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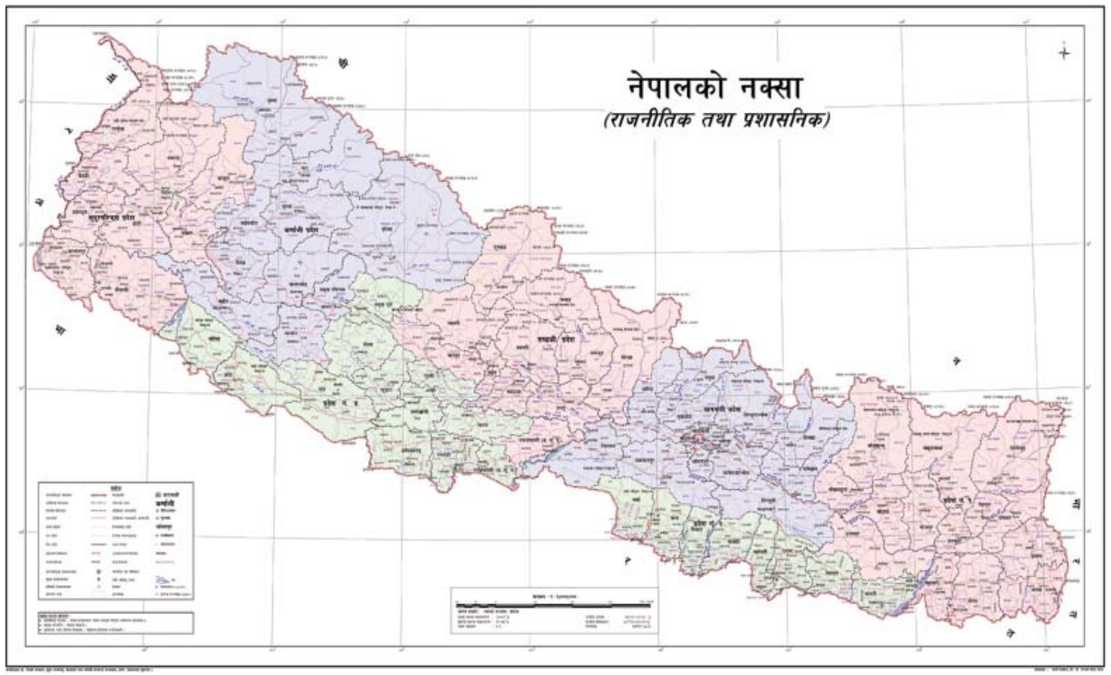

Crop Production

Government of Nepal
Ministry of Education, Science and Technology
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Technical and Vocational Stream

Learning Resource Material

Crop Production

(Grade 10)

Secondary Level

PLANT SCIENCE

Government of Nepal
Ministry of Education, Science and Technology
Curriculum Development Centre
Sanothimi, Bhaktapur

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Preface

The curriculum and curricular materials have been developed and revised on a regular basis with the aim of making education objective-oriented, practical, relevant and job oriented. It is necessary to instill the feelings of nationalism, national integrity and democratic spirit in students and equip them with morality, discipline and self-reliance, creativity and thoughtfulness. It is essential to develop in them the linguistic and mathematical skills, knowledge of science, information and communication technology, environment, health and population and life skills. it is also necessary to bring in them the feeling of preserving and promoting arts and aesthetics, humanistic norms, values and ideals. It has become the need of the present time to make them aware of respect for ethnicity, gender, disabilities, languages, religions, cultures, regional diversity, human rights and social values so as to make them capable of playing the role of responsible citizens with applied technical and vocational knowledge and skills. This Learning Resource Material for Plant Science has been developed in line with the Secondary Level Plant Science Curriculum with an aim to facilitate the students in their study and learning on the subject by incorporating the recommendations and feedback obtained from various schools, workshops and seminars, interaction programs attended by teachers, students and parents.

In bringing out the learning resource material in this form, the contribution of the Director General of CDC Dr. Lekhnath Poudel, Prof. Khemraj Dahal, Lal Prasad Amagain, Arjun Prakash Poudel, Bishnu Prasad Bhattarai, Dinesh Timalsina, Mahesh Paudel, Santosh Koirala is highly acknowledged. The book is written by Bal Chandra Chaulagai and the subject matter of the book was edited by Badrinath Timsina and Khilanath Dhamala. CDC extends sincere thanks to all those who have contributed in developing this book in this form.

This book is a supplimentary learning resource material for students and teachrs. In addition they have to make use of other relevnt materials to ensure all the learning outcomes set in the curriculum. The teachers, students and all other stakeholders are expected to make constructive comments and suggestions to make it a more useful learning resource material.

2072 BS

Ministry of Education, Science and Technology

Curriculum Development Centre

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UNIT-1

Introduction

A. Objective(s)

The main objective of this course is to develop student's ability to:

- Define the meaning and concept of subsistence and commercial agriculture
- Classify the different agronomical crops plants.
- Explain the importance and scope of agronomical crops in Nepal
- Discuss about the comparative advantage of agronomical crops.

B. Content elaboration:

1.1 Definition of subsistence and commercial agriculture

Subsistence agriculture

Subsistence agriculture is defined as the type of agriculture which is concerned with the production of food by a farmer to feed himself and his family. Subsistence agriculture is a self-sufficiency farming system in which the farmers focus on growing enough food to feed themselves and their entire families. The output is mostly for local requirements with little or no surplus trade. The typical subsistence farm has a range of crops and animals needed by the family to feed and clothe themselves during the year.

Advantages of subsistence agriculture

1. Provision of basic needs of the family like food and clothing
2. Small plot of land can be used to cultivate such as the backyard garden.
3. Little or low capital is required to carry out subsistence farming.

Disadvantages or problems of subsistence agriculture

1. Family labour supply is unreliable because they are not paid for job done.
2. Crude tools are used such as cutlass, hoe and rake.
3. Fragmentation or small farmland is available because lands are owned communally and usually shared among family members regardless of whether they are interested in farming or not.
4. No surplus for sale to earn income. All produce are consumed by the family.
5. Pest and diseases are not controlled.

Commercial agriculture

Commercial agriculture is defined as the type of agriculture which is concerned with the production of food, rearing of animals and cash crops in large quantities for sale.Commercial agriculture is generally associated with intensive farming and large production which is only done to sell and earn profit. It is carried out in large scale and mostly involves mechanized and smart farming. All the cash crops come under commercial Agriculture.

Advantages of commercial agriculture

1. It increases yield and economies of large production is enjoyed.
2. Specialization of labour is practiced because large area of farmland needs to be cultivated.
3. There is always encouragement of research work such as pest control and use of new seedlings.
4. Provision of cheap products because enough supplies are sent to the market for sale.
5. Provision of quality products. This is so because adequate investments are invested into the mechanized farming.

Problems or disadvantages of commercial agriculture

1. Problem of acquisition of large hactares of farmland arising from the fact that lands are held communally as against when it is held by one individuals who can decide to dispose of it at any time.
2. It is very expensive. Commercial farming is capital intensive because modern machineries like tractors are employed in cultivation.
3. Harvesting / marketing is tedious. Harvesting in a commercial farm is a dungeon task because a large portion of farmland is involved. So it is difficult to market such large quantity of output.
4. Problem of storage. In developing countries, there is absence of adequate storage facilities like cold room, silos etc to store the large quantity of output.
5. Outbreak of pests and diseases. It is difficult to control pests and diseases because science is relatively under developed in developing countries, therefore pests and diseases reduces farm produce.

Difference between Subsistence and Commercial Agriculture

SN	Subsistence Agriculture	Commercial Agriculture
1	A small areas of land is cultivated	A large area of land is cultivated and mechanized
2	Produce is mainly for family consumption	Produce is mainly for sale
3	Crude tools and implements are used	Complex and modern tools and implements are used
4	Family / manual labour is usually employed	Paid / skilled labour is usually employed
5	Yield or returns are low	Yield or returns are high
6	Pest and diseases are not controlled	Pest and diseases are usually controlled
7	Mostly practiced by peasant farmers	Mostly practiced by very rich farmers / companies

1.2 Classification of agronomical crops (Cereals, oil seeds, Grain legumes, Cash and Industrial crops)

Classification may be defined as the act of distributing things into classes or categories of the same type. Crop classification is a systematic grouping of crops based on well demarcated characteristic. Knowledge of classification crops helps grower and concern people to generalize similar crops as a class of group for attaining a better understanding about them. Agronomical crops can be classified in several classes of groups depending on the basis of classification. Plants can be classified according to the following criteria,

i) Botanical classification: It is based on morphological characteristic of plants as well as on their anatomy, physiology and DNA sequence.

ii) Descriptive Classification: It is based on environmental adoption, growth habit and other observable features.

iii) Agricultural Classification: The crop can be broadly classified as either useful or unuseful. Those which are useful are called crops while those which are not useful are called weeds.

A common well defined system of crops classification is important in agronomical

crop science. Grouping of plants following established system will simplify plant collection in initiatives, research, breeding and specialized development efforts.

Importance of classifying the agronomical Crop Plants:

- To get acquainted with agronomical crops.
- To understand the requirement of soil & water to different crops.
- To know adaptability of crops.
- To know the growing habit of crops.
- To understand climatic requirement of different crops.
- To know the economic produce of the crop plant & its use.
- To know the growing season of the crop
- Overall to know the actual condition required to the cultivation of plant.

Classification of Agronomical Crops

Agronomical crops can be classified based on different aspects such as botany, climate, growing season, uses, photoperiod and soil requirement.

i) Classification based on botany

According to the botanical classification agronomical crops can be classified as,

Kingdom: Plantae

Division: Tracheophyta

Sub- division: Pteropsida

Class: Angiospermae

Sub-class: Monocotyledon

Order: Graminales

Family: Poaceae/ Graminae

Genus: *Oryza*

Species: *sativa*

Cultivars: Radha-12

ii) Classification based on climate

a) Tropical crops

Crops grow well in warm & hot climate. E.g. Rice, sugarcane, Jowar etc

b) Sub- tropical crops

Crops grow well in moderate climate. E.g. Maize, Finger millet, Lentil etc.

c) Temperate crops

Crops grow well in cool climate. E.g. Wheat, Oats, Gram, Potato etc.

iii) Classification based on growing season

a) Rainy/Monsoon/ Kharif crops

The crops grown in monsoon months from June to Oct-Nov (Jestha to Ashoj-Kartik), Require warm, wet weather at major period of crop growth, also required short day length for flowering. E.g. Cotton, Rice, Jowar, bajara.

b) Winter/cold seasons/ Rabi crops:

This crop require winter season to grow well from October to March (Ashoj to Falgun)month. Crops grow well in cold and dry weather. Require longer day length for flowering. E.g. Wheat, gram, sunflower etc.

c) Summer/Zaid crops

Crops grown in summer month from March to June (Falgun to Jestha). Require warm day weather for major growth period and longer as length for flowering. E.g. Groundnuts, Maize, Soyabean etc.

iv) Classification Based on Uses

a) Grain crops

Grain crops may be cereals as millets cereals are the cultivated grasses grown for their edible starchy grains. E.g. rice, maize, wheat barley, and millets etc.

b) Pulse/legume crops

Seeds of leguminous crops plant used as food. On splitting they produced dal which is rich in protein. E.g. green gram, black gram, soybean, pea, cowpea etc.

c) Oil seeds crops

Crop seeds are rich in fatty acids, are used to extract vegetable oil to meet

various requirements. E.g. Groundnut, Mustard, Sunflower, Sesamum, linseed etc.

d) Forage Crop

It refers to vegetative matter fresh as preserved utilized as food for animals. Crop cultivated & used for fickler, hay, silage. Eg- sorghum, elephant grass, guinea grass, Berseem & other pulse bajara etc.

e) Fiber crops

Grown for fiber yield. Fiber may be obtained from seed. E.g. Cotton, steam, jute, sun hemp, flax.

f) Tuber crop

Crop whose edible portion is not a root but a short thickened underground stem. E.g. Potato.

g) Sugar crops

The two important crops are sugarcane and sugar beet cultivated for production of sugar. E.g. Sugarcane, Sugar beet etc.

v) Classification based on length of photoperiod required for floral initiation

Most plants are influenced by relative length of the day & night, especially for floral initiation, the effect on plant is known as photoperiodism depending on the length of photoperiod required for floral ignition, plants are classified as:

a) Short-day plants

Flower initiation takes plate when days are short less than ten hours. E.g. rice, Jowar, green gram, black gram etc.

b) Long day's plants

Require long days are more than ten hours for floral ignition. E.g. Wheat, Barley,

c) Day neutral plants

Photoperiod does not have much influence for phase change for these plants. E.g. Cotton, sunflower. The rate of the flowering initiation depends on how short or long is photoperiod. Shorter the days, more rapid initiation of flowering in short days plants. Longer the days more rapid are the initiation of flowering in long days plants.

vi) Classification based on soil requirement

According to soil requirement agronomical crops can be classified based on suitability of topo sequence.

a) High land crops

These are group of crops that are susceptible to water logging and are grown in high land such as Maize, seasam, cotton etc.

b) Mid lands crops

These are those crop that are adopted to tolerate certain degree of water stagnation and required abundant soil moisture for maximum yield such as Chickpea, upland rice, Jute, wheat etc.

c) Low land crops

These are those which require abundant supply of water and can stand prolong water log condition. E.g. Rice, Jute etc.

1.3 Importance and scope of agronomical crops in Nepal

Agronomy is the science and technology of using plants for food, fuel, feed, fiber, reclamation. Among all the branch of agricultural, agronomy occupies vital position and is called as mother branch or primary branch. Agronomy is a synthesis of several

branches like crop science, which includes plant breeding, crop physiology, biochemistry and soil science, which includes soil fertilizer, manures, environmental science, meteorology and crop ecology. So agronomy is an important sector of agricultural science. The importance of agronomy can be described under following heading:

i) Source of Food:

Agronomical crops play a vital role in food supply. Majority of Nepalese farming adopted the food crops for supplement of food material for daily requirement. Agronomical crops include major food crops such as Rice, Wheat, Maize, Barley, Finger millet, Potato etc. Similarly larger amount of agronomical crops are used as a source of feeding material for animals.

ii) Source of Raw materials:

Agronomical crops are the major source of raw material for agro-based industries. Number of larger industry in the country depends upon the raw material produce from agronomical crops. Sugarcane for sugar industry, Tobacco leaf for tobacco industry, Paddy for Rice mill etc.

iii) Employment opportunities

Agronomy is the primary source of employment opportunities. Agronomical crops demand the higher amount of labour for care in each and every aspect of cultivation, right from selection of site to harvesting, processing, marketing and storage. All such factors create a great employment opportunities for the working people.

iv) Nutritional Supply:

Agronomical crops are the major's source food to the human being as well as animals which supply the larger amount of nutrient including carbohydrate, protein, fat, lipids, vitamins, minerals nutrient etc. Cereals crops such as rice, maize, wheat, finger millet etc are good source of carbohydrate, legumes crops such as lentil, chickpea, pigeon pea etc are good source of protein, oilseed crops such as rapeseed, sunflower, mustard, groundnut etc are good source of fat and lipids as well many other agronomical crops are rich source of mineral nutrient.

v) Food Security

A stable agronomical crop sector ensures a nation of food security. The main requirement of any country is food security. Food security prevents malnourishment that has traditionally been believed to be one of the major problems faced by the developing countries. Agronomical crop play a vital role in food security by supplying a larger amount of food material because majority of Nepalese people can easily be produce the food crops to ensures the food security in rural as well as urban area.

vi) Soil conservation and Soil fertility

Nepal is a mountainous country where large farming practice is adopted in sloppy area which is highly prone to soil erosion. So agronomical crops especially legumes crops has the best solution to protect soil erosion by adopting different agro-technic such as cover cropping, strip cropping etc. Similarly, cultivation of agronomical crop through the crop rotation helps to enhance the soil fertility status. Grain legumes and other plants of family leguminosae has an ability to fix the atmospheric nitrogen in the soil through symbiosis with nitrogen fixing bacteria which is important in soil fertility improvement as well as supplement of nitrogen to the nitrogen deficient soil.

