is taken place with mancoze 80% 3 kg per a hectare, Kocide 101 2.5 kg/ha, Antracol 3 kg/ha and Baycor 300 E.C 1.5 Lt/ Ha alternately. Baycor 300 E.C is the only alternate chemical to control effectively. Dorado & Score have good results under trail basis.

4. Powder Mildew:- /Podosphaera Leucotricha/

Symptom

- **a whitish fungus on the leaf reduces the photosynthetic area and so leads to loss in yield.**
- **Trees attacked by mildew causes a large amount of flower drops off.**

- **Mildew on the petal results in a net- like russeting on the fruits and so reduces quality.**

Control

-By spraying recommend fungicide / Bayleton 25% WP at a rate of 0.5 kg/ha. Afugan 30% E.C at the rate of 0.7 Lt/ha.

5.GROWN GALL:- **/ Agrobacterium fume Faciens/**

Round and some times elongate over growth which occur most frequently on the roots, crown, and stem near the ground and caused plant to die.

No control measures, there are general preventive measures recommended in the apple growing areas where the disease occurs:-

1.Avoidance of infected plant material and production of clean inspected nursery stock.

2. The denial of entrance of bacteria by reduction of wounds and bruises, the protection of graft unions

3. Control of chewing insects especially subterraneanones.

4. Proper disposal of infected planting materials and disinfestations of soils in nursery.

5. Use clean and disinfected materials for cultivation and grafting.

THE END

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