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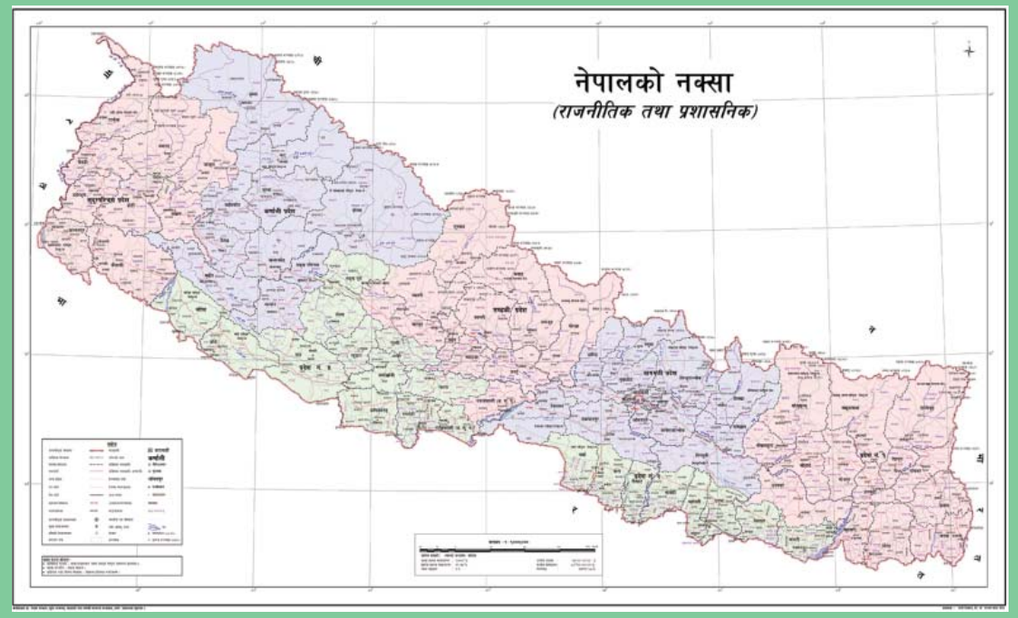

Commercial Vegetable Production and Marketing

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

Learning Resource Material

Commercial Vegetable Production and Marketing Management

(Grade 12)

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.

2076 BS

Ministry of Education, Science and Technology

Curriculum Development Centre

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UNIT- 1
INTRODUCTION

A. Objectives

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

- Explain the importance, scope and constraints of vegetable crop production.
- Classify the different vegetable crops.

B. Content elaboration

1.1. Importance and Scope 1

The term, horticulture is derived from two Latin words, i.e. 'hortus' means garden and 'cultura' means cultivation. Vegetables can be defined as "those annual, perennial non woody plants of which mature or immature succulents' roots, stems, leaf, bulbs, fruits or seed etc. which are eaten as raw or cooked".Definition of vegetables centers on its uses. A plant may be vegetables in one country but a fruit or weed or ornamental plants or medicinal plants in other countries depending upon the use of the crop.

Importance of vegetables

1) Nutritional importance

Nepal is an agricultural country. More than 65% of the population depends upon farming for living. A sustainable number of farmers grow vegetables as main crops or secondary crops. Vegetables production has great influence on the improvement of farm economy and enrichment of the diet. The importance of vegetable in human diet is well known since time immemorial as they supply main components of human diet. As the cereal grain cannot supply enough proteins, vitamins, minerals etc. Vegetables are considered as cheaper sources of vitamins and minerals.

Vegetables contain carbohydrate, proteins, minerals, vitamins, and also possess medicinal properties. Thus vegetables play a vital role in the balance diet of human being.

According to human dieticians about 300 gram vegetables (125 gm. leafy vegetables, 100 gm. root and tuber vegetables and 75 gm. other vegetables) per capita per day are required. But the availability of vegetables in Nepal is only 145 gm. Per capita per day which is very low compared to the recommended dose. The importance of vegetables at future increases as most of the Nepalese population is vegetarians.

Except Tomato, most of the vegetables are alkaline in nature which neutralizes the acidic effect caused by non-vegetarian foods.

1. Consumption of vegetables is necessary for maintaining good health.
2. Vegetables are considered as protective food against diseases.
3. Vegetables are rich and cheap sources of vitamins, minerals, proteins and carbohydrate.
4. They play an important role in balanced diet.
5. Most fresh vegetables contains more than 80% water, the remaining 20% constitutes proteins, carbohydrate, vitamins and minerals.
6. Vegetables are mostly alkali foods and they neutralize the other acidic foods.
7. Vegetables contain a high amount of fibers which help in cleaning the alimentary canal.

Medicinal importance

- White cabbage contains vitamin "U" (ulcus) which prevent ulcer.
- Bitter gourd is used for treating diabetes.
- The ash guard is useful for patients with weak nervous system.
- Vegetable contains antioxidant and bioflavonoids which neutralize free radical formed during metabolism of foods.

Functions and Deficiency Symptoms of Various Nutrients :

Nutrients	Nutritional Contribution	Functions	Deficiency Symptoms/ Medicinal Importance	Sources
Carbohy-drate	100 gm. of edible part of the crops	Supply energy (4 Kcal/gm.) and help in	Loss of energy and weakness	Pea, Beans, Sweet Potato,

	gives the following amount of carbohydrate; Leafy vegetables:- 8.7 gm. CHO. Fruit vegetables:- 5.3 gm CHO. Roots vegetables:- 6.0 gm CHO. Daily requirement of CHO is 400 – 500 gm. 100 gm. of edible part of wheat bread contains 52 gm. of carbohydrate.	the assimilation of other nutrients. Fibers improve digestion, prevent constipation and reduce the level of cholesterol.		Yam, Colacasia, Potato, Garlic, Onion, Carrot, Beet etc.
Protein (7%)	Daily requirement of proteins is 60 – 80 gm/head. 100 gm. Of fresh product gives the following amount of proteins; Leafy vegetables:- 2.2 gm. Fruit vegetables:- 2.0 gm. Root vegetables:- 1.35 gm.	Help in the formation and maintenance of tissue, body growth; provide energy (4 kcal per gm.). Form various enzymes and hormones to regulate various physiological processes in the body.	Retard growth of the children, causes irritability, apathy and retard mental development. Skin and hair looses color, the swelling of faces, lower parts of legs and feet.	Soybean, lime Bean, Pea, Broad Bean, leaves of Fenugreek, Cow pea, Amaranthus, Palak etc.
Fat (1%)	Vegetables fats are present in small amount. The richest sources of vegetables like Peas and Bean contain 8% of the fresh weight and other crop contain less than 1% of fresh weight.	Supply essential fatty acid and energy (9 kcal per gm.) in concentrated form.	Lack of energy and weakness.	
Vitamins	Vitamins are required in small quantities. Human body needs 6 .different vitamins A, B, C, D, E and K.			
Vitamins A	50% of total food supply.	Help in growth and provide protection against infection and night blindness. It	Night blindness, susceptibility to diseases and retardation of	Carrot, yellow colored fruits and vegetables like Pumpkin,

		increases longevity.	growth in young age.	Tomato, Watermelo, Spinach, Radish, Turnip, Lettuce.
Vitamin B Complex Vitamin B_1 (thiamine)	20% of total food supply	Maintain appetite and keep the nervous system healthy and help in the release of energy.	Causes beriberi, loss of appetite, enlargement of throat, loss of sensitivity of skin, loss in weight and fall of body temperature.	Palak, Colacasia leaves, Radish leaves, Lettuce, Cabbage, Carrot, Onion, Pea, Bean etc.
Vitamin B_2		Help in cell respiration, essential for growth, help in maintenance of skin around the mouth and keep the nose smooth.	Cracks at the corner of the mouth, red cracked lips, soreness of the tongue, ulcer in oral cavity, swollen of the nose and redness of eye.	Amaranthus, palak, Colacasia leaves, Radish leaves, Pea, Bean, etc.
Vitamin B_5 Naicine (Nicotinic acid)	20% of total food supply	Essential for growth and release of energy.	Soreness of tongue, pellagra and skin changes in hands, feet, legs and neck	Amaranthus, Palek, Green chilies, Tomato, Kale, Colacasia leaves, etc.
Vitamin C (Ascorbic acid)	90% of total supply	Necessary for healing of wounds and absorption of ions to make cementing substances to hold cells together and to strengthen walls of blood vessels to help resist function and essential for calcification of bones and teeth.	Scurvy, bleeding in gum and mucus membrane, tooth decay, and susceptibility to common cold.	Carrot, Spinach, Radish, Parsley, Agathi, Shimla mirch, Cabbage, Brussels sprout, Chilies, Bitter gourd (small, Cauliflower, Tomato, Cucumber.
Vitamin D		Helps in building strong bones and teeth and essential for the absorption of the Calcium	Causes Rickets and dental diseases.	Green vegetables
Vitamin E		Helps in normal reproduction	Cause sterility	Vegetable oil and green vegetables like Lettuce, Cabbage etc.

Minerals	Vegetables are rich in minerals. They contain over 50 elements among them Fe, I, Ca are most important. Food containing high amount of P, S, Cl are called acidic food whereas food containing high amount of sodium, K, Ca, and Mg etc. are called basic food. Minerals compose skeletal parts of the body and maintain acid – alkali balance and regulate the function of the system.			
Calcium		Essential for formation of bones and teeth. Help in the clotting of the blood.	Causes Rickets and osteomalacia in woman after repeated pregnancy.	Pea, Bean, Cabbage, Cauliflower, Onion, Tomato.
Iron	20% of total supply	Act as O_2 carrier in the body and helps in the formation of the Hemoglobin.	Anemia, Pale and smooth tongue, Paleness lips, eyes and skin and spooned shaped nail.	Spinach, Peas, Beans, Bitter gourd, Lettuce, Onion, Tomato and Leafy vegetables.
Iodine		To form Thyroxin hormone	Causes Goiter (inflammation of the Thyroid gland).	Okra, Onion, Asparagus, Summer squash etc.

2. Economic importance

1. Vegetables production makes effective use of land. Generally, most of vegetable crops are short duration crops. So, 3 – 4 crops can be harvested in a year from the same piece of land.
2. Vegetable production provides more farm employments. Vegetable cultivation is more labor intensive than cereals. A study conducted in Taiwan shows that Tomato cultivation requires 8020 labors while rice requires 761 labors/hactors. Vegetable production has great potential for

employing seasonally unemployed workers.

3. Vegetables production increases the net income of the farmers. Vegetable productions are high yielder and fetch good price compared to cereals.
4. Vegetables production stimulates sub-urban employment. Commercial vegetable production creates employment opportunity in the field of transportation, marketing, processing and manufacturing of package.
5. Vegetable cultivation expands exports. Vegetable can be exported to the area where they are in high demand but cannot be produced in such amount during summer and rainy season. Vegetable grown in high land of Nepal can be exported to Bangladesh, India, Srilanka and Pakistan.
6. Vegetable production supports the establishment of agro base industries. Many of the vegetables crops are used as raw materials in the industries. Example:- canning industries uses Tomato, Peas and Beans. Pickling industries use Cucumber, chilies and Cauliflower. Flour industries make use of Potato, sweat Potato, Yam and palm. Alcohol and starch extraction industries use Potato, sweet Potato and Yam.
7. Seasonal and off-seasonal vegetable production.