1.4 Comparative advantage of agronomical crops in Nepal

Agriculture which is the predominant sectors of Nepalese economy provides the major source of livelihood to 65 percent of the population and therefore must take the lead in Nepal development. Nepalese agriculture is largely characterized by a mixed farming system, heavily dependent on monsoon rainfall.

The principal food grain crops are paddy, maize and wheat which account for nearly 86 percent of the total cropped area and almost 93 percent of total cereal production. Paddy is cultivated on about 60 percent of the total cereals crop area. Maize 60 percent of which is produced in the hills, occupies between 20 and 22 percent of the total cereal crop area. Wheat accounts for 16 and 18 percent of the total cereal crop area and is increasing. Other minor cereals crops are millet, barley and buckwheat. The pulses are also important crops, both as part of the Nepalese diet and as key components of the cropping system in Nepal. Jute, sugarcane, tobacco, oilseeds and

potato are the major nonfoodgrain crops and account for 10 to 12 percent of the total cropped area. Therefore agronomical crop shows the comparative advantage in nation economy as well as in food security.

1.5 Geographical distribution of agronomical crops in Nepal

Nepal is a landlocked country located between China and India. Spanning the central part of the Himalayas, Nepal's total area is 147,181 km2. Five distinct physiographic regions with unique altitudinal and climatic conditions give the land its splendid diversity. These regions consist of the High Himal, High Mountain, Middle Mountain, Siwalik, and the Terai. 35 percent of the total area is made up of mountains, 42 percent is hills, and 23 percent is Terai .There is a wide diversity in landscape, altitude, topography and temperature in the country. Temperatures range from arctic to tropical. The High Himalayan region is always below freezing whereas the Terai and the low valleys are always warm. In winter mornings and nights in the hills are bitterly cold and days are chill whereas in the plains and the river valleys mornings and nights are chill and the days are pleasant. Summers in the hills are pleasant but in the plains and valleys are swelteringly hot. January (Poush) is the coldest and June and July (Jestha and Ashar) the hottest months. Rainfall and temperature are the two main factors affecting Nepalese agriculture.

High Himalayan region.

This region which is always covered by snow occupies 23.7% of the total land – 3 447 500 ha. Its altitude ranges from 3 000 m to 8 848 m. The mountains are very steep with active glacier systems. The geology consists of gneiss, schist, limestone and shale of different ages. Physical weathering predominates and soils are very stony. This region falls largely within the alpine and arctic climate regimes, so there are active glacier systems where there is enough precipitation in high catchments. The climate is dependent on elevation and location in the mountain massifs. The few pockets of arable land of Solukhumbu, Mustang, Manang and Dolpa are the result of a unique combination of aspect, shelter from wind and availability of water for irrigation.

Characteristic landforms are glaciers, cirque basins, moraines, U-shaped valleys and avalanche slopes. Bedrock in most of the areas is exposed at or near the surface including gneisses, schist and the Tethys sediments. Less than 1% of the region has soil and climate suited to crop production and then only where irrigation is available.

High Hills (or Mountain) region.

The altitude of this region ranges from 2 000 m to 2 500 m and it lies below the permanent snow line. This region occupies 2,899,500 ha making up 19.7% of the country. It has a cool climate and receives heavy to moderate snow in winter. Mountain slopes are very steep but there are some flat valleys as well. The geology is characterized by phyllite, schists, gneiss and quartzite of different ages. Soil formation on the slopes is slow and they are rocky.

This region borders the Middle Hills to the south and the high Himal to the north. The boundaries are defined by changes in geomorphic processes, bedrock geology, climate and relative relief. This region has more metamorphosed and structurally consolidated rocks. Gneisses and garnetiferous mica schists are common. Most of the major valleys have been glaciated. High river gradients and enhanced river down-cutting resulted in the formation of deep canyons since glaciation. Agriculturally this region is of lesser importance. After the snow melts the mountains are covered with thick grasses and livestock like sheep, yak, and other mountain animals graze in this region. In the valleys, in summer, one crop a year can be harvested. The crops are potato, naked barley, buckwheat, and maize.

Middle Hills (or Mountain) region.

This region includes a wide range of physiography. Its area is 4 350 300 ha, about 29.5% of the area of the country. Mountain peaks range up to 2 000 m with narrow river valleys. The mountains are the Mahabharat range. The geology consists of a complex of phyllite, schists, quartzite of Cambrian to Precambrian ages and granites and limestones of different ages. The climate ranges from warm subtropical to warm temperate. The higher peaks receive occasional snow whereas some lower parts receive occasional frost in winter, which causes damage to crops. Soils are extremely variable because of the differences in bedrock, geomorphology and microclimate. The southern margin mostly consists of a prominent belt of uplifted mountains known as Mahabharat Lekh. This belt is made up of deeply weathered granite, limestone, dolomite, shale, sandstone, slate and quartzite; is intensively cultivated and is home for more than 60% of the population. It produces most of its food, yet food is always transported from surplus regions to this area. Subtropical dense forest occupies the non-agricultural land.

Siwalik region.

This region lies at the foot of the Mahabharat range. Its area is 1 888 600 ha: 12.7% of the total land. Altitudes range from 300 m to 1800 m. The geology mainly consists of tertiary mudstone, sandstone, siltstones and conglomerate. Soils vary depending on the materials from which they are developed. There are several inner valleys or duns, which are densely populated. Because of alluvial deposition these valleys are very fertile. The landscape is very rugged and unstable, consisting of weakly consolidated Tertiary sediments with gentle to strongly sloping dip slope. Siwalik soils are unable to retain high precipitation which frequently occurs resulting in flash floods. Duns, a very important part of the Siwalik landscape, are structurally stable and sometimes, in the past, their outlets were blocked by rapid tectonic uplift of the Siwalik range. The major dun valleys are: Chitwan, Dang, Deokhuri, Surkhet, Trijuga and Kamala. Climate in the duns is modified by the regular occurrence of winter fogs; otherwise it is very dry.

The Terai region.

The Terai, a flat extension of the southern Indo-Gangetic plain, occupies 2,142,200 ha, 14.4% of the country. Altitudes range from 66 m to 300 m. The region enjoys a warm sub-tropical climate and its alluvial soils are fertile. It is the granary of Nepal. Wherever irrigation is available the land is intensively cultivated. It consists of recent and post-Pleistocene alluvial deposits forming a piedmont plain adjacent to the Himalayan ranges. Although the whole length of the Terai has a common geomorphology, it has obvious differences in land use due to presence of different land systems and land units. The obvious difference is the increased amount of rice cultivation in the eastern Terai indicating a greater proportion of higher quality alluvial soils and more availability of water/rainfall compared to the west.

Table: Characteristic of different ecological belts

Climate Characteristic in Different Ecological belts of Nepal				
Physiographic zone	Ecological belt	Climate	Average annual Precipitation	Mean annual temperature
High Himal	Mountain	Arctic/alpine	Snow/150mm-200mm	<3°C-10°C
High Mountain				
Mid-Mountain	Hills	Cool/warm	275mm-2300mm	10°C-20°C
Siwalik	Terai	Tropical/sub-tropical	1100mm-3000mm	20°C-25°C
Terai				

C. Learning process and support materials

The learning process includes the participation of student in group work, presentation and skill development, written methods etc.

D. Assessment

Very short (Answer question)

1. Define subsistence agriculture.
2. Define commercial agriculture.

Short (Answer question)

1. Write down the difference between subsistence and commercial agriculture.
2. Classify the agronomical crop based on growing season.

Long (Answer question)

1. Write down the importance of agronomical crops in Nepal.
2. Write down the comparative advantage of agronomical crops.

UNIT-2

Cultivation of Cereals

A. Objective(s):

The main objective of this course is to provide students the knowledge and Skill about improved agronomical practices of different cereals crops.

B. Content elaboration:

Paddy

S.N: *Oryza Sativa*

Family: *Gramineae/ poaceae*

Area, Production & Distribution:-

Rice is the staple food for 40% of the world's population. 90% of the world's rice is produced & consumed in Asian countries where about 58% of the world population lives. China & India cultivate major proportion of rice because more than half of the world's populations live there. In Nepal paddy dominates the agriculture sector occupied more than 54% of the total cultivated land & about 7% of the paddy land is covered by double cropping of rice(rainy & summer season), low land rice contribute about 91% where as about 9% of the rice is grown in high lands.

Rice has grown in almost all parts in Nepal except Manang, Mustang & Western Mountain belts. According to Nepalese agriculture status of 2072-2073, production is 4299078Mt with the cultivated area 1362908hactar having the productivity3.15 Mt/hactar.

Importance/trade:

- Rice is staple food for 40% of the world population.
- Rice provides employment to majority of the people in rural areas.
- Different factory are established for hulling, threshing & milling paddy which is an employment for rural people.
- The by-product like husk is used as litter for poultry. Brand & rice police is extensively used as animal feed.

- Rice straw is used as animal food during lean period. It is also used as thatching material in house, cattle sheds & stalls.
- The nutrient contain of 100 gm(raw) rice is 6.8gm P, 0.5gm F, 78.2gm CHO, 0.6 gm minerals, 10mg calcium, 0.2gm fiber& 345k Cal energy.

Climatic requirement:-

Rice is a tropical plant but it can be grown in sub- tropic & warm temperate climate. 20-30°c is the critical mean temperature for rice growth. Temperature affects photosynthesis & respiration & Very low temperature rice required longer time to acquire heat units to pass from one physiological stage to another. At high temperature photo respiration takes place which reduces the yield.

The onset of monsoon, its duration & its intensity of rain determine rice production. In Nepal 85% of the land is cultivated in rain feed condition. Too little & too much rainfall at any stage of crop growth partially or totally damages the crop. On an average 1000-1500 mm well distributed rain fall is needed for rice cultivation.

Solar radiation of about 200 hrs is needed for optimum production higher the sun light higher will be the production so planting time should be adjusts in such a way that maximum sunlight will be received by the crop. The relative humidity of 50-60% is needed for rice leaves to posse's maximum photosynthesis & slow gentile wind during the growing period is necessary. Strong wind caused lodging & shattering.

Soil:-

Paddy is grown in very fertile to low fertile soil in diver's agro climatic condition people use to grow paddy in area where water is available. Paddy requires soil containing high percentage of organic matter & retains maximum water. Clay loam, clay or soil containing high proportion of clay having 6-7 PH is highly favourable for rice.

Improved variety:-

Many improved variety of summer season (chaita dhan) & rainy season(barkhe dhan) are released.

Chaita dhan:

Hardinath-1, chaita-2, chaita-6, mallika, chadine, IR-24, Parwanipur-1, CH-45

Barkhe dhan:

Terai:-

IR-8, IR-20, IR-22, Jaya, Rampur munsuli, Ram, Mithala, Barkhe-3004, Locktantra

Terai & inner terai:-

Munsuli, Durga, Janaki, Shabetri, Makwanpur-1, Barkhe-2, Ghaiya-2, Radha-7,4,12, Radha Krishna-9

Mid hill:-

Tainan-1, Chainan-2, Hemali kanchan, khumal-2,3,4,5,6,7,9 Manjushree-2, Locktantra

High hill:-

Taichung-176, Chainung- 242, Machhapuchre, Chandan nath-1,3

Seed & Its treatment:

Seed should be pure, viable, free from insect pest& diseases, certified, having high germination percentage, & high purity percentage. Bold seed are selected & seed are treated with carbandizim @ 2.5-3 gm/kg seed in a rotatory seed treatment drum.

Method of raising seedling:-

1. **Dry bed method:**

It is practiced in those areas where water is not sufficient to grow seedlings. Plough the field 3-4 times, destroy the clods & remove weeds &make pulverized soil. Prepare raised seed bed of 1-1.5 cm width & 10 m length. The bed should be raised 15 cm above soil surface & maintained 30-50cm spacing between the beds. Apply 10-15 ton of FYM per hactar& apply 225gm urea & 500 gm SSP/ 10m² Area. If seedling becomes peal yellow apply urea as spray @ of 10 gm/ litre of water. the nursery area of 500m² with seed rate of 50kg/hac transplanting with 33 x 15 bed containing 1.5 kg seed per bed. Sow the seed in line of 10cm apart & cover the seed with 2-3 cm by soil. The covered soil is removed after 6-7 days. The seedling becomes ready in 25-30 days.

2. **Wet bed method:**

It is practiced in areas having sufficient water. Plough the field once by deep ploughing, saturated the field by water & then puddles the soil & then levels it. Seed rate, manure & fertilizer are similar to dry bed method. In wet bed incubated seeds are

broadcasted uniformly &water level is maintained 2 cm. After 10 days water level is gradually increased 5cm. The seedlings are become ready after25-30 days.

Different between dry & wet bed

Dry bed	**Wet bed**
The yield is more	The yield is less
More & longer roots	Less & shorter roots
More resistant to transplanting injury	More susceptible to transplanting injury
High rooting ability	Less rooting ability

3. Dapog method:-

In this method 30m² area is needed for raising seedling for hactar area. Banana leaf or plastic is spread in a flat floor. 2-3 cm sand is placed over a plastic & 36-48 hours incubated seed are broadcasted over the sand. Sprinkler irrigation is given 4 times a day up to 4 days & then twice a day for remaining 10 days. The seedling becomes ready at 12-15 days for transplanting. The seedling are rolled like a carpet with the root facing outside & carried to the transplanting site. The seedlings are very week thin & about 2-3cm.

Cultivation Practices:-

Land Preparation:

1. For transplanting paddy:

It starts at least 3-4 weeks before transplanting to prevent the seedlings from the effect of nitrogen depression period. Plough the field with one deep ploughing followed by 2-3 sallow ploughing by saturate the field by water. FYM/compost is applied 3 weeks earlier to transplanting. Land is levelled by puddleing in a saturated condition.

2. For upland paddy:

In upland areas where water is not available for planting seedling, the soil is ploughed 2-3 times, destroy the clods, removed weeds, prepare the bunds & the seed are broadcasted @ 100kg seeds/ hactar. The rainfall collects in the bund & provides

proper germination & growth.

Transplanting of paddy:-

It is a process of planting seedlings from nursery bed to the main field which is well levelled & saturated with water. During transplanting 2-3 seedling/ hill are used with a depth of 2-3cm. Deeper transplanting delay tillering by 10 days or poor tillering.

Spacing of seedlings depends upon tillering ability of variety, time of transplanting, fertility status of soil etc. But in general transplanting in the month of ashar 20cm x 20cm(RR x PP), Shrawan 1^{st}–15^{th} 20x15 & 15 Shrawan 20cmx10cm.

Method of planting paddy:

1) Broadcasting: 100kg seeds/hac is broadcasted in upland by making bunds.
2) Line sowing: 60-75kg seed/hac with RRxPP(20cmx20cm) are dropped or seeding behind the plough is done.
3) Transplanting: Seedlings are transplanted by maintaining RR x PP distance with a seed rate of 50 kg/hac.

Manure & fertilizer:-

Chemical fertilizer is applied on the basis of soil test value. The general recommended dose is

For irrigated paddy: 6ton FYM & 100:30:30kg NPK/hac.

For rain fed paddy: 60:20:20kg NPK/hac with 8-9 ton FYM/hac.

Basel dose: ½ N + full PK at final land preparation

Top dressing: ¼ N at tillering stage & ¼ N at panicle initiation stage.

In zinc deficient in soil apply zinc sulphate @ 20-25 kg/hac once in every three year.

Irrigation:-

After transplanting water should be allowed to stand up to 2-5cm after tillering (20-25DAT) 5cm water level is maintain continuously up to dough (milking) stage. Tillering is the most critical water requirement stage.

More water levels at the time of tillering give poor tillers & less numbers of effective tillers per unit area. To provide uniform growth water should be drained once at 30 DAT, 50 DAT & 70 DAT. 7-15 days before harvesting remove water completely to

produce uniform maturation.

Weeding:

Weed is a serious problem in rice field because it is grown in rainy season which favour weed growth & rice need high fertile soil where maximum nutrient & light is used by weed because weed are heaving high availability to grown even in adverse climate.

To suppress weed manual weeding & continuously flooding irrigation can be adopted. In additional to these different herbicides are used. Two manual weeding i.e 25-30 DAT & 50-60 DAT is commonly adopted.

Herbicides like Propanil 3kg ai/hac

Bulachlor @2kg ai/hac

Fluchlorin @1kg ai/hac

Nitrofin @2kg ai/hacare used as pre- emergence herbicides at 3-4 DAT & it is effective for 35 days.

Harvesting:-

It is done when the plant reaches physiological maturity. Manual harvesting of sickle is common practice in Nepal through mechanical harvester are used in develop country. The proper time for harvesting is 30-35 days after heading or when grain posse's 77% moisture.

Threshing:-

Different techniques are used for threshing paddy they are:

- Beating rice bundles in a ground or wooden plat form.
- Bullocks are used for threshing
- Tractor threshing
- Paddy thresherare commonly used.

Drying & Storage:-

Harvesting grains are clean & dried for4-5 days in the sun light or air force drying. The seeds having 10-12% moisture are stored or marketed.

What is SRI?

The ***System of Rice Intensification,*** known as SRI. It is an agro-ecological methodologyfor increasing the productivity of irrigated rice by changing the management of plants, soil, water and nutrients. SRI is originated in Madagascarin 1980s and is based on the cropping principles of significantly reducing plant population, improving soil conditions and irrigation methods for root and plant development, and improving plant establishment methods.

Benefits of SRI

The benefits of SRI have been demonstrated in over 50 countries. They include: **20%-100% or more** increased yields, **up to a 90% reduction** in required seed, and **up to 50%** water savings SRI principles and practices have been adapted for rain fed rice with yield increases and associated economic benefits.

SRI Principles

SRI methodology is based on **four main principles** that interact with each other:

- Early, quick and healthy plant establishment
- Reduced plant density
- Improved soil conditions through enrichment with organic matter
- Reduced and controlled water application

Based on these principles, farmers can adapt recommended SRI practices to respond to their agro ecological and socioeconomic conditions. Adaptations are often undertaken to accommodate changing weather patterns, soil conditions, labour availability, water control, access to organic inputs, and the decision whether to practice fully organic agriculture or not.

Recommended SRI Management Practices for Irrigated Conditions

- Rice Plants › seedlings are transplanted:

Very young › at the 2 leaf-stage, usually between 8 and12 days old

Carefully and quickly › protecting the seedlings' roots and minimizing the transplanting shock

Singly › one plant per hill instead of 3-4 together to avoid root competition

Widely spaced › to encourage greater root and canopy growth

in a square grid pattern › 25x25 cm or wider in good quality soil

Note: Adaptations for direct-seeding and mechanical transplanting have been undertaken in a number of countries.

weeder – is most often used starting at 10 days after transplanting, repeated ideally every 7-

10 days until the canopy is closing (up to 4 times). Soil›The soil is enriched with organic matter to improve soil structure, nutrient and water holding capacity, and favour soil microbial development. Organic matter represents the base fertilization for the crop and is complemented if needed by fertilizer.

Water ›Only a minimum of water is applied during the vegetative growth period. A 1-2 cm layer of water is introduced into the paddy, followed by letting the plot dry until cracks become visible, at which time another thin layer of water is introduced. During flowering a thin layer of water is maintained, followed by alternate wetting and drying in the grain filling period, before draining the paddy 2-3 weeks before harvest. This method is called 'intermittent irrigation' or 'Alternative Wetting and Drying' (AWD). Some farmers irrigated their fields every evening, other leave their fields drying out over 3-8 days, depending on soil and climate conditions.

Nutrients ›As soils are improved through organic matter additions, many nutrients become available to the plant from the organic matter. Additionally the soil is also able to hold more nutrients in the rooting zone and release them when the plants need them. Depending on the yield level and on the farming system, some farmers use exclusive organic fertilization for their SRI plots. The majority of farmers complement the organic matter amendment with chemical fertilizers, most often urea, in order to achieve a balanced fertilization of the crop.

Weeds›While avoiding flooded conditions in the rice fields, weeds grow more vigorously, and need ideally be kept under control at an early stage. A rotary hoe - a simple, inexpensive, mechanical push-

Diseases of paddy

1. Bacterial wilt

C.O: *Xanthomonas compertris* var *oryzea*

Symptom:

Yellow to white stripes begin as water socked strips at the margin of the leaf blade. Stripes appear on the both the edges on the leaves and gradually cover the whole leaves. Bacterial effect starts from transplanting or in the nursery. They first attack the vascular bundles & gradually spread on the leaves & then in the stalk & than in panicle.

Control:-

- Drain out water from time to time to avoid bacterial infection & disease spread.
- Apply balance dose nitrogen fertilizer.
- Give 3-4 spray of Agrimycine – 100 @ 0.75gm/ litre of water & 500 gm copper only chloride (blitox) per hactar.

2. Rice blast: (maruwa)

C.O: *Pyricularia Orygae*

Symptom:

Broad or eye shaped spot with gray or dark margins appear on the leaves or leaf sheath in severe condition the spot combine to form larger spots. At the time of panicle initiation the stand below the ear head gets infection turning it into dark & dark brown spot.

Control:

- Seed treatment with thiram or beracrasn @ 2.5gm/kg seed in epidemic area spray 0.1% benelate or carbendazim 3-4 times at every 10 days interval.
- In epidemic area soil treatment is donr by using Kryoxil @ 25gm/10m².

3. Leaf spot of rice: (daduwa)

C.O: *Helminthosporium Oryzea*

Symptom:

The pathogen cause seedlings blight in the leaf. Circular, oval or irregular dark brown or purple brown spots develop in the leaf & leaf sheath. Pathogen enters inside the steam which cause rooting & plant falls off.

Control: Same as blast

4. False smut:

C.O: *Ustilagonidae Virus*

Symptom:

Symptoms Appear after flowering when milk starts developing in the kernel. The fungus multiply externally showing dark brown yellow, pink or orange coloured mass. Diseases appear on few grains in the panicle. High or sever incidence occur in heavy rainfall & use of high nitrogen fertilizer.

Control:

- Use certified seed
- Collect & destroy them as soon as possible to reduce secondary inoculums.
- Seed treatment with mercury chloride ($HgCl_2$) @ 1:1000 ($HgCl_2$:H_2O) for 30 minutes & wash the seed with cold water before sowing.

5. Tungro virus: (C.O: *Virus*)

Symptom:

Older leaves turn yellow to orange starting from tip & margin. Plant become stunted, delay flowering, panicle bear empty glumes & inter vein chlorosis Occur.

Control:

- Use certified seed.
- Uproot & destroy infected plants.
- Control sucking pest by spraying cypermethrin @ 2ml/litre of water

6. Khaira diseases: (*zinc deficiency*)

Symptoms:

It appears in the nursery & even in the field. Affected plant becomes stunted, chlorosis between the veins of new leaves where brown spots are formed in the lower leaves. Large number of small brown stripes appears.

Control:

- Spray a mixture of 5kg zinc sulphate + 2.5kg lime in 1000 litre of water & spray at 10 days & 20 days after sowing seed in the nursery.
- In the field condition spray zinc sulphate @ 20-25kg/ hactar or foliar spray of 5kg zinc sulphate + 2.5kg calcium oxide in 1000 litre of water for 500m² area (2 times at 7 day interval).

Insect - pest of paddy

1. **Steam borer:**

a) Stripped steam borer *(chilo suppresalis*)
b) Yellow steam borer (*Sciropophaga Incertula*)
c) White steam borer (*Sciropophaga innotata*)
d) Pink steam borer (*Sesamia inferens*)

Mode of action:

They lay eggs under the surface of leaf. Newly develop larvae feed 2-3 days on young tender leaf. They slowly enter inside the steam either from the top or from inner surface of leaf sheath. The affected plant shows dead heart symptoms i.e the affected part become dry.

Control:

- Apply furadon 3G @ 12.5-15kg/hac at the time of tillering stage & milking stage.
- Foilar application of systemic insecticide like cypermethrin 25Ec @ 1.5-2ml/litre of water.
- Use of BT or NPV @ 3gm or 3ml/litre of water provide effective control.
- Clean cultivation & Draining of water at 35 DAT & 55DAT minimizes borer infection.

2. Gall midge: (Orseolia Oryzea)

Mode of action:-

They have small size like mosquito. Female have bright red abdomen & they active in night. Female laid eggs on under surface of the leaves. Larvae makes tubular as if like onion leaf. It is a sucking pest.

Control:

- Clean cultivation & removable of grasses like oat & barley.
- Spray systemic pesticide @ 1.5 ml/litre of water (Decis 1.8 Ec)

3. Leaf roller: (Cnaphalacroci Spp)

Mode of action:

Adult laid eggs on under surface of leaves larvae develops & roll or web the leaves & feed internally. Feeding leaves have only skeleton without chlorophyll.

Control:-

- Clean cultivation & draining of water at 30 & 50 DAT.

- Apply systemic pesticide in the soil or foliar spray.

4. Plant hopper:

a. **Green leaf hopper** (*Nephotoltix Virescens*)

b. **Brown leaf hopper** (*Nilaparvata Lugens*)

Mode of action:-

They are sucking pest. Nymphs & adult suck the plant sap from tender leaves & steam. Point of infection turns into yellow spot called hopper burn. They also transfer viral diseases.

Control:

- Use rogar @ 1.5ml/litre of water or furadon @ 12.5kg/hactar.

5. Rice ear head / Gundi bug *(leptocorisa Oratoria)*

Mode of action:

Both nymph & adult are Active after milk formation in developing grains. They suck the milky juice from the grain & make the grain chaffy.

Control:

- Spray rogar @ 1ml/litre of water or superkillar @ 1.5ml/litre of water or carbaryl @ 0.5ml/litre of water.

Wheat

S.N: *Triticum Aestivum*

Family*: Gramineae/ Poaceae*

Distribution, Production & Area:

Wheat is one of the most important crops of the world on the basis of area used for cultivation but its productivity is less than rice & maize. It is a staple food for 1/3 of the world's population.

In Nepal it is a third important crop after rice & maize in terms of area (753470 hac) with production of (1811889 Mt) & yield (2.40 Mt/hac) as per the Nepalese agriculture statistics of 2005. The train of wheat cultivation is increasing day by day in terai region due to the release of improved variety & better irrigation facilities.

Eastern central & western terai are more popular for its cultivation. Through wheat is cultivated in almost all geographical belts in small amount.

Trade & importance:-

- Wheat is grown as cereals. Grain is used for making flour. Flour is the main source for making bread, biscuits, chapatti, noodles etc.
- Wheat flour is also used as beverages.
- Wheat brand, husk & other portion of grain obtain as bi product is utilized as animal feed.
- Wheat grains are used for making maida, suji, alcohol etc.
- Wheat straw is used for making paper, straw hat, art object etc.

Climatic requirement:

Wheat is a winter crop. Its needs cold temperature & moderate humidity (50-60%). The temperature requirement is differ in different growth stage such as for

- Germination: 24-27°c
- Tillering: 15-25°c
- Booting and heading stage: 18-30°c
- Grain filling stage: 22-32°c

500-750mm well distributed rainfall during the growing season is optimum. Wheat can be grown up to 3300 MASL.

Soil:-

Wheat needs a soil having neutral PH (6-7) with good water holding capacity. It is cultivated in the paddy land after harvesting paddy. General clay soil, clay loam or the best soil is loamy soil with proper drainage.

Variety:

Terai: Gautam, BL-1473, RR-21, NL-30, HD1982, UP 202, Nepal-297, Nepal 251, BL-1022, BL-1473, Cumbizi, Trabani, Vaskar, Rohini, Aachyut etc.

Mid hill: Kranti, Lerma-52, Lerma roho-64, Pitik-62, Annapurna-2, pashing lamu etc.

High hill: Annapurna-1, Annapurna-2, Annapurna-3, annupurna-4, Kanti etc.

Land preparation:

Land preparation is done to obtain good tilt for better germination of seed, growth & development of crop plant. One deep ploughing (20-25cm) followed by 2-3 shallow ploughing (15cm), destroy the clods, levelling the land & burning the residuals & are

the major activities. Provide treatment to termites & white grub before sowing.

Seed treatment:

Seed should be pure, viable, free from insect pest& diseases, certified, having high germination percentage, & high purity percentage. Bold seed are selected & seed are treated with Vitavix @ 2.5 gm/kg seed in a rotatory seed treatment drum. The general recommended dose of seed is 120 kg/ hactar but under late planting increase the seed rate by 10-12%.

Sowing time:

It differs depending upon the altitude that is in the hills last week of Ashoj to end of Kartik to 2nd week of Mangsir. Planting wheat after 3rd week of Mangsir, yield reduction starts. The depth of seedling is 5-6 cm for dwarf verities & 8 cm for tall variety because the length of coleoptiles is only about 3.6cm in triple dwarf variety.

Method of sowing:

Broadcasting:

- **Pora & kera method** (seeding behind the plough): when the seed is dropped in a furrow made by sallow plough (5-6cm) or seed are dropped from pora (pores) designed to sow the seed in the soil.
- **Ferti- seed drill:** It needs well pulverised soil free from clods & seed is dropped from the seed drill at proper spacing & proper placement of fertilizer.

Manure & fertilizer:-

Fertilizer requirement differs depending upon fertility status, irrigation facilities, planting time, use of organic manure & previous crop growth. In general10-15 tons FYM or compost & 100:50:50 kg NPK for irrigated crop & 60:40:25 kg NPK per hactof for rain feed crop.

Basel dose: ½ N + full PK at sowing time

Top dressing: ¼ N at 40-45 DAS & ¼ N at panicle initiation stage.

In zinc deficient in soil apply zinc sulphate @ 20-25 kg/hac once in every three year.

Irrigation:

Crown root initiation stage (20-25 DAS), tillering stage (40-45 DAS), let jointing stage (70-75 DAS), flowering stage (90-95 DAS) & milk forming stage (110-115

DAS) are the essential water requirement stage. In addition to this pre-sowing irrigation is needed. Irrigation & drainage facility should be adjusted according to its requirement.

Weeding:

Weed is a serious problem in wheat field from sowing up to tillering stage. If proper control of weed is not done reduction of yield is observed. Clean cultivation, use of weed free seed, & complete removal of weed propagules is essential. Manual weeding is not commonly used as it consumes more labour usually chemical herbicides are used.