Scope of vegetable crops

Presence of different agro-ecological conditions

Due to the great variation in altitude, Nepal has different agro climatic conditions, as we can grow fresh vegetables &seeds of numerous crops.

Increasing demand of fresh vegetables & vegetable seeds

Human nutrition requires a 300gm of fresh vegetables per day. Out of this, green vegetables: 120gm, root vegetables: 90 gm and other vegetables: 90gm.Above quantity is lacking in the majority of both rural & urban communities. Deficit quantity of seeds of vegetable can manage.

Export potential

Potentialities to export off-season vegetables & vegetable seeds to the neighboring countries, as they can't produce due to the climatic regions.

Availability of cheap farm labors

Fresh vegetables and vegetable seed production can employ the surplus farm labor and improve the economy of small farmers.

1.2. Potentiality of vegetable production in relation to local as well as international markets 7

Vegetable production and marketing is gradually emerging as an important sub-sector contributing to gross domestic product (GDP) in Nepal. Agriculture sector contributed about 33 percent to the GDP (MOAC, 2007) with 14.38 percent (about two-third of total

horticultural share) shared by vegetables including potato (MOAC, 2007). According to an estimate, area under vegetable crops in the recent years is increasing by nearly five percent per annum. In addition, the productivity and accordingly the production show an increasing trend (MOAC, 2007). Apart from which, vegetable is a potential source of export earnings, rural employment and economic growth (NPC, 1995). In such situations, improving production and marketing efficiencies is only way to sustain local produce in the market. However, the country is not able to harness available market for vegetables, and different factors at production and marketing levels hindering vegetable business are not fully identified and abated. Studies on vegetable production and marketing to substantiate economic relation between farmers and traders are limited in Nepal. Some rapid market appraisals and national seminars have raised some issues as problems.

1.3. Constraints in commercial vegetable production and possible remedies7

Poor people

Economic status of Nepalese farmer is poor than developed countries. Poor people can't afford the initial installment and management. Vegetable crops require intensive care and management

Small land holding and acreage

Fragmented and scattered land. Average land size per household is 0.789 ha

(Terai: 0.944 ha, Mid Hills: 0.655 ha and High hills: 0.633ha). Small size land holding limits the commercial vegetable production

Geophysical situation

Due to vivid geophysical & topographical ranges, problems in transportation and marketing of perishable vegetables.

Climate situations

Often frost, freeze, hailstone, speedy winds, thunderstorm occurs in various parts of the country & cause serious losses in vegetable production.

Biological phenomena

Self incompability, heterostyle, male sterility etc. are the biological phenomena that enforce not to set seed & hence to vegetable production.

Plant protection measures

All vegetables are affected with insects, pests and diseases in different growth stages. There are several such problems which are not yet considered. Example: Late blight of potato, blight of tomato and mustard aphid.

Lack of extension support staff

Trained persons on programs, policies and activities of vegetable crop extension are lacking to disseminate the knowledge that helps to expand cultivation of vegetable crops in Nepal.

Varietal improvement

The varietal improvement program in Nepal is not yet progressed. Some of the newly released varieties are not well adapted to local conditions of Nepal because mostly imported from foreign countries. So, they have problems of adaptability.

Social constraints

In rural areas, vegetables are not normally sold. Some tribes do not have vegetables according to their culture, examples: onion and garlic by Brahmin. This brief has hindered development of commercial vegetable production in Nepal.

Seasonal price fluctuation

The extent of seasonality on individual vegetable price varies greatly example: more than 400% in cauliflower, 200% in tomato. The average seasonality in the price of all vegetables as a group about 200%, which is much higher than any other crops.

Labour intensive business

Labour inputs to vegetable cultivation are higher than to cereal cultivation. In Nepal, most of the active population working on foreign countries for full-time employment resulting to labour shortage in the peak period for vegetable farming.

Migration and Feminization of Agriculture

Agriculture has not been perceived as no prestigious work. Major trends in rural areas they out to leave their villages for the labor work to urban areas. This has created a shortage of labour for senior citizens, women and children in the villages. This has created problems in reduction of overall agricultural production, including vegetable ones.

Marketing constraints

No special vehicles are used to transport vegetables. Nepal is lacking infrastructure facilities such as integrated market centers, wholesale markets, collection centers, warehouses and processing centers. Lack of marketing information system to farmers about the price prevailing at different market levels for various commodities does not exist. Linkage and coordination among farmers, transporters, middleman or agents, wholesalers and retailers are not institutionalized

Lack of credit

Studies show that only 24% of the farm families who take loans obtain them from institutional sources. Among those who borrow from institutional sources, large farmers have better access to credit than small &marginalized farmers.

Poor irrigation facilities

The gravity based irrigation networks so far developed in Nepal have the reduced

flow of water during winter.

Shortage of good quality seeds

Climatically adapted & disease free seeds are not usually available in Nepal. Annual requirement of vegetable seed is estimated 500 tons, but the current level of quality seed production is about 200 tons. The rest of the demand is met through farmer to farmer exchange seeds of unknown quality.

Support for the cold storage industry

Nepali farmers transport their perishable produce across the border for cold storage in India because the charges for cold storage in Nepal are 2.5-4.5 times higher than in India.

Trade restrictions

The unauthorized cross border trade in vegetables is promoted because of the valuation by costumer offices and advance income tax collection, resulting in unnecessary cost and delay. No government intervention for import commodities.

Lack of support system (inputs and services)

Nepalese farmers often face a crisis of agricultural inputs and other services in the period of crops planting. Government's subsidies and other incentive in agriculture remain to be almost nill.

Inadequate production planning

The vegetable seed should be produced only in technically feasible locations. For example, Bagarkot in Dadeldhura was designed a pocket area for seeds of some vegetables cauliflower and chillies which is failed showing that there have been indequate efforts made while designating pocket areas. Incase of vegetable production there is no better vision of the planning according to their pocket areas.

Impact due to climate change

Climate change resulted to enhanced greenhouse effect to the cropping environment. This has negative effects on seasonality in vegetable production.

1.4. Classification of vegetable 11

Vegetable crops consist of 1200 species of which 78 are familiar. More than 8600 species belong to 59 families of dicotyledoneae and 801 to the monocotyledoneae. 90 species of vegetables are cultivated in the tropical and sub-tropical parts of the world, but hardly 15 species are of commercial importance.

Different methods of classification of vegetables

a. Classification based on hardiness

Vegetables are classified into three groups

Hardy vegetables (can withstand frost without any injury)	Broccoli, Cabbage, Pea, Brussels sprout, Garlic, Onion, Leek, Radish, Spanich, Turnip, Parsley etc.
Semi-hardy vegetables (Generally they are not injured by light frost)	Carrot, Cauliflower, Potato, Celery, Lettuce, Beet, Palak etc.
Tender vegetables (cannot withstand frost and are even killed by light, frost)	Tomato, Chilli, Brinjal, Cucumber, Okra, and all Cucurbits, French bean, Sweet potato, Cassava, Yam, Drumstick, Elephant foot yam etc.

b. Classification based on parts used

Leaves/ stems	Flower	Fruits	Modified stem	Underground
Cabbage, Palak, Fenu Greek, Amaranthus, Salad Crops, Lettuce, Celery, Parsley All The Pot Herbs And Greens etc.	Broccoli, Globe Artichoke etc.	Tomato, Brinjal, Chillyi, Beans, Okra, Cucurbits etc.	Knolkhol, Cauliflower, Asparagus etc.	Carrot, Turnip, Beet, Radish, Potato, Sweet Potato, Ginger, Garlic, Onion, Elephant Foot Yam, Cassava etc.

c. Classification based on the growing season

Summer or spring season vegetables Optimum Monthly Average temperatures = 20-27 °C Tolerate minimum temperature= 15 °C	Tomato, Brinjal, Cucumber, Okra, French Bean, Cowpea, Most Of The Cucurbits, Amaranthus, Cluster Bean etc.
Rainy or kharif season vegetables	Tomato, Brinjal, Cucumber, Okra, Chilli, Gourds, Ginger, Turmeric, Cow Pea, Bean,

	Amaranthus And Cluster Bean etc
Winter or autumn season vegetable Optimum Monthly Average temperatures = 12-17 °C Tolerate minimum temperature= 5 °C	Cauliflower, Cabbage, Broccoli, Radish, Carrot, Turnip, Spanich,Onion, Garlic, Pea, Fenugreek, Potato etc.

Cool season vegetables are those vegetables of which the vegetative parts; roots, stems, leaves and buds or immature flowers are eaten; exceptions are sweet potato. The vegetable of which the immature fruits are eaten are warm season crops pea and broad bean are exceptions, being cool season crops.

d. Classification based on tolerance to soil reaction

Vegetables are classified into 3 groups according to their tolerance to soil acidity

Slightly tolerance (pH 6.8-6.0)	Moderately tolerant(pH 6.8-5.5)	Very/highly tolerant (pH 6.8-5.0)
Broccoli, Cabbage, Cauliflower, Okra, Spinach, Leek, Chinese Cabbage, Lettuce, Beet, Asparagus, Muskmelon, Onion etc.	Beans, Carrot, Cucumber, Brinjal, Garlic, Garden Pea, Tomato, Radish, Turnip, Brussel Sprouts, Knolkhol, Parsley, Pumpkin etc.	Potato, Sweet Potato, Water Melon, Chicory etc.

e. Classification based on salt tolerance

Sensitive	Moderately resistant	Resistant/tolerant
Pea, Beans, Potato, Radish, Brinjal, Sweet Potato etc.	Onion, Carrot, Cabbage, Cauliflower, Broccoli, Tomato, Melons, Chilli etc.	Asparagus, Beet, Lettuce, Bitter Gourd, Ash Gourd etc.

f. Classification based on photo period requirement

Vegetables are grouped according to the periods for which the light is available. The response of plants to light for induction of flowering is called photoperiodism.

Long day vegetables crops (8-10 hours of dark)	Short day vegetables crops (10-14 hours dark)	Day neutral vegetable crops (photo insensitive)
Onion,Cabbage Cauliflower, Potato, Radish, Lettuce, Knolkhol, Turnip, Carrot etc.	Sweet Potato, Lablab Bean, Winged Bean, Cluster Bean etc.	Tomato, Brinjal, Chilli, Okra, French Bean, Cucumber, Cow Pea etc.

g. Classification based on rooting depth

The knowledge of rooting depth is essential for scheduling the time and quantity of irrigation water. Shallow rooted crops require frequent and light irrigation where as deep rooted crops require less but heavy irrigation. There are five groups of vegetables in this classification

Very shallow rooted (15-30 cm)	Shallow rooted (30-60 cm)	Moderately deep rooted (60-90 cm)	Deep rooted (90-120 cm)	Very deep rooted (120-1800 cm)
Onion, Lettuce etc.	Cabbage, Cauliflower, Garlic, Celery, Palak, Potato, Spinach, Cow Pea, Radish, Broccoli etc.	Brinjal. Cucumber, Musk Melon, French Bean, Carrot, Beet etc.	Chilli, Turnip, Summer Squash, Garden Pea etc.	Asparagus, Artichoke, Lima Bean, Pumpkim, Sweet Potato, Tomato, Water Melon etc.

h. Classification based on method of Culture

Crops belonging to the same group have the same general culture and are subject to similar pests and diseases.

1. Leafy vegetables

Crops used mainly for their leaves, whether eaten raw or cooked, e.g., lettuce, mustard, amaranth, and celery.

2. Cole crops, crucifers or Brassicas

Crops belonging to the cabbage family (Brassicaceae formerly Cruciferae) including Chinese cabbage, cauliflower, and broccoli (excluding radish).

3. Cucurbits

Crops belonging to the Cucurbit family to which cucumber and the gourds belong.

4. Pulses or legumes

Members of the Fabaceae formerly Leguminosae family like cowpea: vegetable soybean, yard-long bean, edible podded pea, and the other peas and beans.

5. Root, bulb and tuber crops

Onions, garlic, potato, sweet potato, radish, and carrot.

6. Solanaceous crops - tomato, eggplant, and pepper.

C. Learning process and support materials

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

D. Assessment

1. Very short (Answer question)

1. Define horticulture.
2. Give any two examples of perennial vegetable crops.

2. Short (Answer question)

1. Write any three branches of horticulture.
2. List out the scope of vegetable production in Nepal.

3. Long (Answer question)

1. Write down the importance of vegetable crops in Nepal.
2. Classify the vegetable crops on the basis of part utilization and cultural requirements with suitable examples.

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UNIT- 2

Cultivation Practices of Cole crops (cauliflower, Cabbage, Broccoli, Knolkhol) 15

A. Objectives

After the completion of this course, the students will be able to:

- Explain about the origin, distribution, cultivars, climate and soil requirement etc.
- Describe about the cultivation practices of different cole crops in various aspects.

B. Content elaboration

Cole crops comprise of a large number of species, mostly annuals, of which different parts like stem, leaf, flower bud, flower, etc. are consumed either raw as a salad or cooked. They are essential items of balanced diet and are rich in nutrients. Most of the cole crops which are commonly cultivated are:

Cauliflower

It is the most important vegetable crop grown for its white and tender head orcurd formed by the shortened flower parts. It is not a rich source of nutrient, however, substantial amount of protein, carbohydrates, phosphorus, calcium, iron and ascorbic acid is present. The edible part of cauliflower is curd.

Botanical name: *Brassica oleracea var. botrytis L.*

Common name: Phool Gobhi

Family: Cruciferae

Origin: Mediterranean region

Chromosome number: 2n=18

Uses

Cauliflower is one of the most important vegetable crops of Nepal. It is grown in

winter season for its white tender curds formed by the pre floral fleshy apical meristem. It is used as vegetable in curies, soups and for pickling.

Nutritive value

The nutritive value of cauliflower per 100 g of edible portion is given here under:

Energy (kcal)	27	Vitamin A (IU)	60	Ca (mg)
Moisture (%)	91	Thiamin (mg)	0.11	P (mg)
Protein (g)	2.7	Riboflavin (mg)	0.1	Fe (mg)
Fat (g)	0.2	Niacin (mg)	0.7	Carbohydrates (g)
Ascorbic acid (mg)	78			

Trade

Cauliflower is an important winter season vegetable crops grown in almost all areas of the country. The area under its cultivation was 34967 ha with production of 50044.8 Mt having 15.7 t/ha.

Variety

SN	Variety	Varietal character	Released Year	Recommended area	Production
1	Sarlahi Deepali	• Open pollinated, Early variety • Curd white as wax, whitish yellow, round and medium size • Harvesting: 55-65 DAT	2051	Terai	0.5-1 kg/curd, 18-20 Mt/ha
2	Kathmandu local	• Open pollinated local variety • Mid-season variety with vigorous vegetative growth • Curd milky white • Harvesting: 110-120 DAT	2070	Terai, MH and HH	1-3 kg/curd, 25 Mt/ha
3	Snow ball 16	• Open pollinated • Curd: soft, mildly	2051	Terai, MH and HH	1.5-2.5 kg/curd

		green • Late variety • Harvesting: 120 DAT			
4	Silver cup 60	• Hybrid variety • Plant medium size • Curd: white • Harvesting: 60 DAT	2066	Terai and MH	0.6-1 kg/curd
5	Milky way	• Hybrid • Plant medium size • Curd: attractive white • Harvesting: 70-80 DAT	2066	MH to HH	0.8-2 kg/curd
6	Ramy	• Hybrid • Curd: clean white, • Plant: large, smooth & straight • Harvesting: 55-65 DAT	2066	Terai and MH	0.8-2 kg/curd
7	Snow crown	• Hybrid • Plant: intermediate • Susceptible to downy mildew • Harvesting:75-90 DAT	2066	Mid Hill to High Hill	1-3 kg/curd
8	Snow Mystique	• Hybrid • Lately matured, large leaves • Required more spacing • Harvesting: 120-135 DAT	2066	Mid hill to high hill	2-4 kg/curd
9	White Moon	• Hybrid variety • Curd: attractive, white & round • Harvesting: 125 DAT	2067	Terai and Mid Hill	48 Mt/ha
10	White Top	• Hybrid • Curd: spherical, attractive and white	2067	Terai and MH	42 Mt/ha

		• Harvesting: 90 DAT			
11	Super white Top	• Hybrid • Curd: spherical, white, firm and attractive • Harvesting: 95 DAT	2067	Terai and MH	56 Mt/ha
12	Snow Queen	• Hybrid • Straight • Harvesting: 50 DAT	Registered: 2067	Terai and MH	
13	Snow Dome	• Hybrid • Plant: Straight • Harvesting: 85 DAT	2066	Terai and MH	
14	White king	• Hybrid • Plant medium size • Harvesting: 70 DAT	2066	Terai and MH	
15	Yukon	• Hybrid • Plant height: 40 cm • Harvesting: 75 DAT	2066	Terai and MH	56 Mt/ha
3	Snow ball 16	• Open pollinated • Curd: soft, mildly green • Late variety • Harvesting: 120 DAT	2051	Terai, MH and HH	1.5-2.5 kg/curd
4	Silver cup 60	• Hybrid variety • Plant medium size • Curd: white • Harvesting: 60 DAT	2066	Terai and MH	0.6-1 kg/curd

Climate

Cauliflower can be grown under a wide range of environmental conditions but cool, moist climate is most suitable.Climatic factors play an important role during transformation from vegetative to curding and curd development stages. Temperature of 10-21ºC is good for germination.It is thermo-sensitive, i.e. temperature influences growth stages from vegetative to reproductive. Transformation from vegetative to curding take place from 5ºC to nearly 28-30ºC, depending on the cultivar of a particular maturity group. The optimum temperature for growth of a young plant is 23ºC in initial stages while growth in

later stages is more favourable at 17-20°C. The tropical cultivars can grow even at 35°C or more. The temperature should not fluctuate too much during the curd initiation phase, otherwise curd quality deteriorates. Temperature higher or lower than optimum for curding results in physiological disorders like riceyness, leafyness, blindness, loose and yellow curd.

Soil

It can be grown in all types of soil but soil with high OM, high fertility & good drainage is preferred. Optimum pH is 6 – 6.5.The deficiency symptoms of Mg may quickly appear in acidic soils while pH higher than 7 reduced the availability of boron causing browning.

Nursery raising

Cauliflower is basically a transplanted crop. The seeds are sown in a seed bed. In the plains, the seed beds for early crop require cover (mulching) to save the small seedlings from rains, while in the high hills, it may be better to grow them under glass flames or poly tunnels. The seedlings of mid-season or late cultivars may be raised in the open. The soil of the nursery should be well prepared and free from diseases. Well rottened farmyard manure should be added @ 2-3kg/m^2 the optimum spacing between rows in the nursery beds is 10cm and the depth of sowing is 1.5-2.5cm. For planting one hectare, about ten nursery beds of 300 x 100 x 15 cm dimension is required. After sowing, the seeds are properly covered with a thin layer of mixture of fine manure and soil. Regular and optimum moisture supply is needed. Then cover the nursery beds with dry grass.

Generally, 4-6weeks old seedlings are ready for transplanting, but seedlings up to 8weeks age can also be transplanted. The time of transplanting varies in different climatic conditions. In plains, it can be done from August to December and in hills from April to August.

Planting

Planting of cauliflower depends on the topography. In high hills, seeds are sown in May-June for summer/autumn crop. In the hilly areas which receive heavy rains, the summer and autumn crop is rather limited and sowing is done in autumn

to harvest them in late spring or early summer by over watering them. In the plains sowing in situ or in seed beds starts from August to September.

Seed rate

Seed rate depends on the growing season. Generally 400-500 gm seed is required for one hectare of land.

Spacing

The planting distance may be varying according to cultivars, planting season and soil.

Early maturing cultivars: 45 cm x 30 cm,

Mid and late season: 60 cm x 45 cm

Nutrient Management

Manures and fertilizer requirements in cauliflower depend upon the fertility of soil. Accordingly, add 200-250q/ha farmyard manure and it should be mixed thoroughly at the time of field preparation. Application of nitrogen, phosphorus and potash varies with soil type, varieties and place. The requirement of N: P: K is 120-180:75-80:60-75kg /hectare. Half quantity of nitrogen and full quantity each of phosphorus and potash is applied at the time of transplanting. Remaining quantity of nitrogen is applied after 30-45days of transplanting.

Use of phyto hormones

PGR	Method of application	Attributes affected
IBA@ 10ppm	Seedling treatment	Increase in yield
GA@ 100ppm +NAA@ 120ppm+Mo@ 2%	Foliar spray	Increase in yield
GA@ 50ppm +Urea @1%	Foliar spray	Increase in yield
GA3 @50ppm	Foliar spray	Increase in yield
NAA 10ppm	Seedlings treatment	Plant stand in the field and vegetative

		growth.
GA4 + GA7 @ 80 mg/l	Foliar spray	Shortens the period from transplanting to the harvest

Water management

First irrigation should be given immediately after transplanting. Being shallow rooted crop, it requires frequent and light irrigation. The early season crop requires irrigation at an interval of 5-7days while mid and late sown crop requires irrigation at an interval of 8-12 days. Curd development is the critical stage. Heavy irrigation is avoided at the time of maturity of heads. Optimum moisture level at the time of curd formation is very essential.

Weed management

Cauliflower is a shallow rooted crop, so it is essential to do shallow hoeing to remove weeds and to avoid any injury to the roots. Regular hoeing operations keep crop weed free and provide aeration to the root system. Earthing up is important in the rainy season as the roots get exposed after every shower and should be done after 4-5 weeks of transplanting. The critical period for crop- weed competition is between 30-50 days after transplanting. Use herbicides in initial stages followed by hand weeding in later stages of plant growth along with fertilizer top dressings. Application of Alachlor (Lasso) @ 2kg a.i./ha before transplanting is beneficial for controlling annual and broad leaved weeds. Pendimethalin (Stomp) @1.2 kg a.i./ha or Oxyflurofen (Gol) @ 600 ml/ha) can also be used before transplanting if there is problem of annual weeds only.

Harvesting

Cauliflower should be harvested when the curd has attained the proper size & compactness. The plant is cut off well below the curd so that the stub thus left protects the curd during transport. Cauliflower curds are tender & damaged easily i.e. why many producers don’t trim the leaf from the head. But th e leaf should be

cut 2.5 – 2 cm projecting above the head before sending the heads to the market. Off quality & damaged heads should be sorted out. Cauliflower heads are packed securely in the basket for market. The early crop gives low yield & mid season crops give high yield. Yields vary from 20 – 30 tons/hac.

Pre and post-harvest handling

Harvesting should be done preferably in the late evening or early morning so that the product remains turgid and fresh. The freshly harvested plants should be put in the truck or cart in such a way that the bruising of the curd is minimum. The bruised portions of the curd become blackish and unattractive for the fresh market.