- Weedone @ 1.4litre ai or Tafacid @ 625gm ai is mixed in 400-600 litre of water & spray at 30-35 DAS.
- Isoproturom or Dosanex-80% wp @ 1.5-2 kg ai is mixed in 400-600 litre of water & spray at 30-35 DAS.

Harvesting:

Wheat is harvest when ears turn golden colour with dry leaf & hard grains (having 27-30% moisture). Harvesting is done by sickle. Threshing is done by beating with stick or bullock trembling or by thresher.

Grain are cleaned & dried up to 12% moisture containing & than stored in air tight container & kept in free from moisture & sun light presence. For seed purpose treat the seed with vitavix @ 3gm/litre of water & stored it. For commercial purpose grain are packed in Jute sack & marketed.

1. **Insect pest of wheat**

a) **White grub** (Phyllophaga rugosa)

b) **Termites** (Odontoterms sp)

Mode of action & control:

Grubs, Nymph & adult of termites & larvae of cut worms stay in soil & feed on roots & penetrate inside the stem.

1) **Aphid** (*Myzus persicae*)
2) **Jassid** (*Emrasca bigutila bigutila*)

Mode of action: Aphids are sucking pests. They suck the plant sap & transfer viral

diseases. Jassids pierce the leaves & leaf sheath. they are also vector for viral diseases.

Control:

- Apply animal urine & water in 3:1 ratio.
- Spray secis or rogar @ of 1 ml/litre of water.

2) Field rat:

Control:

- Provide proper irrigation facilities that can remove the rats from the field.
- Prepare food based baits & place at every 5m distance on the rat path. The commonly used rodenticides in bait are Zinc phosphate, calcium arsenate etc.

Diseases of wheat & barley

1. Rust of wheat:

Brown rust (c.o- Puccinia recondita *tritici*)

Smallround orange to brown pustules irregularly distributed in the leaf & only in severe cases it attracts leaf sheath & steam**.**

Yellow rust (c.o- *Puccinia striformis*)

Small oval lemon yellow spots appear regularly in the leaves in between the veins in advance stage yellow spots gradually turns brown & the leaf sheath, steam and glumes are affected.

Black rust (c.o-*Puccinia graminis tritici*)

Elongated raddis brown pustules appear on the leaf, leaf sheath and glumes. More infection appears in the leaf sheath. in lateral stage leaf are also affected.

Control of rust:

- Adopt clean cultivation
- Grow resistant variety
- Apply balance fertilizer
- Apply sulphar dust @ 30kg/hac or spray systemic fungicide like vitevix @2.5gm/lit of water.

2. Loose smut:

C.O – *Ustilagonuda tritici* (fungus)

Symptom:

A seed borne fungal pathogen which show its symptom after heading formation. It produces black powdery mass in place of wheat grain in the spike. This powdery mass blown away by wind and attack the female gamete (stigma) and multiplies in the ovary.

Control:

- Clean cultivation
- Use certified seed
- Seed treatment with Vitavex
- Collect & burn the affected plant

3. Powdery mildew:

Symptoms:

White powdery mass of fungus appear on the upper surface of the leaf which later cover the younger parts with white powdery masses. Later these powdery mass turns into brown colour with severe infection.

Control:

- Clean cultivation
- Use certified seed
- Spray dithane M-45 or diathin Z-78 two times at 10 days interval.

Maize (*zea mays*)

Family: *Gramineae*

Origin: Central America & Mexico

Distribution, Area & Production:-

Maize is considered to have been originated in Central America & Mexico. The major maize growing countries are USA, Brazil, China, Mexico and India which produce higher yield as compare to other countries.

In Nepal maize is grown in all most all the regions from terai to hill covering an area of 802290 hactar with production of 1345910 Mt with the yield of 1678kg/hactar (according to Nepalese agriculture statistics of 1998/99). According to 2004/5 data in

Nepal 1716000 Mt maize is produced in 1542000 hactar area. The major maize growing areas are terai, inner terai, mid hill & high hill.

Trade/Economic Important:-

- Different food stuffs including bread & porridge can be prepared from maize flour.
- Green cobs are roosted or boiled & eaten with great interest.
- Maize grains are used to prepare animal, birds & fish feed.
- Maize stalks after harvest is used for fuel & thatching.
- Maize grains are used for producing starch, oil, ethyl alcohol.
- Maize grain contains about 10% protein, 4% oil, 65-70% CHO, 2-3% crud fibre & 1.4% minerals.
- It is a good source of vitamin A,E, narcotic acid, Riboflavin & lysine.
- Maize oil is good source of cooking.
- Alcohol obtain from maize grain is a suitable for petrol as develop in Brazil.
- Maize starch & synthetic polymers are used to make biodegradable plastic used in agriculture.

Climate:-

Maize can be grown in different type of climate due to its wider adoptability. It is a day neutral plant grown in summer, rainy & winter season. It requires moderate temperature of 21°c for germination, 32°c for growth & development. The ideal temperature for its growth & development is 24-32°c & maize growth stops below 12°c.

Well distributed rain fall of 500-750mm throughout the growing period provides uniform crop growth. High temperature & low humidity during flowering causes desiccation (sukaune) & death of pollen. The foliage maize is very sensitive to water stagnation so proper drainage facility is required.

Soil:-

Generally maize is grown in wider range of soil but the ideal soil is well drained sandy loam to silty loam soil free from water stagnation with neutral PH.

Variety:-

Terai:- Janaki, Sarlahi seto, Hetauda composite, Rampur yellow, Rampur composite, Rampur-2, Arun-1, Arun-2, Rampur-1.

Mid hill:- Khumal yello, Manakamana-3, Ganesh-2, Manakamana-1, Lumle-2, Hetauda composite

High hill:- Ganesh-1, Kakani yellow

Land preparation:-

Land preparation is done to obtain good tilt for better germination of seed, growth & development of crop plant. One deep ploughing (20-25cm) followed by 2-3 shallow ploughing (15cm), destroy the clods, levelling the land & burning the residuals & are the major activities. Land preparation depends upon soil texture, soil structure & soil type.

Seed & seed treatment:-

Good quality seed with high germination percentage, pure, viable, having vigorous growth habit & true to its type. If hybrid seed are used change the seed every year.

Seed should be treated with captim or thiram@ 2-3gm/kg seed in a rotary seed treatment drum.

Method of sowing:-

Sowing of maize can be done by using following methods:-

- Broadcasting
- Line sowing
- Dibbing by hand hoe
- Use a maize planter

Line sowing is more popular for commercial cultivation. The depth of sowing depends upon moisture status & soil type. In general the depth of sowing is 4cm.

Planting time:-

Maize is a day neutral plant. Planting depend upon cropping pattern, altitude, moisture in the soil & variety.

In high hill – Falgun unwards
Mid hill (600-2000) – Chait & baishak
Terai – Jesth for summer crop, Bhadra- Ashwin for winter crop.

Spacing:-

Spacing depends upon the growth habit. Composite seed require 75 x 25cm²(RR x PP) or plant population of 50000 in one hactar area. Hybrid seed require less RR x PP distance. The seed rate of 20-25 kg per hactar hybrid seed & 20 kg/hac normal seed.

Manure & Fertilizer:-

Fertilizer in maize depends upon fertility status of the soil, organic manure used, irrigation facility etc. Hybrid variety show their full yield potential only when adequate quantity of nutrient is applied at proper time. The recommended dose of fertilizer is based on soil test value. In general recommended dose is 20-30 Mt FYM & 60:30:40kg NPK/hac for rainy season crops, 120-90:40:40 kgNPK/hac for summer season crop. In zinc deficient in soil apply 20-25 kg ZnSo4/hac at every three year interval.

Method: Basal dose – ½ N + full PK

Top dressing – ½ N at tasseling / silking stage

Water management:-

Maize is very sensitive to both excessive water & moisture stress. Never allow water to stand in the maize field at every stage of its growth eg. Water stagnation for 6 hrs continuously can damage or reduce 60% yield.

Pre sowing irrigation (for summer crop), tasseling or silking stage & grain filling stage requires sufficient moisture. Apply irrigation at every 20-25 days interval.

Weeding:-

Weed is serious problem in maize because it is grown only in rainy season. If we do not control weeds at right time there is 50-60% yield reduction occurs. Weeding should be done manually to minimize weed growth. First weeding is done at20-30 DAS and second weeding is done at 40-50 DAS (7-8 leaf stage).

We can also control weed by using herbicide.

- Atrazine:- pre-emergence herbicide use@ 1-1.5 kg ai/hac in 1000 litre of water immediately after sowing.
- Alachlor (less than 50 Ec) :- pre-emergence herbicide use@ 0.5-2 kg ai/hac in 1000 litre of water.

- Simizine (Tetrazine 50wp) :- pre-emergence herbicide use@ 1-2 kg ai/hac in 1000 litre of water.

Apply the above herbicide within 2-3 days of planting. After application don't disturb the soil for 3-4 weeks.

Harvesting/Yield /storage:

Maize cobs are harvested when stalk dry fully or the moisture in grain is 27-30%. In our condition when the husk becomes fully dried with straw colour, the cobs are harvested with sickle. The harvested cobs are clean by removing the husk living 1-2 layer of husk in each cob.

By using husk bundles are made & hanged in a moisture free place. In commercial cultivation green cobs are marketed at late milking stage. After harvested the grains are extracted by hand or hand operated machine dried in the sun for few days & stored at10-12% moisture or marketed.

The average yield of maize is 11128kg/hactars.

Insect pest of maize

1. **White grub (*Phyllophaga rugosa*)**
2. **Termites (*Odontoterms sp*)**
3. **Cut worms (*Agrotis sp*)**

Mode of action (MOA):-

Grubs, Nymph & adult of termites & larvae of cut worms stay in soil & feed on roots & penetrate inside the stem.

Control:-

- Apply full decompose FYM or compost.
- Flooding the field for 24-72 hrs before sowing.
- Apply furadon-3G @ of 12.5 kg/hactar.

4. Field cricket (BrachyTrupes sp)

Mode of action (MOA):-

Nymph & adults are active at night. They cut leafs, young seedlings & take it into their holes.

Control:-

- Irrigate the field to control their holes.
- Multiply the population of wasp & apply in the field which predate the field cricket.
- Apply malathion dust in the field which cause repellent effect.

5. Maize steam borer (Chilo Partillus)

Identification:

They are small having straw coloured mouth with small dots in the wings. They are nocturnal larvae posse's black colour rings from head to abdomen with brownish body.

Mode of action:

Eggs are laid on the leaves surface the newly hatched larvae feed young leaves for few days which latter inter inside the apex & start feeding the young leaves & steam. Small irregular pores develop in the leaf & plant becomes dead heart.

Control:

- Collect the infected plant parts having egg or larvae & destroy it.
- Mass collection of adult by light trap.
- Spray endosulphan 35Ec @ 0.05% or carbaryl @ 0.1%.

Diseases of maize plant

1. **Bacterial leaf blight:**

   C.O: *Pseudomonas Avenue*

Symptom:

In the leaves long strips appears which latter turn Whitish in colour. Sometime in the centre of the strips reddish colour appears with increase in the leaf size the size of the strips increases. After tasseling or silking the infection decreases.

Control:

- Use certified diseases resistant seeds.
- Adopt crop rotation programme.
- Completely destroy the crop stubbles of previous crop during second planting.

2. **Fungal root rot**

C.O: *Pythium sp*

Symptoms:

Root rot is a major problem in Nepal mainly in those areas where there is no drainage & sole cropping (single cropping).

Infected seedlings visible lesions of colourless nature develop at the base of the plant. Brown or black stripes appear & gradually the plant turns yellow. If we pull the roots with thumb & free finger the outer covering comes out but the inner white roots remain in the soil.

Control:-

- Adopt proper drainage facility.
- Seed should be treated by carbendazim or thiram @ 2.5gm/kg seed.
- Follow crop rotation.
- If possible use resistant variety.

3. **Corn blight:**

A. **Southern corn blight**

   C.O: Helminthosporium maydis

   Individual spot are greyish or yellowish with half inch long develop in between the veins which later combines & cover the whole leaf.

B. Northern corn blight

C.O: Helminthosporium turcicum

The individual spot are greyish green or straw colour & boat shaped. They are few in number & large in size than maydis.

Control:

- Adopt clean cultivation
- Adopt proper crop rotation
- Use certified seed by treating with captan or thiram @ 2.5 gm/kg seed.
- Give 3-4 spray of zineb or maneb @ 3gm/litre of water.

4. Common smut of wheat:-

It is a seed borne fungal pathogen which shows its symptom after tasseling & silking stage. Fungus starts multiplication in the ovary as well as in the tassel. Black powdery mass of fungus appear in the male flower and ovary.

Control:

- Clean cultivation
- Use certified seed
- Seed treatment with thiram
- Collect & burn the affected plant

C. Learning process and support materials:

The learning process includes the participation of student in group work, presentation and skill development, practical methods, written methods etc.

D. Assessment

Very short (Answer question)

1. Write down the scientific name and family of rice.
2. Write down the scientific name and family of Maize.

Short (Answer question)

1. Write down the important trade of rice.
2. Write down the important trade of wheat.
3. Write down the important trade of maize.

Long (Answer question)

Write down the cultivation practices of rice with respect to:

a. Climate b. Variety

c. Land preparation d. Irrigation

e. Weeding

Write down the cultivation practices of wheat with respect to:

a. Soil b. Variety

c. Land preparation d. Irrigation

e. Harvesting

Write down the cultivation practices of maize with respect to:

a. Trade b. Family

c. Land preparation d. sowing

e. Irrigation f. Harvesting

GLOSSARY:

Alkaline soil: A soil that has an alkaline reaction, i.e., a soil for which the pH reading of the saturated soil paste is higher than 7.

Available soil water: Depth of water stored in the root zone between field capacity and PWP; mm/m soil depth.

Effective rainfall (ER): Rainfall useful for meeting crop water requirements; it excludes deep percolation, surface runoff and interception; mm/period.

Irrigation interval: Time between the start of successive field irrigation applications on the same field; days

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UNIT-3

Cultivation of Oil Seed Crops

A. Objectives:

The main objective of this course is to provide students the knowledge and Skill about improved agronomical practices of different oil seed crops.

B. Content elaboration:

Area, production and productivity of oil seed crop

According to Nepalese Agriculture Statistics of 2072/73, the total area under oilseed cultivation is 221615 hac with the production of 199010.3Mt and productivity 0.89Mt annually.

Rapeseed and Mustard

Rapeseed:

S.N: *Brassica campestris* var. toria

Brassica campestris var. sarson

Mustard:

S.N.: *Brassica juncea*

Family: Cruciferae

Origin:

Rapeseed: Eastern Afghanistan and adjoining parts of India and Pakistan.

Mustard: China

Importance

- The seeds and oil are used as condiments in the preparation of pickles and flavoring curries and vegetables.
- It is also used in the preparation of hair oil and medicines.
- The oil is utilized for human consumption in cooking and frying purpose.
- The oil cake is used as cattle feed and manure.
- Green stems and leaves are a good source of green fodder for cattles.
- The leaves of young plants are used as green vegetables as they supply enough sulphur and minerals in the diet.

Climate and soil

They are grown from the tropics to temperate climate. They need cool climate but should be free from fog and frost. Rainfall at the time of sowing and germination damages the plant emergence and growth. They grow successfully up to 2400 mean above sea level.

They grow in wide range of soil ranging from sandy loam to clay loam soil with neutral pH and free from water logging condition.

Varieties

Rapeseed

Tori: Lumle Tori-1, Pragati, Bikash, Type-9, Bhawani

Sarson: S4, S5, BR-284, BR-333, PB-24

Mustard

Pusa Bold, Krishna, Rohini, Pusa Bahar

Land preparation

The land should be well prepared before sowing the seed. Ploughing should be done 3-4 times followed by planking, removal of weed and crop stubbles. Soil should be ploughed up to 25 cm depth. Well pulverized soil with good tilth and adequate moisture is essential at the time of sowing.

Seed, seed rate and treatment

Generally true to the type and pure seed should be selected. Seeds with high germination and purity percentage are recommended. The seed rate for rapeseed and mustard cultivation is 8-10 kg/hac and depth of sowing is 2-3 cm. The seed should be treated with fungicide to protect from seed born disease (Captan, Thiram or Carbendazim @ 3gm/kg seed in powder or slurry form. In case of slurry treatment seed should be dried in shade place before sowing).

Sowing time and method of sowing

Rape seed: 15th September -15th October

Mustard: last week of September-Last week of October

The seeds are generally sown by the method of broadcasting and line sowing. Line sowing is more popular. For Line sowing 30cm×5-10cm (RR×PP) is followed.

Manure and fertilizer

The average recommended dose of manure for rapeseed and mustard cultivation is 6 ton FYM/hac.along with 60:40:20 kg NPK/hac. Fertilizers should be applied as half dose of Nitrogen and full dose of Phosphorous and potash as basal dose and remaining half dose of N as top dressing at pod forming stage.

Irrigation

The critical water requirement stages are 4-6 leaf stage, flowering stage, pod forming stage. Pre-sowing irrigation in case of dry soil. Irrigation differs depending upon soil type.

Weeding

Manually at 25-30 days after sowing. The use of pre-emergence herbicide such as Nitrofen @ 1-1.5 kg a.i./hac in 800-1000 liter of water.

Harvesting and storage

Harvesting is done by hand pulling or by cutting with sickle. It is made into bundles, kept for 8-10 days in a threshing floor or kept in heaps. Threshing is done manually by sticks or also done by bullocks. Fully dried seed are cleaned and stored in a air tight container by maintaining 8-10% moisture in the seed.

Yield:

Yield depends upon various factors such as variety to be grown, fertility status of the soil, management practices and growing season.

Rapeseed: It yields about 14-20 quintal/hac.

Mustard: It yields about 20-25 quintal/hac.

Diseases:

Alternaria leaf spot

C.o.: *Alternaria brassicae*

Alternaria brassicola

Symptoms:

This disease shows black spots on leaves, stem and pods. Distinct round, oval or irregular brownish color spot are visible which later turns brownish to black.

Control:

- Collect and burn the affected plant parts.

- Spray Mancozeb 75 WP @3gm/lit. of water.
- Treat the seed with carbendazim @3gm/kg seed.

2. Downy mildew

C.O.: *Pernospora brassicae*

Symptoms:

It appears at later stage of crop growth. It forms light green to yellow spots on the upper surface of the leaf and on the lower surface opposite to the yellow spot dirty white cottony growth of fungus can be observed.

Control:

- Crop rotation and clean cultivation.
- Seed treatment
- Collect and burn the affected plant parts.
- Spray carbendazim @2gm/lt of water.

3. **White Blister**

C.O: *Albugo candida*

Symptoms:

The disease is characterized by the white raised blisters on the leaves, stem and floral parts. These blisters burst and liberate a white powder. There is much deformity of floral parts. Flowers get malformed and become sterile.

Control:

- Keep the field free from weeds.
- Crop rotation and clean cultivation.
- Seed treatment
- Collect and burn the affected plant parts.
- Spray carbendazim @2gm/lt of water.

Insect/pests

1. Cabbage butterfly

S.N: *Pieris brassicae*

Mode of action:

The larva of this pest feed voraciously on the leaves, branches and pods of the crop.

The plants are defoliated with the result the small plants die while the grown up plant suffers in growth and yield.

Control:

- They should be collected by hand picking and killing in the early stage.
- Collect and destroy the egg masses.
- Spraying with Malathion 50 EC @1 lit/hac.

2. Bihar hairy caterpillar

S. N: *Spilosoma obligua*

Mode of action:

They feed on green leaves and tender plant. In severe case they commonly remove the green part of the plants.

Control:

- Hand picking of infected plant parts and destroying it properly.
- Collection of eggs masses from leaves and destroy it properly.
- Spray contact or systemic pesticide like Cypermethrin 50 EC @ of 1.5 ml/lit of water.

3. Mustard Aphids

S.N.:*Lipaphis erysimi*

Mode of action:

It is a very serious pest and is the main limiting factor in the production of rapeseed and mustard. Both nymph and adult suck the sap of the tender leaves, twigs, stem, inflorescence and pods by means of piercing and sucking types of mouth parts. The affected leaves usually curl and in case of severe infestation the plant wilt and dry.

Control:

- Spray Cypermethrin 35 EC @ 1.25lt/hac.
- Use of predators i.e. Lady Bird Beetle.
- Use of soap water, cow urine, ash, etc.

SUNFLOWER

S.N: *Helianthus annuus*

Family: Compositae

Origin: Southern United States and Mexico

Importance

- The oil of sunflower is light yellow in colour and possesses good odour which can be used for a variety of cooking purpose.
- Sunflower oil is rich source of linoleic acid which helps in washing out cholesterol deposition in the coronary arteries of the heart and thus is good for heart patients.
- Suitable for poultry and livestock ration.
- Seeds of sunflower can be eaten raw or roasted just like peanut.
- Oil is also used in the manufacture of soaps and cosmetics.

Climate and soil

It requires a cool climate during germination and seedling growth. Seedling tolerates frost in early stage but need warm and clear sunny days from flowering to maturity. Sunflower is a photo- insensitive crop; therefore it can be grown successfully in any season. Deep loamy soil with good drainage and irrigation facilities favours sunflower cultivation. The optimum range of soil pH for this crop is 6.5-8.5.

Varieties

- Jwala Mukhi
- PAC-36
- PAC-302
- Arun
- Sunbred-275
- GK-2002

Land preparation

The land should be well prepared before sowing the seed. Ploughing should be done 3-4 times followed by planking, removal of weed and crop stubbles. Soil should be ploughed up to 25 cm depth. Well pulverized soil with good tilth and adequate moisture is essential at the time of sowing.

Seed, seed rate and treatment

Generally true to the type and pure seed should be selected. Seeds with high germination and purity percentage are recommended. The seed rate for sunflower

cultivation is 12-15 kg/hac. Depth of seedling is 5-6 cm. The seed should be treated with fungicide to protect from seed born disease (Captan, Thiram or Carbendazim @ 3gm/kg seed in powder or slurry form. In case of slurry treatment seed should be dried in shade place before sowing).

Sowing time and method of sowing

Sowing time of sunflower is 15th Kartik to 15th Mangsir. The seeds are generally sown by line sowing, dibbing and hand planter. Line sowing is more popular.

- Spacing : 60cm*20cm

Manure and fertilizer

- 6 ton FYM, 60:40:20 kg NPK per ha
- basal dose: 1/2 N + full P, K
- Top dressing: 1/2 N at head initation stage.

Irrigation

The critical water requirement stages are:

- Pre sowing irrigation.
- At 4-6 leaf stage (21 DAS)
- At 10-12 leaf stage (50 DAS)
- Grain filling stage (90 DAS)

Weeding

Manual weeding at 25-30 DAS and 50-60 DAS. Thinning at 10-12 DAS provides better growth of crop.

Harvesting and storage

- Harvesting is done when head turns yellowish brown and upper leaf turns yellow.
- Head are harvested with sickles and then dried in the sun for 4-10 days.
- Threshing is done manually by beating the head with small sticks.
- Clean grains with 10% moisture are stored in a air tight container.

Yield

- Yield depends upon various factors such as variety to be grown, fertility status of the soil, management practices and growing season.It yields about 20

quintal/hac.

Diseases

1. Alternaria Blight

C.o.: *Alternaria helianthi*

Symptoms:

The disease appears before flowering and attacks all parts of the plant but is more intense of leaves. Spots composed of alternate light brown and dark brown concentric rings appear on the leaves.

Control:

- Collect and burn the affected plant parts.
- Spray Mancozeb 75 WP @3gm/lit. of water.
- Treat the seed with carbendazim @3gm/kg seed.

2. Rust:

C. O.: *Puccinia sp*

Symptoms:

It is characterized by appearance of pink to brown pustules on leaf and stem. Later on rusty powdery mass gets collected on the under surface of the leaf as well as on the stem. In case of severe infection the growth and development of plant stops completely.

Control:

- Collect the infected plant parts and burn.
- Seed treatment with Carbendazim @ 2.5gm/kg seed.
- Spray Carbendazim or Mancozeb @ 0.2% at every 10 days interval for 2 times.

Insect pests

1. Aphid:

Mode of action:

The aphids are small, black, soft bodies insects. They suck the sap from leaves, twigs, flowers and capsules. Seed production is seriously affected.

Control:

- Spray Cypermethrin 35 EC @ 1.25lt/hac.

- Use of predators i.e. Lady Bird Beetle.
- Use of soap water, cow urine, ash, etc.

2. Caterpillar:

Mode of action:

Caterpillar defoliates the leaves and also damages the tender capsule in the plant.

Control:

- If possible, the caterpillar should be hand-picked and destroyed.
- Dusting of 2% Methyl parathion dust on the plants at the rate of 20-25 kg/hac will control the caterpillars.

LINSEED

S.N: *Linum usitatissimum*

Family: Linaceae

Origin: Mediterranean region

Importance

- The oilcake is used for feeding cattles.
- It is also used as organic manure.
- It is used in the preparation of paints, printing ink, soap, etc

Climate and soil

It is a cool season crop which requires 21-26˚C for ideal growth. Linseed requires well distributed rainfall. High temperature and drought during flowering stage reduces the yield, oil content and oil quality.

Linseed is grown in almost all types of soil where sufficient moisture is available. Clay or clay loam soil rich in humus with a pH of 6.5-8 favours linseed cultivation.

Varieties

- Gaurav
- Garima
- Nagarkot
- Pusa-2
- Sheetal

Land preparation

The land should be well prepared before sowing the seed. Ploughing should be done

3-4 times followed by planking, removal of weed and crop stubbles. Soil should be ploughed up to 25 cm depth. Well pulverized soil with good tilth and adequate moisture is essential at the time of sowing.

Seed, seed rate and treatment

Generally true to the type and pure seed should be selected. Seeds with high germination and purity percentage are recommended. The seed rate for linseed cultivation is 20-25 kg per ha. Depth of seedling is 2-3cm. The seed should be treated with fungicide to protect from seed born disease (Captan, Thiram or Carbendazim @ 3gm/kg seed in powder or slurry form. In case of slurry treatment seed should be dried in shade place before sowing).

Sowing time and method of sowing

- Sowing time of linseed is 15th Ashwin to 15th Kartik.
- The seeds are generally sown by boardcasting.
- Spacing : 30cm*continuous (RR*PP)

Manure and fertilizer

- 6-8ton FYM, 50:40:40 kg NPK per ha
- basal dose: 1/2 N + full P, K
- Top dressing: 1/2 N at 4-6 leaf stage.

Irrigation

- Generally grown as rainfed.
- 1-2 irrigation at flowering and pod maturity stage provides good harvest.

Weeding

Manual weeding at 25-30 days after sowing (DAS) and thinning is sufficient. We can even use Isoproturon@ 1kg a.i./hac in 1000 lit. of water as pre-emergence herbicide.

Harvesting and storage

Harvesting is done when 75% of the capsule starts drying i.e. becomes yellowish brown. Harvesting is done by hand pulling or by cutting with sickle. It is made into bundles, kept for 8-10 days in a threshing floor or kept in heaps. Threshing is done manually by sticks or also done by bullocks. Fully dried seed are cleaned and stored in an air tight container by maintaining 8-10% moisture in the seed

Yield

Yield depends upon various factors such as variety to be grown, fertility status of the soil, management practices and growing season.It yields about 14- 20 quintal/hac

Diseases

1. Alternaria leaf spot

C.o.: *Alternaria lini*

Symptoms:

This disease shows black spots on leaves, stem and pods. Distinct round, oval or irregular brownish color spot are visible which later turns brownish to black.

Control:

- Collect and burn the affected plant parts.
- Spray Mancozeb 75 WP @3gm/lit. of water.
- Treat the seed with carbendazim @3gm/kg seed.

2. Downy mildew

C.O.: *Pernospora brassicae*

Symptoms:

It appears at later stage of crop growth. It forms light green to yellow spots on the upper surface of the leaf and on the lower surface opposite to the yellow spot dirty white cottony growth of fungus can be observed.

Control:

- Crop rotation and clean cultivation.
- Seed treatment
- Collect and burn the affected plant parts.
- Spray carbendazim @2gm/lt of water.
- Mancozeb @ 0.2% at every 10 days interval for 2 times.

3. Rust:

C. O.: *Melampsora lini*

Symptoms:

It is characterized by appearance of pink to brown pustules on leaf and stem. Later on rusty powdery mass gets collected on the under surface of the leaf as well as on the stem. In case of severe infection the growth and development of plant stops

completely.

Control:

- Collect the infected plant parts and burn.
- Seed treatment with Carbendazim @ 2.5gm/kg seed.
- Spray Carbendazim or Mancozeb @ 0.2% at every 10 days interval for 2 times.

4. Powdery Mildew

C.O.: *Oidium lini*

Symptoms:

It appears at later stage of crop growth. It forms light green to yellow spots on the upper surface of the leaf and on the lower surface opposite to the yellow spot dirty white cottony growth of fungus can be observed**.**

Control:

- Crop rotation and clean cultivation.
- Seed treatment
- Collect and burn the affected plant parts.
- Spray carbendazim @2gm/lt of water**.**

Insect pests

1. caterpillar:

Mode of action:

Caterpillar defoliates the leaves and also damages the tender capsule in the plant.

Control:

- If possible, the caterpillar should be hand-picked and destroyed.
- Dusting of 2% Methyl parathion dust on the plants at the rate of 20-25 kg/hac will control the caterpillars.

2. Leaf Miner:

Mode of action:

- Larva of butterfly enters into the leaf and feed internally making tunnels in the leaves. They affect the plant by reducing the photosynthetic area by eating the chlorophyll tissue of the leaves.

Control:

- Hand picking of infected plant parts and destroying it properly.
- Foliar spray of Metasystox @ 1ml/lt. of water.

C. Learning process and support materials:

The learning process includes the participation of student in group work, presentation and skill development, practical methods, written methods etc.

D. Assessment

Very short (Answer question)

1. Write down the scientific name and family of rape seed and mustard.
2. Write down the scientific name and family of sunflower.

Short (Answer question)

1. Write down the area and production of oil seed crops.
2. Enlist the pest and disease of mustard.
3. Write down pest control method of oil seed crops.

Long (Answer question)

1. Write down the cultivation practices of rape seed with respect to:

   a. Area and distribution b. Climate

   c. Variety d. Irrigation

   e. Insect pest

2. Write down the cultivation practices of sunflower with respect to:

a. Scientific name and family b. Variety

c. Land preparation d. Seed sowing

e. Harvesting

GLOSSARY:

Crop rotation: The repetitive cultivation in an ordered succession of crops on the same land. Eg. Jute- Paddy- Wheat

Herbicide: A chemical used for killing or inhibiting the growth of plant.

Weed: A weed is an unsightly, useless injurious plant growing where it is not desired and something else should grow.