Packing and Packaging Material

Generally, packaging material is not used for transportation or storage of cauliflower in Nepal. Freshly harvested plants with most of the leaves intact are loaded in cart/truck keeping the curd downward. By doing this, the curds are not exposed to the sun and the leaves protect the curd from bruising and impact damage. This practice is for the market situated nearby. They are sent in gunny bag packings or in crates to distant market.

Physiological disorders

1. Buttoning

It means the development of small curds or buttons. The general basis is that any check in the vegetative growth of the seedlings may induce buttoning. Buttoning is the result of planting of over-aged seedlings which do not get sufficient time to initiate vegetative growth before transformation to curding or selection of wrong cultivars means planting early variety late or root injury by insects or diseases. Planting a suitable variety at the appropriate seedling growth stage and at optimum time helps in managing this disorder.

2. Riceyness

A premature initiation of floral buds or elongation of a peduncle stalk of inflorescence is characterized by riceyness. The curds are considered to be of poor quality for marketing. A temperature higher or lower than the optimum required

for curding or high application of nitrogen result in riceyness. Manage proper soil moisture and fertility during a curd development stage.

3. Blindness

Blind plants are those, which are without terminal bud. They do not form curd. It is due to poor fertility of the soil or damage to the terminal portion during handling at the time of planting or by insects, diseases, etc. Healthy and vigorous seedlings with terminal portion intact should be planted.

4. Fuzzy:

It is velvety in appearance, and formed when the flower pedicels elongate. This type of curd may result due to hereditary factor, or when plants are grown under unfavorable condition and heads are over matured.

5. Leafy

Curd becomes leafy due to the growing of small green leaves between the curd segments. They may appear in poor and sometimes in good strains also when growing conditions are unfavorable.

Cabbage

Cabbage is a cool season crop and thrives well in a relatively cool and moist climate. It is grown mainly as a winter crop in Terai and midhills area of the country.

Botanical name: *Brassica oleracea var. capitata Linn.*

Common name: Bunda Gobhi

Family: Cruciferae

Origin: Mediterranean region

Chromosome number: 2n=2x=18

Uses

Cabbage is eaten in the raw state as well as cooked. These are known for their rich source of vitamin A and C. Also, contains minerals, including P, K, Ca, Na and

Fe. Cabbage may have some protective properties against human bowl cancer in these vegetables. They are used against ailments such as gout, diarrhea, stomach trouble, deafness and headache. The leaves are used to cover wounds and ulcers and also recommended against hangover. Cabbage juice is said to be a remedy against poisonous mushrooms and also used as gargle against hoarseness.

Nutritive value

Cabbage is an excellent source of minerals such as calcium, iron, magnesium, sodium, potassium, and phosphorus. It contains a good amount of ascorbic acid. Cabbage is used mainly as a vegetable and nice pickle (sauerkraut) is prepared from it.

Table : The nutritive value of cabbage per 100 g of edible portion is given hereunder:

Principle	Amount	Principle	Amount
Energy (k cal)	24	Riboflavin (mg)	0.05
Moisture (g)	92.4	Niacin (mg)	0.3
Protein (g)	1.3	Ascorbic acid (mg)	47
Fat (g)	0.2	Ca (mg)	49
CHO (g)	5.4	P (mg)	29
Vitamin A (IU)	130	Fe (mg)	0.4
Thiamin (mg)	0.05		

Trade

Cabbage is an important cool season vegetable crop grown mainly during the winter season. It is cultivated in area of 28071.4 ha with production of 84036.8 Mt and yields of 17.2 t/ha.

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Pride of India	Open pollinated variety Round compact head		All areas	1.5-2.5 kg/head ,

		Early variety Mature on: 80-85 DAT			1000-1200 kg/ropani
2	Golden Acre	Open pollinated variety Round compact head Early season variety Harvesting: 65-75 DAT		All areas	1-2 kg/head, 1000-1200 kg/ropani
3	Copenhagen market	Open pollinated Round head Bluish green leaves Mid season variety Ready for market 70-90 DAT	Released: 2050 & Recommended: 2066	All areas	1.5-2.5 kg/head, 1200-1500 kg/ropani
4	Pusa drum head	Open pollinated variety Late variety Leaf dark green Mature at: 110 DAT Flat drum head		All areas	3.5-4 kg/head, 1800-2500 kg/ropani
5	Green coronet	Hybrid variety Flat head Dark green leaves Susceptible to black rot	Registered: 2066	MH: Bhadra - Chaitra, HH: Baisakh - Bhadra	1-4 kg/head
6	Super green	Hybrid Head flat, large and green Ready for market: 95 DAT Susceptible to black & soft rot	Registered: 2066	Terai, MH and HH	1.5-2.5 kg/head
7	Green Top	Hybrid Head semispherical, less green crack resistant & holding type	Registered: 2067	Terai and MH	2 kg/head, 48000 kg/ha
8	Nepa Round	Hybrid variety Plant height: 40-45 cm	Registered: 2066	Terai	2.5 kg /head,

		Harvesting: 90 DAT			75000 kg/ha
9	Super coronet	Hybrid Large plant, slightly straight Harvesting: 75-80 DAT	Registered : 2066	Terai and MH	1.4-1.6 kg/head
10	Green Hero	Hybrid Plant height: 33 cm Harvesting: 55-60 DAT	Registered : 2066	Terai and MH	2-2.5 kg/head, 45-60 ton/ha
11	Green Top	Hybrid variety Plant height: 42 cm Harvesting: 100 DAT	Registered : 2066	Terai and MH	2 kg/ha, 48 Mt/ha
12	Golden ball	Hybrid variety Plant height: 24 cm Harvesting: 48-53 DAT	Registered : 2066	Terai and MH	2-2.5 kg/head, 45-60 Mt/ha
13	Green stone	Hybrid variety Dark green leaves Harvesting on: 50-55 DAT		Terai and MH	1.8-2 kg/head
14	Snow King	Hybrid variety			
15	Snow Queen	Hybrid variety			

Climate

Cabbage can be grown under a wide range of environmental conditions but cool moist climate is most suitable. The optimum soil temperature for seed germination is between 21.2 to 26.2ºC.The optimum temperature for growth and heading is between 15-20ºC. Minimum temperature for growth of cabbage is just above 0ºC.

Soil

Cabbage can be grown in a wide range of sandy to heavy soils. Early cultivars grow well in light soils, whereas, late maturing ones perform better on heavy soils. The optimum pH of soil for cabbage cultivation is between 6.0-6.5. Most of the cabbage varieties are tolerant to salts. In saline soils, the plants are more prone to diseases.

Nursery raising

Cabbage is basically a transplanted crop. The seeds are sown in seed bed. In the plains, the seed beds for early crop require cover (mulching) to save the small seedlings from rains, while in the high hills, it may be better to grow them under glass flames or poly tunnels. The seedlings of mid-season or late cultivars may be raised in the open. The soil of nursery should be well prepared and free from diseases.Well rottened farmyard manure should be added @ 2-3kg/m^2 .The optimum spacing between rows in the nursery beds is 10cm and the depth of sowing is 1.5-2.5cm. For planting one hectare, about ten nursery beds of 300 x 100 x 15 cm dimension are required. After sowing, the seeds are properly covered with a thin layer of mixture of fine manure and soil. Regular and optimum moisture supply is needed. Then cover the nursery beds with dry grass.

Generally, 4-6weeks old seedlings are ready for transplanting but seedlings up to 8weeks age can also be transplanted. The time of transplanting varies in different climatic conditions. In plains, it can be done from August to December and in hills from April to August.

Planting

Planting of cabbage depends on the topography. In high hills, seeds are sown in May-June for summer/autumn crop. In the hilly areas which receive heavy rains, the summer and autumn crop is rather limited and sowing is done in autumn to harvest them in late spring or early summer by over watering them. In the plains sowing in situ or in seed beds starts from August to September.

Seed rate

Seed rate depends on the growing season. Generally 400-500 gm seed is required for one hectare of land.

Spacing

Early maturing cultivars: 45 cm x 45 cm or 60 cm x 30 cm,

Mid-season: 60 cm x 45 cm

Late maturing: 60 cm x 60 cm

Nutrient Management

Manures and fertilizer requirements in cabbage depend upon fertility of soil. Accordingly, add 200-250q/ha farmyard manure and it should be mixed thoroughly at the time of field preparation. Application of nitrogen, phosphorus and potash varies with soil type, varieties and place. The requirement of N: P: K is 120-180:75-80:60-75kg /hectare. Half quantity of nitrogen and full quantity each of phosphorus and potash is applied at the time of transplanting. Remaining quantity of nitrogen is applied after 30-45days of transplanting.

Water management

Cabbage is very sensitive to soil moisture. Maximum growth and yield can only be obtained when sufficient quantity of water is available to the plants. First irrigation is given just after transplanting of seedlings. Irrigation may be applied at 10-15days interval according to the season and soil but optimum soil moisture should be maintained regularly. Cabbage is usually irrigated by furrow method of irrigation. Heavy irrigation should be avoided when the heads have formed, as it will result in splitting of heads.

Weed management

Cabbage is a shallow rooted crop, so do shallow hoeing to remove weeds and to avoid any injury to the roots. Regular hoeing operations keep crop weed free and provide aeration to the root system. Crust formation in medium heavy and clay soils hinder water and air penetration in root system and should be broken otherwise adversely affect plant growth.Critical period for crop- weed competition is between 30-50days after transplanting. Use herbicides in initial stages followed by hand weeding in later stages of plant growth along with fertilizer top dressings. Application of Alachlor (Lasso) @ 2kg a.i./ha or Trifluralin @ 0.5kg/ha or Fluchloralin @ 0.5kg/ha before transplanting is beneficial for controlling annual and broad leaved weeds. Pendimethalin @1.2kg a.i. /ha or Oxyflurofen (Goal) @ 600ml/ha) can also be used before transplanting if there is problem of annual weeds only.

Harvesting, processing and marketing

The harvesting of cabbage is done when the heads attain marketable size. The early cultivars grown under comparatively warmer conditions develop loose head at the initial stage, but later become compact. Harvesting should be done at the right stage for getting good quality head. Harvesting should be done preferably in the late evening or early morning so that the product remains turgid and fresh.

The early cultivars take about 60-80days, medium 80-100days and late 100-130days for harvesting after transplanting. Average yield of cabbage varieties from 20t/ha in OP varieties and that of hybrids between 50-70t/ha.

Avoid direct contact of heads with the soil and exposure to direct sunlight. Proper packing is to be done to avoid bruising. Grading of cabbage should be done on the basis of size and firmness of head.The early varieties can be stored for 4-6weeks at 0ºC-1.7ºC and RH between 92-95%while the late ones for 12weeks due to firmness of heads.

Cabbage heads are sent to the market in loose condition in trucks or in sacks. For transportation of early cultivars, either loose or in sacks, there is damage of the heads due to their succulence and looseness. Heads are packed according to their size. Crates are popularly used for packing.

Other Cole crops

English Name	Botanical Name
1.Broccoli	*Brassica deracea var. italica.*
2.Knol-Khol(Khorabi)	*Brassica caulorapa*
3.Brussel's sprout	*Brassica oleracea var. gemmifera.*

Botany

1. **Broccoli :** Morphologically, it resembles cauliflower plant. A main head of green color is produced terminally on a fleshy branching stem. After removal of main head, slender & small heads appear in the axils of leaves. Head consist of green buds & thick fleshy flower stalks.

2. **Knolkhol :** The fleshy edible portion is an enlargement of the stem, which develops entirely above ground.

Climate & soil:-Same as that of cauliflower & cabbage.

Other cultural requirements

S.N.		Broccoli	Knol-khol
1.	Varieties	Green sprouting, Decicco,calabrasse, bronzino.	White Vienna, Purple Vienna, Castor.
2.	Time of planting:-		
	High Hills	May – June.	May – June.
	Mid Hills	Sept. – Oct.	Sept – Oct.
	Terai	Oct. – Nov.	Oct. – Nov.
3.	Field preparation	Same as cauliflower	Same as cauliflower
4.	Seed rate	400 – 500 gm/hac.	1 – 1.5 Kg/hac.
5.	Spacing	45 X 45 cm	40 X 25 cm.
6.	Manures(FYM)	15 - 20 tons/ha	15-20 tons/ha
7.	fertilizers		
	Nitrogen	60 – 80 Kg/hac.	75 Kg/hac.
	Phosphorus	100 Kg/hac.	37 Kg/hac.
	Potash	100 Kg/hac.	37 Kg/hac.
7.	Yield	8 – 10qtls./hac.	10 – 12 qtls./hac.

Harvesting, Processing and marketing of broccoli

It is important to harvest the broccoli heads at correct time i.e. before the buds open and when the bud clusters are compact. The heads are cut along with stalk (around 15cm).

Physiological Disorders

Bolting: Under certain conditions a number of the Oriental brassicas have a tendency to bolt – that is, to produce flowers and run to seed rather than form a good leafy head. Blossoming marks the transition between vegetative and

generative (reproductive) phase.

Diseases and Insect-pests of cole crops

The important diseases and insect-pests of cole crops are described as under:

Disease of Cole crops:

1. Damping off

C. O **:** *Rhizoctonia solani*

Phytopthora infestens

Pythium spp.

Symptoms

This disease causes mortality of seedlings. It is a common soil borne fungal diseases where the rotting start in the collar region of the seedlings collapses.

Control

- Do not raise seedlings at the same site every year.
- Avoid close seeding in the nursery bed.
- Soil drenching of nursery beds with formalin @ of 500 lts/100lts of water 20 days prior to sowing.
- Treat nursery bed with Bavistin@ of 1 gm/liter of water or with Captan @0.5 gm/liter of water before sowing.
- Bavistin @ 2 gm/Kg seed or Thiram 75 W.P @ of 2.5 gm/Kg of seed is recommended for seed treatment.
- Avoid excess watering.

2. Club root (deformed root):-

C.O: *Plasmodiophora brassicae (fungal soil borne)*

Symptoms

This disease is prevalent in the acidic soil. In severe cases malformed roots present a club bed appearance. The foliage wilts on sunny days & recover towards the evening.

Control

- Badly infested area should be abandoned for growing cruciferous crops.
- Soil is kept alkaline by liming.

3. Black rot

C.O: *Xanthomonas campestris (bacterium seed borne)*

Symptoms

Chlorotic areas appear near leaf margin which progress towards the center owing the form of V-shaped yellowish spots. Later the veins become dark. The cabbage head gets discolored.

Control:

- Hot water treatment of seeds at 52ºC for 30 mins gives good results.
- This disease spreads due to seed infection so the seed treatment by Agrimycin (0.01%).
- Practice crop rotation which avoids cruciferous crop for at least 3 yrs.
- Variety Pusa Mukta is resistant to this disease.(Cabbage)

4. Black spot or Alternaria leaf spot

C.O: *Alternaria brassicae (fungal)*

Symptoms

Small dark color spots first appear which enlarge to form large concentric lesions. Under severe condition of the disease development, the linear spots are also seen in the petiole & stem.

Control

- Treat the seed in hot water at 50ºC for 30 mins.
- Treat seed with fungicide.
- Avoid cruciferous crop in crop rotation for three years.
- Spray Diathane M-45 or Bavistin @ 2.5 gm/liter of water in early stage of diseases. 2 – 3 sprayings are necessary at an interval of 10 – 15 days.

5. Black leg

C.O: *Phoma lingam (fungus)*

Symptoms

Infection often occurs on the base of the stem of the young plant in the nursery bed or field, causing dark sunken areas. The welting of the plants is characteristics of the advance stage of the diseases.

Control

- Variety Pusa Orum head of cabbage is resistant of this disease.
- Proper crop rotation to avoid cruciferous crops.
- Seed treatment by hot water or fungicides

6. Downy Mildew

C.O: *Pemospora parasicita (fungus)*

Symptoms

On leaves, purplish brown spot appear under the surface followed by appearance of downy (soft fine feather or hair like) growth on such lesions. Browning & rotting of curd.

Control

- Follow crop rotation & sanitation practices.
- Hot water or fungicide treatment of seed.
- The seed to be used should be cleaned without fragment of pods which may contain fungus.
- Spray Diathane M-45 at 10 days intervals.

Insect- pests

1. Diamondback moth

Spindle shaped pale yellowish green caterpillars feed on the lower side of leaves but later feed on the exposed leaves and enter the head/ curd affecting the produce as well as quality.

Control Measures

- Mustard is effective as a trap crop in suppressing the incidence of diamondback moth and cabbage aphid.
- Release Trichogrammatoidea bactrae @ 0.5-0.75 lakh eggs per ha at weekly intervals for its effective control.
- Spray of malathion (0.05%), deltamethrin (0.028%), cypermethrin (0.01%) and lambda-cyhalothrin (0.004%) can be used for effective suppression of the pest.

2. Cutworms

They damage the seedlings of the newly planted crop. Stems are chewed near the soil level during night.

Control Measures

- Use of well-decomposed manure helps in reducing the incidence. Collect and destroy the larvae after flooding of fields/ beds.
- Soil drenching with chlorpyriphos (0.04%) or spray of cypermethrin (0.01%) on foliage and soil surface reduces the incidence.

3. Aphids

As a result of sucking cell sap, the seed setting stage is seriously affected.

Control Measures

- Foliar application of malathion (0.05%) with the appearance of the pest and repeating every 15 days.
- Stop spraying atleast 7 days before harvesting. In seed crop, apply phorate granules @ 1.5 kg a.i./ha as side dressing during mid February to early March or spray oxydemeton methyl (0.025%) or dimethoate (0.03%) or phosphamidon (0.03%) as soon as aphid population is above 50 aphids per plant.

4. Cabbage butterfly (Pieris brassicae)

Damage is caused by caterpillars. The white winged butterflies deposit yellow coloured eggs in clusters on the undersurface of leaves.

Control Measures

- Collect and destroy yellow egg masses and early stage larvae of cabbage butterfly.
- Use Cotesia glomeratus which parasitizes the larvae. Spray of malathion (0.05%)/ deltamethrin (0.0028%)/ cypermethrin (0.01%) and dichlorovos (0.05%) can be effective.

5. Snails and slugs

They damage the growing tips of plant and also the surface of curd in cauliflower. They are problematic under humid conditions or when crop is irrigated with sewerage water.

Control Measures

- Baiting with metaldehyde and bran (1: 25 in 12 litres of water) is effective for their control. As a repellant, alum may be sprayed @ 2% solution.

C.Learning process and support materials

Learning process includes the Visual methods, Demonstration method, Practical method, Observation method, Exhibition methods.

D. Assessment

Very Short (Answer question)

1. Write down the scientific name and family of Cauliflower.
2. List out the importance Cole crops cultivated in Nepal.
3. Name any two important varieties of Cabbage.
4. List any two major diseases of cole crop.

Short (Answer question)

1. Define cole crops with examples.
2. Write down the requirement of climate and soil for broccoli crop.
3. Write any four varieties of Cauliflower.

Long (Answer question)

1. Write the cultivation practices of cauliflower with respect to, botanical

name,climate, method of propagation, manure & fertilizer and curing process.

2. Write the cultivation practices of Cabbage with respect to, botanical name, family,climate, , manure & fertilizer, weeding and harvesting .

UNIT- 3

Cultivation Practices of Root crops (Radish, Carrot, Turnip)

37

A. Objectives

After the completion of this course, the students will be able to:

- Explain about the origin, distribution, cultivars, climate and soil requirement etc. of root crops.
- Describe about the cultivation practices of different root crops in various aspects.

B. Content elaboration

Root crops comprise of three different species, such as radish, carrot and turnip which are mostly annuals, of which different parts like root, leaf, etc. are consumed either raw as a salad or cooked. They are essential items of balanced diet and are rich in nutrients. Most of the root crops which are commonly cultivated are:

Radish

Radish is most popular vegetable crops in Nepal. It is considered the number one crop in terms of hectarage and productivity in Nepal.

Botanical name: *Raphanus sativus*

Common name: Mula

Family: Cruciferae

Origin: Mediterranean region

Chromosome number: 2n=2x=18

Uses

Radish is a rich source of ascorbic acid (Vit.C) and it supplies a variety of minerals. It is grown for its young and tender roots which are eaten as raw and cooked. Leaves are also used as green vegetables. The roots are also dried and

used as vegetables during the period when vegetables are scarce. Raw roots are mostly consumed as 'Achar'.

Nutritive value

Table : Nutritive value of radish per 100 gm.

Moisture (%)	94.4	Phosphorus (mg)	22
Protein (g)	0.7	Iron (mg)	0.4
Fat (g)	0.1	Sodium (mg)	33
Mineral (g)	0.6	Potassium (mg)	138
Fibre (g)	0.8	Vitamin-A (IU)	5
Carbohydrate (g)	3.4	Riboflavin (mg)	0.02
Calories (kcal)	17	Nicotinic acid (mg)	0.5
Calcium (mg)	35	Vitamin-C (mg)	15
Oxalic acid (mg)	9		

Trade

The area under radish cultivation is 6915.7 ha with production of 268119.6 Mt and yields of 15.9 t/ha (MOAD 2072/73)

Variety

Many local cultivars exist in different parts of the kingdom. But improved varieties occupied a greater part in terms of hectarage and production. Generally,two types are available on the basis of temperature requirement.

a) Asian or tropical varieties: Most of our improved types are Asian types such as White neck, Minow early, 40 days ,Pusa chetaki, Tokinasi,etc.

b) European or temperate varieties: Most of European types are Icicle, red white tipped, etc.

SN	Variety	Varietal character	Release dYear	Recommended area	Production
1	Chalis dine	• Open pollinated • Early variety	2051	Mid Hill	28 Mt/ha

		• Leaves: light green& straight • Plant height: 35 cm • Harvesting: 35-40 DAT			
2	Mino early	• Open pollinated • Early-Mid season variety • Leaves: dark green cerated • Fruit: sweet & tapering end • Harvesting: 40-45 DAT	2046	All areas	30 Mt/ha
3	Pyuthane red	• Open pollinated • Late season variety • Leaves: green cerated with reddish vein • Fruit: reddish white • Harvesting: 70-80 DAT	2051	Mid Hill	43 Mt/ha
4	White neck	• Open pollinated • Late season variety • Leaves: straight & light green • Fruit: clean white & mild pungent • Harvesting: 50-65 DAT	2051	Terai and MH	
5	Tokinashi	• Open pollinated • Late season variety • Leaves: dark green and long • Fruit: white long with pungent • Harvesting: 50-55 DAT	2051	Mid Hill	30 Mt/ha

6	All season white	• Hybrid • Plant height: 12-15 cm • Harvesting: 70 DAT	2066	All areas	20-30 Mt/ha
7	Mino early long white	• Hybrid • Plant height: 12-15 cm • Harvesting: 55-60 DAT	2066	All areas	20-30 Mt/ha
8	Green neck	• Hybrid • Plant height: 12-15 cm • Harvesting: 40-45 DAT	2067	Terai and MH	50-70 Mt/ha
9	Long white minong	• Hybrid • Plant height: 12-15 cm • Harvesting: 60 DAT	2066	Terai and MH	40-60 Mt/ha
10	Sinjin	• Hybrid • Plant height: 10-12 cm • Harvesting: 65 DAT	2067	Mid Hill	40-45 Mt/ha
11	Tropical cross	• Hybrid • Plant height: 40 cm • Harvesting: 40-60 DAT	2066	Terai and MH	40-60 Mt/ha

Climate

Radish is adapted to a cool climate. The root can develop well under an average temperature of 18-24°C and adequate light intensity. Asiatic varieties required a higher temperature for root development than temperate varieties. Radish root becomes tough and pungent during the warmer period and plants bolt earlier.