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UNIT-4

Cultivation of Summer and Winter Legumes

A. Objectives:

The main objective of this course is to provide students the knowledge and Skill about improved agronomical practices of different legumes crops.

B. Content elaboration:

Importance Of legume production:

- Grain legumes are cheap source of protein for both rural and urban population of Nepal.
- Grain legumes help to prevent and cure protein mal nutrition particularly in children (50%).
- It supplies both protein and calories to human and animals.
- Legumes are adjusted in different cropping system due to their wide adaptability.
- Legumes in cropping system increase the total economic yield per unit area & increase nitrogen uptake.
- Legumes improve soil fertility by biological fixation of atmospheric nitrogen in the soil. Both grains and straw are neutriuos which are used as animal feed.
- Grain legumes are short duration income generating short duration crops.
- Some of the legumes have medicinal effect & used for blood purification eg.chikpea

Current status of legumes:

Legumes contributes 2.24% agricultural G.D.P according to 2005 agriculture data. In additional to this the production of pulses is gradually increasing i.e 326400 hac in 2071/72 & has increase to 342333.9 hac in 2072/73 (Nepalese agriculture statistics) legumes are grown in different parts of the country except manang, mustang & humla. Pulses are cultivated in almost all the area in small scale. The total area occupied pulses in 2072/73 is 342333.9 hac with production of 315940.55Mt with the productivity of 8548kg/hactar.

Lentil

S.N:- lensesculenta (musero)

Family:- leguminosea

Origin:- India & central Asia

Trade/commercial importance:

- It contains 30% protein 60% CHO 1% fat & rich in potassium, phosphorous, calcium & vitamin B, C, E. All amino acid are supplied by lentil.
- It is mainly used as dal, porridge mainly in inner terai & terai belts.
- Straw as well as grain are used as neutrinos feed for live stocks.
- It can fixed 88.114kg N/hactar per year

Climate & soil: The optimum temperature for germination is 10-15°c for vegetative growth it requires 10-19°c & to produce maximum production it requires 19-20°c. It is a long day plant matures in 85- 120 DAS it can resists moisture during drought period.

It can be cultivated in all types of soil having rich in organic matter, loose, porous, and well drained & irrigation facilities, high in nutrient contain but the ideal soil is well drain clay loam, sandy loam or silty loam soil with neutral PH. It is susceptible to acidic soil.

Improved variety:

Sindhur, Simrik, Simal, Shikhar,shikar,shital(for terai &mid hills), khajura musuro-1 & khujura musuro-2 (for western terai region),sagun,maheswor bharati for kathmandu valley & mid hils.

Land preparation:

Land should be plough up to 20-30cm during primary tillage followed by 2-3 shallow ploughing, destruction of clods, removal of crop residues & making fine soil with good tilt.

Seed & Seed treatment:

Seed should be pure, viable, vigorous growth habit, physically & genetically pure (>95%), high germination percentage & free from pest, diseases & should be certified seed.

Seed should be treated with Bavestin or carbandizim or sulphur fungicide to minimize the infection of fungal diseases. Seed treatment can be done by slurry, powder & by solution forms 2-3 gm/kg. Rhizobium treatment is important in legumes to increase nitrogen fixing ability of the crop plant.

Seed rate:

20-80 kg/hactar(for mix cropping 20-40 kg/hactar& sole cropping 70-80 kg/ hactar)

Rhizobium treatment:

To increase nodulation in legumes rhizobium treatment is done. To treat the seeds of legumes following methods are adopted.

- Prepare 10% sugar solution & heat it to boiling & then cooled to the room temperature.
- Mixed specific strain of rhizobium (250gm/half hactar seedlings) in the solution & culture it for a day.
- Seeds are dipped in rhizobium culture for an hour & dry the seed under a shade. The fully dried seeds are ready for sowing.

Sowing time & method of sowing:

In the hill & valley 15thoct- 1st week of November & in terai 1st – 15th November. Broadcasting & line sowing are the common method of growing lentil. In line sowing 15cm×15cm (RR×PP).

Manure & Fertilizer:

20 days before sowing 5ton FYM & 20:40:0kg NPK per hactar is the general recommended dose but lentil is mostly grown as relay crop & fertilizer i.e ½ N + full P & full well decomposed organic manure is applied after sowing remaining ½ N is added at flowering stage.

Weeding:

Weeding can be done as requirement of crops but annually weeding is done at 20-25 DAS.

Irrigation:

Lentil grows with residual moisture left by paddy or maize crop. It is drought resistant crop which require 1-2 irrigation i.e. at 40 DAS for vegetative growth & at flower initiation stage.

Harvesting:

Legumes crops are harvested manually by uprooting & even by cutting with sickle. The harvesting plants are made into bundles & collect in the threshing floor. They are piled in heaps or leaf open for sun drying.

Threshing is done manually by beating with sticks or by bullock treading. The harvested grain are cleaned & dried in the sun to maintain the moisture (8-10%) in the seed.

Seed are storage in a storage bin which is air tight, free from rodents & birds. The moisture content of the seed is 8-10%. Low temperature, free from direct sun light & moisture increase the storage capacity. We can even apply celphos @ 1 tablet per quintal of seed.

Marketing:

Grain of all legumes is marketed at different level depending upon their production. Cow pea pods are harvest as vegetable & all other grain legumes are harvested after seed production. The demand of legume is high but the supply is limited. For example consumption of grain legumes in Nepal is 9kg/year/person (FAO 1980) which is 4 times lower than the standard recommendation (36kg/ year/person). Thus legumes have got high market value.

Processing:

The processing units consist of traditional plate mills (made of stone), electric driven plate mills, roller mills etc. are commonly used. Hulling machine, flour mills etc. are used to split grains & to prepare powder. The flour obtain from grains is used for making verities of products. Bran, cakes meals are used for livestock & poultry feed as well as manure.

Pigeon pea (Arahar)/Red Gram

S.N:-CajanusCajan (100-375cm)

Family: - Leguminoseae

Origin: - Africa

Trade/commercial importance:-

- It contain 20-25% protein 60% CHO, 1.5% fat & rich in minerals, vitamin & amino acid.
- It can fixed 168-280kg nitrogen per hactar/year.

- Split seeds are used as dal.
- It is used as wind break & erosion reducing crop.
- Dry steam is used as fire wood & foliage as fodder.

Climate & soil:-

It needs 19-43°c for seed germination with 29-36°c for vegetative growth & 20-28°c for flowering & seed production. It can be bloom successfully 4-5 month duration. It require 600-2500 mm rain fall.

It can be grown in all soils except clay with a PH range of 6-6.5. It is commonly grown in marginal land & in rice bunds.

Variety:

Bageshwari, Rampur arahar-1 For terai & mid hills

Land preparation:

Land should be plough up to 20-30cm during primary tillage followed by 2-3 shallow ploughing, destruction of clods, removal of crop residues & making fine soil with good tilt.

Seed Treatment:

Seed should be pure, viable, vigorous growth habit, physically & genetically pure (>95%), high germination percentage & free from pest, diseases & should be certified seed.

Seed should be treated with Bavestin or carbandizim or sulphur fungicide to minimize the infection of fungal diseases. Seed treatment can be done by slurry, powder & by solution forms 2-3 gm/kg. Rhizobium treatment is important in legumes to increase nitrogen fixing ability of the crop plant.

Seed rate:

30-40 kg per hactar.

Rhizobium Treatment:

Same as lentil.

Sowing time & method of sowing:

It is grown in two season i.e 1st shower of monsoon to 15th June as rainy season crop & erosion protecting crop (winter season crop) is grown for 15th September onwards.

Spacing differs on the basis of growth habits i.e dwarf variety with spacing of 50cm × 10cm & tall variety with 75 × 25 cm.

Manure & Fertilizer:

9-11 ton / hactar of FYM or compost & 20:40:20 kg NPK/hac is the general recommend dose but farmers used on the basis of soil test value ½ N & full PK applied in line sowing at the time of planting. Remaining ½ N is applied in ring method at flower initiation.

Weeding:

Weeding is done manually at 6-8 leaf stage & 20-25 leaf stage for rainy season crop & only once i.e 8-10 leaf stage for winter season crop.

Irrigation:

Rainy season crop grow & multiply with the available rainfall but proper drainage is most needed. Winter season crops require single irrigation at the time of flowering since it is drought resistant crop irrigation is not a major problem.

Harvesting, marketing &Processing:

The whole plants are cut when most of the pods (75-80%) are dried for few days in the sun then threshing can be done vai thresher or manual efforts.dried for 10-12% moisture for storage is maintained.

Yield

The yield of pigeon pea depends upon the cultivar and cultural practices. However in rainfed condition it yield about 10-15quital/hac and in irrigated condition 15-20 quital/hac.

Chick Pea (chana)

S.N:-*Cicer Arietinum*

Family: Leguminaseae

Trade/commercial importance:-

- It contains 18-25% protein, 42-59% CHO 4-8% fat with higher amount of phosphorous along with vitamins & minerals.
- It can be used as green manure crops as it contribute 103kg N/hactar/year.
- It is a nutritious diet which can be used as raw, boiled, roosted, or soup, dal, porridge, dalmoth etc.
- Chick pea flour is used to make variety of sweets &pakaudi .
- It is a concentrate ration for livestock.

Climate & soil:-

It needs 20-30°c for seed germination with 25-31°c for flowering. It is a long day plant having indeterminate growth habit. It can be shown in rice field as relay cropping but requires 2400 ml rainfall for optimum production.

Well drained clay loam & loam soil with 6-9 PH range is suitable for its cultivation.

Variety:

Dhanush, Trishul, Radha, Sita, Kalika (for terai) & Kosheli (Terai& mid hills)

Land preparation:

Land should be plough up to 20-30cm during primary tillage followed by 2-3 shallow ploughing, destruction of clods, removal of crop residues & making fine soil with good tilt.

Seed Treatment:

Seed should be pure, viable, vigorous growth habit, physically & genetically pure (>95%), high germination percentage & free from pest, diseases & should be certified seed.

Seed rate:

50-60 kg per hactar.

Rhizobium Treatment:

Same as lentil.

Sowing time & method of sowing:

15^{th}oct to 15^{th} nov is the proper time for sowing chick pea. Broadcasting & line sowing are the common method used by the farmers. In line sowing 25cm x 10cm (RR x PP)

distance with the depth of 3 to 5cm is commonly adopted method.

Manure & Fertilizer:

Farmers used fertilizer on the basis of soil test but general fertilizer dose is:

Organic manure – 10 -15ton/hactar

N: P: K – 20:90:0 kg/hactar

Weeding:

Weeding is adopted in sole cropping but in case of relay cropping weeding operation is not common. 30-35 DAS single weeding operation increase the crop yield.

Irrigation:-

3-4 irrigation are applied depending upon soil type & growth stage i.e pre sowing, 30-35 DAS, flowering & grain filling stage.

Harvesting:

Legumes crops are harvested manually by uprooting & even by cutting with sickle. The harvesting plants are made into bundles & collect in the threshing floor. They are piled in heaps or leaf open for sun drying.

Threshing is done manually by beating with sticks or by bullock treading. The harvested grain are cleaned & dried in the sun to maintain the moisture (8-10%) in the seed.

Seed are storage in a storage bin which is air tight, free from rodents & birds. The moisture content of the seed is 8-10%. Low temperature, free from direct sun light & moisture increase the storage capacity. We can even apply celphos @ 1 tablet per quintal of seed.

Marketing:

Grain of all legumes is marketed at different level depending upon their production. Cow pea pods are harvest as vegetable & all other grain legumes are harvested after seed production. The demand of legume is high but the supply is limited. For example consumption of grain legumes in Nepal is 9kg/year/person (FAO 1980) which is 4 times lower than the standard recommendation (36kg/ year/person). Thus legumes have got high market value.

Processing:

The processing units consist of traditional plate mills (made of stone), electric driven plate mills, roller mills etc. are commonly used. Hulling machine, flour mills etc. are

used to split grains & to prepare powder. The flour obtain from grains is used for making verities of products. Bran, cakes meals are used for livestock & poultry feed as well as manure.

Cow pea

S.N:*VignaSinesis*

Family: Leguminoseae

Trade/commercial importance:-

- It contains 27-28% protein, 47-49% CHO, 1.5% fat & 5.2% fiber& rich in vitamins & other minerals.
- Dry seed are used as pulses & green tender pods are used as vegetables.
- It can fix 73-354 kg N/ hac/year so it can be used as green manure crop & forage for livestock.

Climate & soil:

It needs an average of 20°c for seed germination & below 32°c for vegetative growth & development but above 18°c is must require for grain filling. Summer crops require proper irrigation. It is a short day plant which resists drought.

Loamy soil & sandy loam soil of 6.5-7 PH is highly favourable. It can tolerate acidity up to 2.5-5.5 PH but highly sensitive to alkaline soil.

Variety:

Akash, Prakash, Surya (terai& inner terai), Sarlahi tanae, khumal tanae, trishuli ghew shimi, jhangae semi-1(mid hills, high hills, terai)

Land preparation:

Land should be plough up to 20-30cm during primary tillage followed by 2-3 shallow ploughing, destruction of clods, removal of crop residues & making fine soil with good tilt.

Seed Treatment:

Seed should be pure, viable, vigorous growth habit, physically & genetically pure (>95%), high germination percentage & free from pest, diseases & should be certified seed.

Seed rate:

60-80 kg per hactar in case of dwarf variety (Akash, Prakash, Surya) & 20-25 kg/hac in all other variety.

Rhizobium Treatment:-Same as lentil.

Sowing time & method of sowing:-

Cow peas grown in divers climate. It is sown in may- June, August- September & February- March. In line sowing 45 x 8 cm (RR x PP) for dwarf variety & 100 x 50 cm (RR x PP) for tall variety is adopted. Dibbling is also common method adopted in potato & maize field.

Manure & Fertilizer:-

20:40:20 kg NPK/hactar with 2kg FYM per plant is common/ recommended dose of fertilizer.

Weeding:-

They are deep rooted crop Which Requires weeding at 20-25 DAS & weeding + ear thing up at 40-45 DAS. Stalking is a common technique adopted for tall varieties.

Irrigation:-

Cow pea is a drought resistant crop but to produce good yield 3-4 irrigation are given for summer crop. Proper drainage facility is mostly needed for rainy season crop.

Harvesting, marketing & Processing:- Same as lentil.

Diseases of Grain legumes

1. Fusarium wilt

C.O:- *Fusariumspecies* (Fungi)

Symptom:-

Seed & soil borne pathogen that affect the seedling in advance stage. The leaf starts yellowing & after wards they dry. The plant become too yellowish, root turn black & plant become wilted.

Control:-

- Seed treatment by sulphur fungicide such as thairam@ of 2.5gm/kg seed.
- Growing of resistant variety.
- Crop rotation of legumes with cereals.
- To protect other plant in the field spray mancozeb 75wp@ of 0.2% at every 10 days interval for 3 times.

2. Rust:-

C.O:- *UromycesFabae* ,*PucciniaSpecies* (Fungi)

Symptom:-

It is characterised by appearance of pink to brown pustules on leaves & steam. Latter on rusty powdery mass gets collected on the under surface of the leaf as well as on the steam. In case of severe infection the growth & development stops completely.

Control:-

- Collect the infected plant parts & burn.
- Seed treatment with carbendazim@ of 0.2% at every 10 days interval for 2 times.

2. Downey Mildew

C.O:- *PernosporaSpp* (Fungus)

Symptom:-

It appears at late stage of crop growth. It forms light green to yellow spots on the upper surface of the leaves & on the lower surface opposite to the yellow spots dirty white cottony growth of the fungus is observed. Later the whole affected leaves get covered by cottony growth of fungus. In severe infection the yield reduction goes to 10%.