Soil

It can be grown in almost all types of soils, but higher yields are obtained from light, friable, loam to sandy loam soil with high humus content. For early crops, sandy to sandy loam soils are preferred. However, for a summer crop, a cool, moist soil gives the best result. If the heavy and rough, misshapen roots with number of small fibrous lateral roots are produced. Thus, such soils should be avoided. The pH of soil should be 6-7.

Planting

Radish is planted through the direct seeding methods. So that it require 8-10 kg of seed per hectare. The time of planting depends uponthe variety and agro climatic condition.

Varieties		Agro climatic Regions		
		Terai	Mid-Hills	High hills
Mino Early	Kartik- Poush	Shrawan-Mangsir	Chaitra-Shrawn	Mino Early
White Neck	Kartik- Poush	Shrawan-Mangsir	Chaitra-Shrawn	White Neck
Pyuthane Red	Kartik- Poush	Shrawan-Mangsir	Chaitra-Shrawn	Pyuthane Red
40 days	Bhadra- Poush	Ashad- Kartik	-	40 days
Pusa Chetaki	Bhadra-Poush	Ashad- Kartik	-	Pusa Chetaki

Spacing

Plant spacing depends upon the variety, nutrient of soil, climatic condition where it grown and others factors. It is generally planted at the spacing of

Tropical type: 45cm x5-10 cm

Temperate type: 5-10cm x 2-3 cm

Nutrient Management

Well-rotted compost or FYM @ 30 mt/Ropani should be applied at the time of field preparation. Undecomposed organic manure should not be applied because it enhances for the roots damage ,insect pest as well as disease. Generally, N: P: K @ 70:50:40 kg should be applied per hactare of land. 500gm borax/ropani should also be applied. The whole amount of P2O5 and K2O and ½ N should be applied at the time of field preparation where as ½ dose N should be applied as dressing one month after planting.

Water management

The frequency of irrigation during the crops period depends on a number of factors: season, types of soil, amount of organic matter present, age of crops, etc. it is therefore give a definite recommendation regarding the amount if irrigation to

be given. Plenty and continuous moisture in the soil helps in rapid germination seed and development of tender attractive roots. During the summer months, frequent irrigation at an interval of 5-7 days is necessary. If the soil dries up during the root development period, the roots become pungent, rough and unattractive.

Weed management

Regular weeding should be done to check the growth of weeds. During the rainy season two weeding, two hoeing and earthing up are required.

Harvesting

The time of harvesting depends on variety. It becomes ready for harvesting at about 30-45 days in early varieties and it matures in about 50-70 days in late varieties. Delayed maturity results on pithy and bitter roots. Roots should be harvested when they are still tender. European radish matures within 20-30 days. In Nepal, harvesting is done manually. A light irrigation before harvesting facilitates the lifting of roots.

Yield

Average yield ranges between 1000 - 2500kg / ropani.

Early varieties: 400kg / ropani

Late varieties: 700 - 1500kg / ropani

Storage

Radish root cannot be stored for more than 2-3 days under room temperature without impairing its quality. However, it can be stored for about 2 months in cold storage at 0°C and 90% relative humidity.

Insect Pests

1. Aphids: spray Malathion 1 ml/lit of water. Dusting of BHC is also effective for its control.
2. Mustard saw fly: Hand picking of larvae when the area involved is small or dusting with BHC at the rate of 25-30 kg/hac is recommended.

3. Semi-looper: Dusting the crop with 5% malathion or 4% endosulfan or 2% Lindane

Diseases

1. White rust: spraying of Dithane-Z-78 @ 0.2-0.3% and use of resistant cultivars.
2. Leaf spot: Treating seed with Thiram @ 2.5 gm/kg of seed or spray Bavistin @ 2.5 gm/lit of water.
3. Black rot: infested plants should be collected and burnt.
4. Radish mosaic virus (RMV): controlling aphids with insecticides and eliminating weed +hosts.

Carrot

Botanical name: Daucus carota L.

Common name: Gazar

Family:Umbelliferae

Origin: Europe and South-Western Asia

Chromosome number: 2n=18

Uses

Carrot is a valued as a nutritive food mainly because of high carotene content. It is used as a salad, cooked and used in preparation of soups. It increases the quality of urine and helps the elimination of uric acid. Black carrots are used for the preparation of a soft beverage called Kanji. Red type is good for preparing various types of sweets especially Gajar Halwa. Carrot seed oil is used for flavouring liquors and all kind of food substitutes. Carrot seeds are aromatic, stimulant and carminative.

Nutritive value

Table: The nutritive value of carrot per 100 g of edible portion is given here under:

Moisture (%)	82.2	Iron (mg)	0.7
Protein (g)	1.1	Sodium (mg)	35.6

Fat (g)	0.2	Potassium (mg)	108
Mineral (g)	0.6	Vitamin-A (IU)	11000
Fibre (g)	1.2	Riboflavin (mg)	0.05
Carbohydrate (g)	9.7	Nicotinic acid (mg)	0.6
Energy (kcal)	42	Vitamin-C (mg)	8
Calcium (mg)	37	Thiamine (mg)	0.06
Oxalic acid (mg)	5	Sulphur (mg)	27
Phosphorus (mg)	30	Copper (mg)	0.13

Trade

The area under carrot cultivation is 2933.9 ha with production of 37724.9 Mt having yields of 12.9 t/ha (MOAD 2072/73)

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Nantes Forto	• Open pollinated • Stumpy end • Sweet taste and orange color • Harvesting: 100-120 DAS	2046	Terai and MH	
2	Chantany	• Open pollinated • Tapering end • Red color with sweet taste • Harvesting: 100-120 DAS	2046	Terai and MH	
3	Kuroda Mark II	• Hybrid • Plant height: 10 cm • Harvesting: 50-60 DAS	2067	Terai and MH	15-20 Mt/ha
4	New Kuroda	• Hybrid • Plant height: 12-15 cm • Harvesting: 100 DAS	2066	Terai and MH	50-60 Mt/ha
5	Sigma	• Hybrid • Plant height: 15-20 cm • Harvesting: 120 DAS	2066	Terai and MH	25 Mt/ha

Climate

Carrot is widely adapted to cool climate but generally restricted to regions with low rainfall during summer and early autumn. A dry warm atmosphere is desirable for maturing plants that are tough and woody. A temperature range of 7.2 to 23.9ºC is considered optimum for seed production. Good colour and growth of carrot roots has been observed in the temperature range of 15.6 – 21.1ºC. Seed production is suited to those regions which are away from coastal areas, where condition is drier for maturing seed. For temperate type cultivars, a chilling temperature of 4.8-10ºC for 4-6 weeks is desirable as cold stimulus (vernalization) any time during the development of roots. Seed stock formation takes place only when these plants are subjected to a temperature of 12.2-21.1ºC. Plants grown continuously at a temperature region range of 21.1-26.7ºC fail to develop floral primordial.

Soil

The soils of selected fields should be light, deep and fields should be well drained with pH range from 6.6-7.1. Deep, loam and loamy soils are preferred for good crop. For early crop, a sandy loam soil is preferred, but for higher yields, silt or silt loam soils is desirable. Long, smooth and slender roots desired for fresh market are successfully grown on deep well drained light soils.

Planting

August-November is the optimum time of sowing for Asiatic group while for European types it is October-November. In higher hills, the seed sowing is done during March to July depending upon the temperature. It requires a seed rate of 5-6 kg/ha and planted at the spacing of 30 cm x10 cm.

Method of Sowing

For better development of roots, sowing on ridges is preferred over flat sowing. Double row ridges 75cm apart produces large number of well-developed roots than singlerow ridges.The seed takes about 8-10 days for germination.For uniform germination the ridges should remain moist till germination takes place. Hence the field should be irrigated just after sowing. Afterwards, when plants are 5 to 6 cm

in height, thin out the plants to a distance of 6 to 7cm.

Nutrient management

For getting good yield, 25-30 mt/ha well rotten Farm Yard Manure is thoroughly mixed in soil 15-20 days before sowing of seeds. Add 70 kg/ha N, 50 kg/ha P and 40 kg/ha of K. Half quantity of N and full quantity each of P and K and Farm Yard Manure should be applied at the time of sowing. Remaining quantity of N may be given 30-45 days after seed sowing.

Water management

Irrigate the field just after sowing. Optimum level of moisture in the field is essential for better germination growth and development of roots. Crops should be irrigated at an interval of 5-7days depending upon rain or weather conditions.

Thinning

Thinning is the most important operation during carrot cultivation as thick sowing is done because of small sized seed. The thinning operation is done 20-30 days after sowing to maintain 10 cm plant to plant distance.

Weed management

Weeds are a serious problem and timely control of weeds is essential to avoid heavy loss in yield of top quality roots due to weed competition. Timely weeding, hoeing and earthing up therefore should be done.Generally two weedings at 15-20and 30-35days after sowing are sufficient to control the weeds. Pre emergence application of propazine@ 1.12kg/ha or Amiben@2.24-4.48kg/ha or Diuron and monuron@1kg/ha controls weeds very effectively.

Harvesting

Harvesting of roots depends upon the variety. Hence, size of the roots cannot be taken as reliable criteria to harvest the crop. However, in general the crop becomes ready for harvesting in 65-85days depending upon the variety. Sometime delay in harvesting even make it unfit for consumption.

Yield

The temperate types are poor yielder and produce about 100-150q/ha whereas

tropical types yield higher i.e. 250-300q/ha.

Physiological Disorders

Root splitting

Splitting or cracking of carrot roots is a major problem.

Possible Reasons:

- Wider spacing as larger roots tend to split more
- Dry weather followed by wet weather is conducive to cracking of roots.
- Increases as the amount of N in the soil increases
- Early cultivars tend to split more readily than late ones.

Correction

- Maintain optimum moisture in the field.
- Harvest the crop at right maturity stage.
- Grow resistant varieties.
- Sow the seeds at close spacing.
- Supply recommended dose of nitrogen.

1. Cavity spot

It appears as a cavity in the cortex. In most cases, the subtending epidermis collapses to form a pitted lesion.

Possible Reasons

- Calcium deficiency associated with an increased accumulation of K and decreased accumulation of Ca.

Correction

- Incorporate calcium containing fertilizers in the soil.
- Harvest the roots at optimum maturity.

2. Forking

A common disorder in carrot and radish formed by the enlargement of secondary root growth.

Possible Reasons

- Excess moisture during the root development is the cause. It occurs on heavy soils due to soil compactness.

Correction

- Avoid excessive moisture.
- Avoid heavy soil for root production.

Insect pest

1. Carrot Rust Fly

Larva burrows into the roots, often causing it to become misshapen and subject to decay, leaves become rusty or dried.

Control measures

- Mix folidol M (2%) or malathion dust (5%) @ 20-25kg/ha in the soil at the time of soil preparation.

2. Aphids

These are small in size, both adults and nymphs suck sap from leaves and flowersdue to which, the plant become weak and leaves curl.

Control measures

- Spray malathion (0.05%) at 15 days interval on root crop. On seed crop, spray oxydemeton methyl (0.025%).

3. Mustard saw fly: (Athalia promixa)

Adult feed on pods and leaves which show holes. Seed crop is also adversely affected.

Control measures

- Mix folidol M (2%) or malathion dust (5%) @ 20-25kg/ha in the soil at the time of soil preparation.

Diseases

Fungal Diseases

1. Leaf blight or Alternaria blight: *(Alternaria radicina and Alternaria dauci)*

It is predominant in winters. On the foliage, small dark brown to black spots with yellow edges appear at first mostly along the leaf margin. The number of spots gradually increases and the interveinal tissues die. In moist weather the blackening and shriveling progress so rapidly that entire field resembles frost injury. Disease is seed borne.

Control measures

- Crop rotation should be adopted.
- Seed treatment with captan or thiram @ 3g/kg of seed before sowing will be helpful. Later on spray mancozeb (0.25%) at an interval of 7-10days.

2. Leaf spot or Cercospora blight: (*Cercospora carotae*)

It is a wide spread disease of carrot.Symptoms appear first as elongated lesions along the edge of leaf segment,resulting in a lateral curling. In dry weather, the spots are light tan in colour whereas in humid weather the spotsare darker in colour.

Control measures

- Dipping seeds in 0.1 per cent carbendazim solution for 5 minutes is suggested.
- Crop rotation and sanitation are necessary.
- Spray with copper fungicides or Zineb@ 0.25-0.3per cent as and when the attack is noticed.

3. Powdery mildew: (*Erysiphe spp.*)

It appears first on leaves, but later may spread on flowers, stem and fruits. Symptoms first appear as faint, slightly discoloured and tiny checkers from which white powdery spots spread to form various sized areas.

Control measures

- Before observing symptoms, spray dinocap (0.05%) or wettable sulphur (0.2%) at 10-15 days interval.
- Sulphur dust is most effective. It is applied even after the appearance of the disease as this fungicide is both eradicative and protective.

Viral Diseases

1. Carrot Yellows

First appear on leaves which become yellow sometimes accompanied by vein clearing. Dormant buds in the crown grow out into chlorotic shoots which give a "witches broom" appearance on the tops. Older leaves are reddish, twisted and may eventually break off. The disease is transmitted by six spotted leaf .

Control measures:

- Spray insecticides to control the hopper e.g. Dimethoate (0.05%) or Carbaryl(0.15%).

Root Diseases:

1. Watery soft rot: (Sclerotinia sclertiorum)

Infected roots become soft and watery and white mycelium with black sclerotia isformed.

2. Gray mold rot: (*Botrytis cinerea*)

The affected tissue is water soaked and light brown and later become spongy.Gray mold appear in moist atmosphere.

3. Black rot: (Alternaria radicina)

It is a wide spread disease. Foliage symptoms are just like those caused by Alternaria blight. On roots, black sunken areas irregular to circular in outline may develop.

Control measures of root diseases

- Store roots at 0-2^{o}C to keep storage decay at a minimum level.

Bacterial Diseases

1. Bacterial soft rot: (Erwinia carotovora pv. carotovora)

The infected tissue softens, becomes watery or slimy and as the rot progress the watery extrusion becomes more evident. A foul odour from decayed roots distinguishes it from the soft rot.

Control measures:

- Careful handling of roots during harvesting, grading or transit so that all bruises on root surface can be avoided.

Turnip

Botanical name: *Brassica rapa*

Common name: Salgam

Family:Brassicaceae

Origin: Europe

Chromosome number: 2n=20

Uses

Turnip is a cool and warm season crop. It is a leaf-cum-rootvegetable. The root, along with the tender leaf, eaten cooked, or used in salads and pickles.

Nutritive value

The root contains7–9% sugar and Vitamin B. The leaf contains Vitamin A and C. The leaf contains different minerals and vitamins and has a higher nutritional value than the root.

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Purple Top White Globe	• Open pollinated • Leaves dark green • Root: globe shaped with purple • Harvesting: 60-70 DAS	2046	All areas	
2	Fuyunosho	• Hybrid	2066	Terai and MH	15-18 Mt/ha

		• Plant height: 12-15 cm • Harvesting: 50-60 DAS			

Climate

Turnip requires a cool or moderate climate and grows well in sub-tropical and temperate climate. It is predominantly a cool season crop. It can tolerate frost and mildly freezing temperature. Turnip grows well in fullsunshine and cannot be grown in the shade. For good root growth, optimum temperature is 15° to 25°C. Turnip seed germinates at 10°–15°C. If seed is sown at temperatures below 10°C, it may lead to bolting; above 25°C theroot becomes a little hard, pithy and pungent.

Soil

Turnip can be grown in almost all types of soil; however, light loam to sandy loam soil rich in organic matter, a highlevel of fertility and high water-holding capacity is best for quality root production. Soils with high clay and high sand, and muddy and waterlogged soils should be avoided. Turnip requires slightly acidic soil with pH range 5.5 to6.8. In soils with a lower pH, club root attacks the plant and phosphorus and calcium availability is restricted. Adding agricultural lime improves pH and increases phosphorus and calcium availability.

Land preparation

Turnip is a shallow-rooted root crop. The field should be ploughed or dug 15–20 cm deep and the soil should befriable, loose and well levelled. To plant four rows per bed, 120 cm wide beds are prepared with a 25 cm widetrench between two beds. Turnip is sown in well-prepared 15 cm raised beds, maintaining a 20 cm row-to-rowdistance. Organic manures like FYM should be applied at the time of preparing the main field. All chemical fertilizers except half dose of nitrogen should be mixed thoroughly with soil during bed preparation.

Method of Sowing

In the 120 cm wide raised flat beds, 3–4 cm deep small furrows are made at a spacing of 20 cm. To make sowingeasy, 8–10 parts sand or ash is thoroughly mixed with seed and the seed mixture is dropped continuously in the furrows. The

seed is then covered with a wooden hand plank. After 10–15 days of germination when plants develop3–4 true leaves, the plants are thinned to maintain a plant-to-plant distance of 10 cm.

Nutrient management

Turnip requires a smaller amount of NPK compared to other root crops. FYM 20 tonnes/hac. or compost should be added to the soil during final digging before bed preparation. To supplement the FYM, apply 40 kg nitrogen, 2kg P_2O_5 and 20 kg K_2O per ha. Apply the full dose of FYM during the final digging. The full dose of P_2O_5 and K_2O and half dose of nitrogen mix thoroughly in the soil at the time of making beds. Apply the remaining half dose of nitrogen as top dressing in two batches: first after 15–20 days of germination after thinning and second dose after 35–40 days of germination at 2–3 cm deep as band placement with slight hoeing.

Water management

If the soil is dry, pre-sowing irrigation is essential for quick germination and vigorous growth and production of roots. If pre-irrigation is not possible, irrigation just after sowing and light irrigation at 5–7 day intervals is necessary to maintain a proper soil moisture level. During the rainy season, only protective irrigation should be provided. The critical stages of irrigation in turnip are just after sowing, urea top dressing, after weeding and intercultural operation. During dry weather, irrigation should be provided more frequently. A furrow system of irrigation is always better. After irrigation and heavy rain, it is important to drain excess water; otherwise club root, root rot, etc. mayattack the crop. Constructing a water-harvesting and waste water collection pond near the cultivated field ensures water security for irrigation.

Thinning

Thinning is the most important operation during turip cultivation as thick sowing is done because of small sized seed. The thinning operation is done 20-30 days after sowing to maintain plant to plant distance.

Weed management

Weeds are a serious problem and timely control of weeds is essential to avoid

heavy loss in yield of top quality roots due to weed competition. Timely weeding, hoeing and earthing up therefore should be done.Generally two weedings at 15-20and 30-35days after sowing are sufficient to control the weeds. Pre emergence application of propazine@ 1.12kg/ha or Amiben@2.24-4.48kg/ha or Diuron and monuron@1kg/ha controls weeds very effectively.

Harvesting

Turnip roots become ready for harvest in 45–55 daysafter germination depending on the variety. Lightirrigation before harvest facilitates easy uprooting. It is best to harvest in the afternoon when the sun ismild and there is no dew on the plants. After harvest,turnips should be kept in the shade for cleaning,grading and packaging.

Yield

The root yield ranges from 20–25 tonnes/ha depending on the variety.

Cleaning and grading

After harvest, the roots should be washed, graded and packed for marketing. Roots are graded as small, medium and large. They are made into bundles, each weighing up to one kg, and tied with a straw or aplastic rope.

Packaging and transportation

The leaves are removed before the bundles are piled up and packed in gunny bags for distant markets. For local market, they are usually transported on bicycles. If they are packed in bamboo baskets or plastic crates along withthe leaves with proper aeration, they will reach the market in fresh condition.They are usually transported in trucks and minibuses. The packages should be piled up carefully so that they don't shake during the journey. Turnips produced in the high hills are sold in the Terai and large towns of Nepal.

Storage and marketing

Most of the turnips commercially grown in Nepal are harvested and sent to the market within a day or two.Smallholder producers who live in the periphery of cities make bundles and carry them to the market in padded bamboo baskets. They sell them either to local wholesaler or retailers, or directly to consumers in market

areas.If marketing is obstructed or delayed due to transportation problems, they can be stored at 10°–12°C and 85–95%humidity for up to 10 days.

Physiological Disorder

Brown Heart : Brown Heart can be found in turnip by splitting open a root where firm, water-soaked patches occur on the flesh. The tissue may eventually turn brownish and become pulpy and hollow. Affected roots will not store well.

Plant protection

Aphids, Mustard Saw Fly and Flea Beetle are the main insects that attack turnip. When the attack is severe at the early stage of crop growth, these insects can be controlled by spraying metasystox @ 1ml/litre of water twice within15 days. Main diseases include damping-off of seedlings, leaf spots and club root. Alternaria leaf spots appear on older leaves. Remove such leaves and bury or burn them. Club root appears in waterlogged conditions and soils with low pH. Therefore, apply 100 kg lime and 100 kg mustard cake/ha. Limeincreases the soil pH and reduces the attack of club root.

C.Learning process and support materials

Learning process includes the Visual methods, Demonstration method, Practical method, Observation method, Exhibition methods.

D. Assessment

Very Short (Answer question)

1. Write down the scientific name and family of Carrot.
2. List out the important root crops cultivated in Nepal.
3. Name any two important varieties of Radish..
4. List any two major diseases of root crop.

Short (Answer question)

1. Define root crops with examples.
2. Write down the requirement of climate and soil for turnip crop.
3. Write any four varieties of Carrot.

Long (Answer question)

1. Write the cultivation practices of Radish with respect to, botanical name,climate, method of sowing, manure & fertilizer and storage.
2. Write the cultivation practices of Carrot with respect to, botanical name, family,climate, , manure & fertilizer, weeding and harvesting.