Control:-

- Clean cultivation & Crop rotation for 2-3 years can reduce soil born infection.
- Seed treatment with thiram or carbendizim @ of2.5gm/kg seed.
- In field condition spray carbendizim or bevistin@2gm/litre of water.

3. Powdery mildew

C.O:-*ErysiphePolygoni* (fungus)

Symptoms:-

Whitish patches appear on the lower leaves which gradually multiply & cover leaves, steams & pods as white powdery mass. Highly infected leaf & pods are twisted.

Control:-

- Spray sulphur fungicide or sulfex @ of 0.3%& repeat this process at 25 days interval.
- Same as rust

Anthracnose (kottre rog)

C.O:- *Colletotrichumspp* (fungus)

Symptom:-

Production of dark brown circular spots on the steam leaves which later increased in sized by developing concentric rings or ridges. The infection may increase to pods where dark brown spots become visible.

Control:-

- Spray mencozeb (zine-b)@ of 2gm/lit of water.

4. Seed/ seedling rot

C.O:- *Macrophoniaspp ,Aspergillusspp , FusariumSpp* (Fungus)

Symptoms:-

Poor emergence due to rotting of seeds, some time seedling may rot before or soon after emergence. In seed water socked lesions appear in the collar reason which latter turn brown & wrinkled.

Control:-

- Seed treatment with vitavex or thiram @ of 2.5 gm/kg seeds.
- Seedlings raised in poly bag are treated with bavestin while preparing potting material.
- Spray vitavex @ of 2gm/lit of water & repeat this process at 12 days interval.

Insects' pest of legumes

1. **White grub** (Phyllophaga rugosa)
2. **Termites** (Odontoterms sp)
3. **Cut** worms (*Agrotis sp*)

Mode of action (MOA):-

Grubs, Nymph & adult of termites & larvae of cut worms stay in soil & feed on roots & penetrate inside the steam.

Control:-

- Apply full decompose FYM or compost.
- Flooding the field for 24-72 hrs before sowing.
- Apply furadon-3G @ of 12.5 kg/hactar.

1. **Field cricket** (*BrachyTrupessp*)

Mode of action (MOA):-

Nymph & adults are active at night. They cut leafs, young seedlings & take it into their holes.

Control:-

- Irrigate the field to control their holes.
- Multiply the population of wasp & apply in the field which predate the field cricket.

2. Gram pod borer

Mode of action (MOA):-

Helincoverpa is a serious pest that affects the developing pods & even the green foliage. They have baiting & chewing type of mouth part. They may remain hidden inside the pods. Single larvae can damage 5-7 pods in single life cycle.

Control:-

- Spray Nuvacron/Monocrotophos 35ec @ of 1.5 ml/lit of water at the time of pod formation
- Collection of egg masses from leaves & in case of minor damage affected pod can be collect & destroyed
- Spray colorophyrous @ of 1.5 ml/lit of water or Endosulphan 35Ec @ of 0.2%.

3. Aphids

S.N:- *Lipaphis Erysimi* (oil seed) , *Brevicoryne Brassicae* (cole crop) ,

Myzus Persicae (cotton)

Mode of action (MOA):-

They produce honey dew & reduce the rate of photosynthesis. They are sucking pest they suck the plant sap from tender, leaves, buds and pods. They also transfer viral diseases.

Control

- Use animal urine water in 1:1 ratio, provides effective control by applying at every 3 days interval.
- Systemic pesticides like Delphin @ 1.5 ml/lit. Of water, Decis or Rogar @ 1.5 ml/lit. Of water.

4. Leaf Miner

S.N: *phytomyza harticala*

Mode of Action

Larva feed by making tunnels in the leaves. They cause serious damage during December to march. They reduce the amount of chlorophyll which minimizes the rate of photosynthesis.

Control

- Spray systemic pesticide like rogar, decis or metasystox @1ml/lit of water.

5. Bihar hairy caterpillar

S.N: *spilosoma obliqua*

Mode of Action

Larvas are voracious feeder. They feed the young leaves, twigs and can defoliate the whole plant. 3 species of hairy caterpillar affect the legumes.

Control

- Collection and destruction of eggs and larva.
- Use *Bt*. or NPV @ 3 gm or 3ml/lit of water. It starts controlling the larva after 8-10 days of spray.
- Spray Chloropyriphos or Malathion @ 1.5ml/lit of water. Use sticker @ 1 ml/lit of water.

C. Learning process and support materials:

The learning process includes the participation of student in group work, presentation and skill development, practical methods, written methods etc.

D. Assessment

Very short (Answer question)

1. Write down the scientific name and family of lentil.
2. Write down the scientific name and family of cow pea.

Short (Answer question)

1. Write down the important trade of legumes crops.
2. Write down the important variety of lentil.
3. Enlist the pest and disease of legumes crop.

Long (Answer question)

1.Write down the cultivation practices of lentil with respect to:

a. Climate b. Variety

c. Land preparation d. Irrigation

e. Weeding f. Harvesting

2.Write down the cultivation practices of Pigeon pea with respect to:

a. Scientific name and familyb. Variety

c. Land preparation d. sowing

e. Marketing

GLOSSARY:

Grains: The fruit of large seeded grasses. Botanically a grain or kernel is a fruit containing one seed.

Green manuring: A practice of ploughing or turning into the soil the undecomposed green plant tissue for the purpose of improving physical structures as well as fertility of the soil.

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UNIT-5

Cultivation of Industrial Crops

A. Objectives:

The main objective of this course is to provide students the knowledge and Skill about improved agronomical practices of different industrial crops.

B. Content elaboration:

Sugarcane

S.N.: Saccharum officinarum

Family: Gramineae

Origin: New Guinea

Importance:

- Sugarcane is the main source of sugar. Sugarcane juice is used for making white sugar, brown sugar and jaggery
- It is a cash crop covering largest area comparing to other cash crop. It is one of the main crops of earning foreign exchange.
- Sugarcane is a raw materials for several factories i.e. sugar, wine, molasses, etc.
- Molasses is used as good feeds for livestock.
- Green tops of sugarcane are a good source of fodder for cattle.
- It can provide high employment from the field to the processing and storage unit.
- It is used for making juice, wine, sweets, etc.
- It can be grown as ratoon crop which greatly reduces labour requirement.

Area, production and productivity of sugarcane crop

According to Nepalese Agriculture Statistics of 2072/73, the total area under sugarcane cultivation is 67372 hac with the production of 2988418Mt and productivity 44.35Mt annually.

The major districts for sugarcane cultivation are: Jhapa, Morang, Sunsari, Saptari, Siraha, Dhanusha, Mahottari, Sarlahi, Rautahat, Bara, Parsa and Chitwan.

Climate and soil

Sugarcane is a tropical crop but can also be grown in sub-tropical region. It requires temperature of 26-32˚C for better growth and development. It requires 1000-1500mm yearly rainfall. Sugarcane requires a long growing season, from 10 to 12 months, because certain number of heat unit is required to bring the plant to maturity.

Sugarcane can be grown in all types of soil but well drained loamy soil with pH 6.5 to 7.5 is optimum for sugarcane.

Variety

A) Early maturity variety

Jitpur-1, Jitpur-2, BO-128, COP-9301, COS-8436, COS- 95425, COS-98231

B) Mid/Late Maturity variety

BO-110, Kas-767, COS-8432

Rainfed Crop variety

BO-91, Kas-737, Jitpur-2, BO-128

C) Water Resistant variety

BO-91, Jitpur-2, BO-128, UP-9530, COS-96436

Land preparation

Sugarcane requires a very clean preparation of land. Sugarcane needs deep tillage. Shallow ploughing with local plough limits the development of root system resulting in lodging of cane plants. Deep ploughing specially in heavy soils helps in the root system penetrating deep into the soil.

One deep ploughing followed by 5-6 ploughing will be enough. Make the field smooth and clod free and complete removal of weed should be done.

Planting season

Sugarcane is mainly planted in two seasons:

Autumn planting (October or 15th Ashoj to end of Kartik)

Spring planting (February or 15th Magh- end of Falgun)

Planting material

1)Top one-third part of the cane setts:

They are active, young, viable which provides faster and quicker germination.

2) Immature cane setts:

Sugarcane planted in February is cut after 6-7 month to prepare immature cane setts.

3) Rayungans:

It is a Japanese word meaning a developed cane setts. In this method, cut off the top of the standing canes and apply high amount of fertilizer and irrigation. Rayungans become ready after 4-6 weeks of topping to use as seedling materials.

4) Single bud settlings:

Cane setts with roots and shoots are known as settlings. Cut one buded setts and after treatment with fungicide, plant it in the nursery by making potting mixture. After 45-55 days it becomes ready for planting in the main field.

5) Water suckers:

They are the tiller which comes in the vicinity of the main shoots. They are not used in commercial purpose.

Sugarcane treatment

To control fungal disease setts are treated with vitavex, carbendazim @ 3gm/lit of water. Setts are dipped in pesticide solution for 5 minutes before planting.

Method of planting

Four types of planting methods are commercially practiced in sugarcane. They are:

A) Furrow method

90% of the farmers in Nepal use these method of planting. After field preparation, make a furrow of 15-20 cm deep at a distance of 90cm (R*R). Apply basal dose of fertilizer in the furrow and plant three buded setts by end to end or bud to bud method.

B) Trench method:

It is popular in area where there is high wind velocity. It is common for longer cane varieties, heavy production and lodging tendency. After field preparation make a trench of 30 cm deep at 90cm(R*R) distance. Apply FYM and basal dose of fertilizer mixed with soil and then place 3 buded setts with bud to bud method.

C) Pit or Ring Method:

Make a pit of 40cm diameter with 30 cm depth. Apply 8kg FYM and 10:10:10 gm

NPK Per pit , 2 buded setts are placed along with 5gm Phorate and covers 5-7cm with the soil.

D) Transplanting method:

It is a common method used for gap filling. Potting mixture is placed in the polythene bag and 1 buded setts which is treated with fungicide is placed in each polybag. Temporary thatch house is prepared over the nursery bed. The seedling becomes ready for gap filling or transplanting within45-55 days. (4-6 leaf stage).

Manure and fertilizer

Sugarcane needs high amount of nutrient as compare to other crop. The general fertilizer dose is 100 qntl/hac of FYM and 150:100:100 kg NPK/hac is the requirement of chemical fertilizer in rainfed condition and 120:60:40 kg NPK/hac in irrigated condition.

Basal dose: ½ N,full P,K

Top dressing: ¼ N at 60-75 days after transplanting.

¼ N at the time of earthing up.

Irrigation

The frequency and amount of irrigation depends upon:

For autumn planting: 6-7 irrigation

For spring planting: 4-5 irrigation

First irrigation should be given at 40-45 days after planting then after the irrigation can be given at 20-25 days interval. Apply irrigation during fertilizer application and after earthing up.

Training in sugarcane

Training involves proper weeding, earthing up, propping and wrapping.

A) Weeding:

To minimize weed infestation 2 weeding are done i.e. 30-40 DAP, 55-60 DAP. Weeding also helps to improve aeration, provide mulching and saves nutrient loss.

B) Earthing up:

When canes becomes 2-3 feet tall first earthing up is done and 2nd earthing up is done

at top dressing (90 DAP). Earthing up prevents the canes from lodging, reduce the production of water suckers and provide faster growth.

C) Propping:

It is the process of binding the canes in a triangular manner by rice straw or by twisting of leaves to prevent lodging of canes. Generally canes of 2 hills of one row are tight with one hill of another row in a triangular manner. It completely protects the plant from lodging even in areas having high wind velocity.

D) Wrapping:

It is the system of removing old, dried leaves from canes. The main purpose of wrapping is:

- To reduce hibernating place for insect pest and pathogens.
- The stem with dry leaves becomes heavier and there is more chance of lodging, so wrapping prevents from lodging.

Harvesting

Sugarcane is harvested when it reaches the stage of maturity with highest sugar content. The taste of ripeness is usually done by taking random sample at 7-10 days interval by examining the juice with Hand refractometer. If the sample of juice taken from middle portion of stalk shows a reading between 17 and 18, the cane crops may be considered ready for harvest.

Stalks are cut at the ground level, preferably after digging down the earthed up ridges. The dried leaves are stripped off from the cane and green top is cut from the topmost part of the cane and clean canes are tied up in bundles.

Yields:

Yield depends upon various factors such as variety to be grown, fertility status of the soil, management practices and growing season.

Sugarcane yields about 43141 kg/hac.

RATOONING

- After the harvest of main crop of sugarcane the stubbles which remain inside the soil sprout again and give rise to another crop of sugarcane which is called ratooning.

- Ratooning saves 50-60 qntl/hac of planting materials, labour need for land preparation, preparing planting materials,etc.
- Ratoon crops give same yield as main crops if managed properly.

RATOON MANAGEMENT

- After harvest of main crop, ridges should be destroyed to create better air-water relationship. The leaves, weeds, etc should be burned completely and add organic manures.
- Gap filling is done after sprouting of ratoon. One buded seedling is used for gap filling.
- Apply basal dose of fertilizer with 25% more nitrogen then that of main crop as they are shallow rooted and cannot absorbs nutrients as compare to main crop.
- Frequency of irrigation is more for ratoons which should be given at 15-20 days intervals.
- Apply proper plant protection measures to control termites, early shoot borer and other soil pest.

Processing of sugarcane

Harvesting

Sugarcane should be cut when it reaches the peak maturation, with a maximum content of sucrose and minimum of simple sugars (reducers). These reducing sugars do not crystallize during the sugar or "sakhar" processing, therefore prejudicing their production, besides affecting the flavor (sensorial quality) of the products.

Transport

It may be accomplished in motorized vehicles (trucks and vans) or with animal traction (bulls, horses, asses, etc). The vehicles must be clean to avoid impurities such as dirt and stones to contaminate the sugarcane, nor endanger the quality of the juice and the grinding efficiency. The sugarcanes should be cut and transported to the mill in order to be ground, preferentially at the same day they were cut.

Washing

This stage is optional. In the case it is accomplished, the drinking water must be used. This stage helps to reduce the contamination of the juice by dirt, straw, and other strange materials. The straw contributes to an increase in the volume of the fiber to be

processed during juice extraction.

Milling

The main objective of sugarcane milling is the extraction of the juice from the sugarcane. This stage occurs in equipment so-called mills. The cut and clean or yet washed sugarcane passes through rollers of the milling equipment, where the extraction of the juice occurs and a fibrous by-product so-called bagasse is the leftover. The sun-dried bagasse is the fuel to be burned for the obtainment of thermal energy to be used in concentration of the sugarcane juice. The mill or the juice extracting mill should be always well lubricated, regulated and friezed.

Filtering and Settling

The broth in a settling must be placed so that coarse impurities presents in the broth settle, separating them. In this way, these are removed by the deep one, and the light ones stay in the top. The filtration has as objective to remove these light impurities that stay in the top. For this, a filter of coarse mesh is used (07 mesh). This stage is of extreme importance because it allows the work with cleaner broth of sugarcane, contributing for the attendance of the quality requirements. Also, if carried through well, eliminates it necessity of one second settling in the manufacture of the sugarcane syrup one.

Preparation and cleaning of the juice

The normal sugarcane juice has a pH around 5.7. In case it is below this value, it is necessary to correct the acidity in order to avoid an excessive darkening of the product, besides the excessive inversion of sucrose, which is harmful in the case of both sugar and ‘sakhar’ production. This correction is accomplished in the juice destined to the production of those two products; in the case of sugarcane syrup, this operation is not necessary.

Correction is accomplished, by adding the milk of lime to the cold juice or during heating, when juice is at the range temperature of 55ºC to 60ºC. The milk of lime is slowly added to the cold juice, and then this juice is vigorously agitated. The milk of lime is prepared, by extinguishing the CaO (calcium oxide or quicklime) in water. The CaO added to a low water volume and the obtained suspension are sieved and added to the juice. The CaO should have purity content between 85 and 95%.

Concentration and Cooling

The juice is poured into large bowels, where it will be warmed. As boiling goes on, the juice must be constantly stirred until becoming concentrated – at the end it can reach up to 92ºBrix, depending on the product. During this phase, consistent foam will appear on the surface of the juice. This foam contains some impurities that must be removed. The qualities of the sugar, and sugarcane syrup will depend on the efficiency of the clarification work (juice cleaning) accomplished at this phase. The cooking end of the may be verified through several practical alternatives, and one of them is the toffee proof which consists of removing approximately 50 ml from the syrup undergoing concentration and pouring it into a vessel with cold water. By handling with the fingers, the syrup turns cold and becomes a candy from which the desirable consistence depends on the product under manufacturing sugar. The concentration temperature of the syrup and its final Brix vary as a function of the final product.

Special Safety Cares

As the production of these products involves operations in that the temperatures are high, it is recommended that the operators work with gloves, apron of impermeable material and small boots. With that broth splashes and hot syrup and consequent burns can be avoided. And important that the equipments allow a better handling of the operations. The use of extinguishers of fires is now a demand.

Quality Control

Quality is considered as the group of characteristics that differentiate the individual product units and are important for determination of this unit acceptability level by the buyer/consumer. The quality must be throughout the environment of the production system. In other words, since choosing the sugarcane varieties, the area and soil for planting, cutting and transportation of the sugarcane, facilities and cares during all production operations, safety of the labor or staff until the product to be acquired by the consumer.In fact, even beyond this point, when consumer is advised for the best way to using the product.

Raw material quality attributes

The sugar content in the sugarcane juice: this parameter affects the industrial production. It may be estimated through either soluble solids (°Brix), by using instruments so-called refractometers. Sugarcane pH: the average pH is around 5.5.

Strange matter: they might be from vegetable or mineral origin; the one from vegetal origin is constituted of sugarcane straw and weeds, whereas that from mineral origin is the earth. These impurities should not be transported to the industries, because they can endanger the quality of the final products.

Insect pests

1. Early shoot Borer

S. N.: *Chilo infuscatellus*

Mode of action:

Larva born on the under surface of the leaves starts feeding young tender leaves and enter by making tunnel and eat the tender stem tip causing dead heart to the plant.

2. Root Borer

S. N.: *Emmalocera depressella*

MOA:

Young larvas feed 2-3 days on green leaves and gradually move to the root region making semi-circular tunnels. Roots mainly the basal part is destroyed and plant shows wilting.

3. Top Borer

S. N.: *Tryporyza nivella*

MOA:

Larva develops on the under surface of the young leaves, feed tender leaves for 2-3 days and then enter from the top causing dead heart. After node formation the pest attack the top most node and then gradually moves downward.

Control of Borer:

- Use light traps to control adults.
- Apply Carbofuran @1kg a. i. followed by irrigation.
- Spray Endosulphan 35 EC or Nuvacrone @ 1.5 ml/lit of water.
- Apply Phorate @12.5 kg/hac at the time ofplanting.

Diseases

1. Red Rot

C.O.: *Collectotrichum falcatum*

Symptom:

The stalk becomes red, dry, wrinkled and hollow. If the stalks are open the pith is found reddened. The disease part emits alcoholic smell. These pathogen lives in dry leaves, stubbles and setts for many years.

Control:

- Clean cultivation and management of diseases free ratoon.
- Sett treatment with Carbendazim @ 3 gm/lit of water.

2. Smut:

C.O.: *Ustilago scitaminea*

Symptom:

It causes greater damage in later stage. The disease appear in the form of long, black, whip like structure at the apex of the stalk, infected plants produce more tillers and canes are taller than normal cane.

Control:

- Clean cultivation and management of diseases free ratoon.
- Sett treatment with Carbendazim @ 3 gm/lit of water.

3. Ratoon Stunting

C.O.: Ratoon stunting virus

Symptoms:

The plant remains stunted with short and thin canes. The leaves are completely pale and the roots are poorly developed. A pink coloration at the growing point is the main symptom.

Control:

- Do not ratoon the diseased crop.
- Use setts from healthy crop

4. Albino (Grassy shoot virus)

C.O.: Grassy shoot virus

Symptoms:

Affected plants give numerous very thin tillers. This tillers bear pale yellow colour with narrow leaves like grasses. Internode of this tillers are much reduces.

Control:

- Use disease free setts for planting.
- Infected ratoons are removed immediately from the field.
- Uproot and destroy the affected parts.

TOBACCO

S.N.: *Nicotiana spp.*

Family: *Solanaceae*

Origin: North West Argentina and Peru

Area, production and productivity

According to Nepalese Agriculture Statistics of 2072/73, the total area under tobacco cultivation is 372 hac with the production of 602Mt and productivity 0.013 Mt annually.

Importance

- It is an important cash crop.
- Tobacco is mainly grown for its leaves which are used to produce cigarettes, cigars and other products.
- It is used in preparation of Nicotine sulphate which is use as an insecticide.
- It is also used as a source of nicotinic acid (a component of Vitamin B complex.)

Climatic requirements and soil

Tobacco is a tropical crop. Tobacco seeds requires about 21˚C temperature for germination. Temperature between 27 and 32˚C are desirable for rapid uniform germination. Tobacco plant grows and matures rapidly when average temperatures are about 25˚C. Lower temperature increases the growth period. During cold weather and at low temperatures there is slow growth of the plants and this also affects the quality of the tobacco. Similarly, during very hot weather and high temperatures there is loss of moisture from the tissues of the plant and as a result of it the leaves become thicker and the aroma becomes stronger. Atmospheric humidity also influences the quality of the leaf and also the yield and curing of the leaves. Droughty conditions along with low humidity affect the quality and yield adversely. A crop which has been subject to a moderate drought throughout growing period produces leaves which are thicker, darker in colour, have more gum, does not ferment well and are inferior in

taste and aroma.

The water requirements of the tobacco plant are very high. When it is grown as a rainfed crop, it requires at least 50cm of well distributed rainfall throughout the growing season. Rainfall is undesirable at the time of maturing of the crop as gums and resins on the leaf get washed. Tobacco suffers severe injury from strong winds and hail.

Quality of tobacco is greatly influenced by the soil conditions. Tobacco is adapted to moderately acidic soils, with a pH ranging from 5.5 to 6.5. Tobacco will not grow well in water logged soils as it is sensitive to water logging condition.

Varieties

- Oxford
- Maryland
- Sona
- Virginia Gold
- Virginia Bright
- Harrison Special

Land preparation

A clean and well pulverized field of good tilth is needed for transplanting tobacco seedlings. The field is ploughed 2 or 3 months before the seedlings are transplanted. As a rule deep plough with mould board plough and three four cross harrowing are practiced. Each harrowing is followed by planking to make the soil pulverized and leveled.

Sowing

Tobacco seeds are very small and are not sown directly in the field, but are sown in nursery. While the main field is being prepared tobacco seedling are raised in specially prepared seed beds. Much of the success in growing a good crop of tobacco depends on the production of healthy and vigorous seedlings. Usually, at least six to eight weeks are required to obtain transplantable seedlings.

Transplanting

Seedling with good root system and 5-6 leaves are planted. Transplanting is done in the month of March –April. Seedling are transplanted at a distance of R*R: 50-100cm

and P*P: 10-60cm.

Manures and fertilizers

In tobacco crop it is a well-known fact that economic returns are largely dependent on the right combination of yield and quality rather than on the yield alone. Quality in tobacco, particularly in the smoking types depends on the balance of the nutrients in the leaf. Heavy manuring with nitrogen increases the yield, but has an adverse effect on the quality. With excess of nitrogen supply, the carbohydrate-nitrogen ratio gets reduced. It is observed that in chewing, bidi and hookah tobaccos better quality is generally associated with higher yields that may be obtained with heavy manuring of nitrogen together with other nutrients. Phosphorous requirement of tobacco is comparatively low. Potash is an important element.

In addition to the inorganic fertilizers, application of organic matter in the form of well-rotten farm yard manure or compost is also recommended at the rate of 6-7 tonns/hac for heavy soils and 10-12 tonns/hac for light soils to improve the physical condition of the soil.

Plant management

Plant management of tobacco includes soil loosening, weeding, top dressing, irrigation, topping and desuckering.

Weed control

Interculture operations should start after 10-15 days of transplanting when the seedlings are well established. Tobacco is a quick growing crop which requires good aeration in the soil. It is very susceptible to poor aeration and water logging conditions. Interculture with khurpi or hoe helps in removing the weeds and improves aeration in the soil.

Water management

Water requirement of tobacco crop depends upon the type of tobacco and the region where it is grown. The irrigation requirement of tobacco crop often depends on the distribution of rainfall, soil moisture status, stage of crop growth. In order to raise a successful crop on light soils it is necessary that correct quality of water is given through timely irrigations. Too much irrigation leaches the nutrients from the soil and produces slick leaf with dirty colour. Insufficient irrigation, on the other hand, restricts

crop growth and the curing of leaf becomes difficult.

Topping

It is most important operation for quality of tobacco leaf. It gives a uniform quality product and prevents excessive coarseness in the leaves. It prevents the plants from producing seeds and allows carbohydrates and nutrients to go towards vegetative part instead of reproductive. It causes thickening of the leaves and increase their body. It helps in the increment of sugar and nicotine content especially in the upper leaves

Desuckering

Because of the topping the dormant buds in the axils of leaves becomes active and develop into shoots known as sucker. Removal of these suckers or lateral branches is called desuckering. Suckers should be removed as soon as they are large enough to be pulled.

Harvesting

In tobacco the leaves do not ripe uniformly. The first to ripe are the lower old leaves then the middle ones follow and after that upper leaves. The ripening process in the tobacco plants consists in the deposition of starch and gradual elimination of green coloring matters. So, when the leaves are ready to harvest they turn into lighter shade of green to slightly yellow colour and become thick and so brittle that when a section of leaf is folded between figures it snaps easily. Usually harvesting starts after 55-60 days of transplanting. Generally 2 methods of harvesting are practiced. They are

1) Priming
2) Stalk cutting

1) Priming

In this method, harvesting starts from the bottom and each time 2- 3 leaves are harvested at weekly interval. The entire harvesting is completed in about 5-6 priming. After harvesting the leaves are strung on bamboo sticks @ of 100 leaves per stick and are loaded in the barn for curing.

2) Stalk cutting

The entire plant is cut close to the ground with sharp sickle and left over night in the field for curing. The stalk is then hung upon a stick. It is done by piercing the stalk near its base with a removable metal placed on the end of the stick. A stick holds 6 to

8 stalks. Plants are allowed to wilt for 4-5 days. Wilted plants are easier to handle without damage. The leaves are not removed from the stalk until curing is finished.

PROCESSING

Curing

It is most important operation in tobacco production. It is done in order to impart the required colour, texture and aroma to the final product. Curing involves the process of drying decomposition of chlorophyll until the green colour disappears from the leaf.

Different types of curing

1) Flue curing:

The harvested leaves are strung on bamboo sticks which are then placed on flue cured barn. Flue curing is usually done in brick barns. The green leaves are loaded on the upper half and lighter ones on lower half. Curing process consists of three main stages:

i) Yellowing of the leaf:

For yellowing of the leaf, a temperature ranging from 26 to 28.3˚C is kept during the first 12 hours and then raised to 36.6 ˚C for the next 6-7 hours. After that temperature of 36.6 to 37.7 ˚C are used for 12-15 hours when the leaves become yellow. The main objective is to give optimum humidity and retain as moisture as possible to keep the leaves alive for 30-36 hrs.

ii) Fixing the colour:

After yellowing the temperature is gradually raised and humidity is lowered by opening ventilation. Temperature is increased from 37.7 to 48.8˚C in order to kill the leaf, destroy the enzymes and dry out the web of the leaf. At this stage the leaves becomes dry but the midrib and the vein still contain some moisture. So fixing is a critical process and should be carried out with great care. About 80% of the moisture should be driven off. It takes about 12 to 24 hrs.

iii) Drying of the leaf:

It lasts from 28 to 50hrs. The ventilators are closed and the temperature is raised up to 74˚C in order to dry the veins and midrib. After this process, ventilators are opened to cool down the barn. The leaves are left in barn overnight for absorbing moisture and to come to normal condition for handling and storage.

2. Air curing

This is a natural process and curing is done in a wooden barn under normal atmospheric conditions. The leaf should be yellow before it dries out and after that the rate of drying is gradually increased by increasing ventilation. After this, leaves are placed in a pit for 24 hours and then transferred to 2nd pit for 48 hours and then back to first pit for 24-48 hours. During this process, fermentation of leaves takes place and leaves attain dark brown colour with fruity smell.

3. Fire curing

Leaves are harvested in such a way that a small portion of stem remains attached to leaves. The leaves are allowed to wilt in the field for few hours, the tied into the bundles and then hung in a smoke hut. They are smoked for about 12 hours by burning dried leaves of trees. After this dried leaves are fermented in bulk for 3-4 weeks. The fermented leaves are then treated with salt water.

4. Sun curing

Most commonly adopted method by Nepalese farmers. There are several modifications in sun curing:

a) Curing whole plants on racks.

After initial wilting in the field the plants are strung on bamboo poles and cured in sun. The entire process takes about 15 to 20 days.

b) Curing leaves with pieces of stem on racks.

In this method of curing, racks are not exposed on the direct sun, therefore it takes longer period. (6-8 weeks).

c) Curing whole plant on the ground.

In this curing, leaves are allowed to dry in sun on the ground and are turned over twice a day. This process continues for about a week and then heaps are made which are opened on the next day and reheaped.

- This process of heaping, opening of heaps, and spreading and reheaping continues for about 10 to 15 days.
- By the end of this period leaves become completely cured.

Yield

Yield depends upon various factors such as variety to be grown, fertility status of the soil, management practices and growing season. It yields about 1298 kg /hac.

C. Learning process and support materials:

The learning process includes the participation of student in group work, presentation and skill development, practical methods, written methods etc.

D. Assessment

Very short (Answer question)

1. Define ratooning.
2. Define toping.
3. Define curing.

Short (Answer question)

1. Write down the economic importance of sugarcane.
2. Write down the variety of tobacco.
3. Differentiate between propping and desuckering.

Long (Answer question)

Write down the cultivation practices of sugarcane with respect to:

a. Climate b. Variety

c. Land preparation d. Method of planting

e. Fertilizer e. Maketing

Write down the ratoon management in sugarcane.

Write down the cultivation practices of tobacco with respect to:

a. Trade b. Soil

c. Land preparation d. sowing

e. Manure and fertilizer f. Harvesting

g. Curing

GLOSSARY:

Cash crop: Crop grown for sale and brings money immediately. Eg. Tobacco

Ratoon crop: The practice of taking the second crop from previous one is known as ratooning.

Sugar crop: The crop grown for the purpose of producing sugar from them. Eg. Sugarcane

Topping: The removal of the terminal bud with or without some of the small top leaves just before or after the emergence of a flower bud.

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