UNIT- 4

Cultivation Practices of Leafy Vegetable (Broad Leaf Mustard, Spinach, Swisschard, Cress) 57

A. Objectives

After the completion of this course, the students will be able to:

- Explain about the origin, distribution, cultivars, climate and soil requirement etc. of different leafy vegetable crops.
- Describe about the cultivation practices of different leafy vegetable crops in various aspects.

B. Content elaboration

Leafy vegetable crops comprise of different species, such as Broad leaf mustard, spinach, swisschard and cress which are mostly annuals and some are binneial of which different parts like root, leaf, stem flower and flower bud etc. are consumed either raw as a salad or cooked. Leafy vegetables are rich source of minerals and vitamins. Dieticians recommended daily consumption of 100-120 gm of leafy vegetables for a balanced diet. A variety of leafy vegetable are grown in Nepal. Most of the leafy vegetable crops which are commonly cultivated are:

Broad leaf mustard

Broad leaf mustard commonly known as rayo, occupies first position in terms of hectarage and production among the leafy vegetable. It is widely adapted and can be grown from the terai to the high hills of Nepal.

Botanical Name: *Brassica juncea var rugosa*

Family: Cruciferae

Chromosome number: 2n=36

Origin: Central to Eastern Asia

Uses

Green leaves are used for cooking vegetables as well as for making dry product like gundrug in Nepal.

Nutritive Value

Table: Nutritive value of broad leaf mustard per 100 gm.

Principle	Nutrient Value
Energy	27 Kcal
Carbohydrates	4.67 g
Protein	2.86 g
Total Fat	0.42 g
Cholesterol	0 mg
Dietary Fiber	3.20 g

(**Source :** USDA National Nutrient data base)

Trade

It is cultivated under the area of 12791.7 ha with the production of 151774.6 Mt and yields of 11.9 t/ha.

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Khumal broad leaf	Open pollinated Leaf: broad, dark green, late bolting, Harvesting: 50-55 DAS	2046	All areas	6 Mt/ha
2	Marpha Broad Leaf	Open pollinated Leaf: broad, light green, no spiny, late bolting Harvesting: 50-65 DAS	2051	All areas	25-30 Mt/ha
03	Khumal Red Leaf	Open pollinated Leaf: purple red pigment, light green without spiny Harvesting: 60-70 DAS	2051	All areas	25-30 Mt/ha

4	Tankhwa Rayo	Open pollinated Leaf: light green, veins creamy in color, Late variety and late bolting Harvesting: 33 DAS	2051	Mid Hill	
5	Red giant	Hybrid Plant height: 15-20 cm, Harvesting: 30-40 DAS	2046	Mid Hill	1-2 Mt/ha
6	Mike Purple Giant	Hybrid Plant height: 15-20 cm, No bolting in high temperature Harvesting: 30-45 DAS	2046	Mid Hill	1-2 Mt/ha

Climate

It requires cool temperature. It thrives best at higher altitude in tropics and sub tropics. The seed germinate quickly at 21-24^{o} C. But lower and higher temperature is harmful for germination. Temperature above 22^{o}C promotes bolting causing bitterness in leaves and accelerates the development of tip burn and rot. Seeds become dormant and fail to germinate when the soil temperature is above 22-30^{o}C.

Soil

It grows well in light, well manured, well drained soils with adequate moisture. It is slightly tolerant to acid soil (pH 6.0 -6.8) but highly susceptible to acidic soil.

Planting

In the plains, the seeds are sown in the nursery beds in September to October. At high altitude, the sowing is done from March-June/July. It requires a seed rate of about 400 to 500 gram seed for one hectare area. It can be sown directly in the field or by raising the nursery beds. In the nursery beds, the seedlings are transplanted after 4-6 weeks of sowing. Seedlings are transplanted at a spacing of 45×45, 45 ×30 or 30 ×30cm depending on soil type and cultivars.

Nutrient management

For getting good yield, 100-150q of well rotten Farm Yard Manure should be

incorporated during land preparation. Besides this apply 50 kg each of N and K2O and 90 kg of P2O5. Entire quantity of Farm Yard Manure, P K and half nitrogen is applied in the field at the time of field preparation. The remaining nitrogen is top dressed one month after first application at the time of hoeing/earthing up.

Use of growth regulators

- The plant fresh weight increase with IBA and NAA at 50 to100 ppm, the use of GA3 @10 mg/l stimulate respiration in lettuce seedling when applied at active stage of growth and development.

Water management

When sufficient moisture is not present in soil, a pre-sowing irrigation is done for seed germination in directly sown crops. Soon after transplanting, the lettuce crop should be irrigated. Subsequent irrigation is done at 8-12 days interval.

Weed management

Shallow hoeing and weedings are essential to keep the field free from weeds and to maintain proper aeration. About 3-4 hand weedings at 15-21 days interval are sufficient. Pre-transplant application of Fluchloralin @ 1.0-1.5 kg/ha effectively controls most of the weed. Herbicides like Propyzamide @ 1.5 kg/ha when applied as pre-planting proved effective for the control of weeds.

Harvesting and marketing

Leaves become ready for harvesting at about 25-30 days after seedlings transplanting. Leaves should be harvested without damaging the plants and should be cut with the help of a knife at the base of the sheath. Delayed harvesting of over mature leaves causes lower yields. Tender leaves should be harvested regularly to get higher yields. Green leaves are marketed to local market.

Insect pest

Aphids, caterpillar and bettles are common pest of broad leaf mustard which can be controlled by spraying malathion @ 1-2ml/lit of water.

Diseases

Dmping-off, Cercospora leaf spot, mildew and rust are the common disease of

broad leaf mustard which can be control by spraying Dithane M-45 @ 0.2 % has founf effective where as in case of powdery mildew, 5% sulphur @15kg/ha control the disease.

Spinach

Spinach is herbaceous for leaf production and biennial for seed production. It produces bunch of leaves from the stem near the surface to ground during vegetative phase

Botanical name: *Spinacia oleracea L.*

Common name: Palak

Family: Chenopodiaceae

Origin: Iran

Chromosome number: 2n=2x=12

Uses

The edible part of spinach is a compact rosette which is normally consumed as a cooked vegetable. Sometimes, it is also used as salad along with lettuce and other vegetables. Spinach is highly suitable for hydroponics. Spinach is also processed, primarily canned and fried. Leaves of spinach are rich in vitamin-A (9300 IU) and contain considerable amount of iron and calcium.

Nutritive value

Table: Nutritive value of Spinach per 100 gm

Energy (kcal)	26	Riboflavin(mg)	0.2
Moisture (%)	90.7	Niacin (mg)	0.6
Protein (g)	3.2	Ascorbic acid (mg)	51
Fat (g)	0.3	Calcium (mg)	93
Carbohydrate (g)	4.3	Phosphorus (mg)	51
Vitamin-A (IU)	9300	Iron (g)	3.1
Thiamin (mg)	0.1	Oxalic acid	658

Trade

Spinach is cultivated under 1928.3 ha with production of 21144.5 Mt and yields of 11 t/ha (MOAD 2072/73)

Variety

SN	Variety	Varietal character	ReleasedYear	Recommended area	Production
1	Haripate	• Harvesting: 40-45 DAT	2051	All areas	12-16 Mt/ha
2	W king, F_1	• Late variety • Harvesting: 120 DAT	2066 reg.	All areas	18-27 Mt/ha
3	Asia bol dong, F_1	Harvesting: 50 DAT	2067 reg.	All areas	10-18 Mt/ha

Climate

Spinach is strictly a cool season vegetable. It does not grow well during hot weather. Spinach growth is best at temperature of about 18-20^{o}C. Spinach is a short day plant and the growth is slow at 10^{o}C. Acclimated plants can tolerate freezing temperature up to -10^{o}C.

Soil

It can be grown on a wide range of soil types however soil having high moisture holding capacity and good drainage are preferred. Plants have some tolerance of salinity and favorable pH range is 6.5 to 7.0.

Planting, Seed Rate and Spacing

Spinach can be sown round the year in different agro-climate conditions of the country. The different sowing times are as follows:

In plains: September-October

In low hills: July-November, February-March

In high hills: March-June and September

The seed rate of 37-45kg/ha is required. Seeds are either broadcasted or line sown. However, line sowing is preferred for the convenience in intercultural operations. Row to row spacing is maintained at 30 cm and plant to plant at 10-12cm.

Nutrient management

Apply 5-6 mt/ha well rottened Farm Yard Manure/compost during field preparation. An application of 75 kg N, 55 kg P and 30 kg /ha gives best yield. Nitrogen should be applied in 2 splits, first half prior to sowing along with full quantity of Farm Yard Manure, P and K and other half after 1 month of seed germination.

Water management

Spinach is a quick growing shallow rooted crop that is not tolerant to water stress. Adequate moisture should be maintained by frequent irrigation when necessary. Irrigation practice that splash soil into the leaves is damaging and should be avoided. About 12-13 inch water may be sufficient during the entire crop season. Moisture requirement is not very high since rate of transpiration is low during cool season. Water logging of the field should be prevented.

Weed management

Weed control is very important because spinach plant cannot compete well with the weeds. For weed control, one to two shallow hoeings are needed. Herbicides can also be used to control the weeds effectively.

Harvesting

Harvesting should not be done early in the morning because leaves are crisp and break easily. The crop is ready for harvest 4-6 weeks after sowing. Cutting is done with a sharp knife/ sickle. About 3-4 cuttings may be obtained throughout the season. Product should be hydro or vacuum cooled immediately after harvest.

Storage

Spinach can be stored at 0^{o}C and at 95-100 per cent RH. It can be stored only for 10-14 days. Temperature should be as close to 0^{o}C as possible because spinach deteriorates rapidly at higher temperature.

Insect pest

1. Aphids

These are small in size.Both adults and nymphs suck sap from plant tissues due to which, the plant becomes weak.

Control measures

- Spray malathion (0.05 %) or oxy-demeton methyl (0.025 %).

2. Leaf eating caterpillar: (Laphygma exiqua)

Caterpillars feed on leaves and make holes.

Control measures

- Spray malathion (0.05%) for effective control.

Diseases

Fungal Diseases

1. Damping off: (Pythium spp.)

Seedlings are attacked by the fungus before or after germination and killed.

Control measures

- Avoid thick sowing of seeds.
- Treat seeds before sowing with any one of the fungicides like carbendazim or captan @2.5g/kg of seed.
- This disease can be controlled by drenching the infected seedlings with a mixture of mancozeb (0.25%) and carbendazim (0.05%).

2. Downy mildew: (Peronospora spinaciae)

Affected plants show similar symptoms as that of downy mildew of peas. The causal organism can survive in soil as oospores, in seed as dormant mycelium, on the seed as contaminating oospores, or on perennial spinach beet.

Control measures

- Use clean seed.
- Remove crop debris and destroy it.
- Follow a three year crop rotation and spray zineb at 0.2 per cent.

3. Leaf spot: (Cladosporium variabile and Stemphylium botryosum)

It is a seed borne disease. Older leaves show dirty white, water soaked circular spots.

Control measures

- Seed treatment with hot water or with fungicides like carbendazim. (0.05%) is recommended to check the disease.
- The pathogen can be eradicated by 1.2 per cent chlorine treatment for 10 minutes.

4. Anthracnose : (Colletotrichum dematium)

Affected leaves show water-soaked spots, which later on coalesce and cause drying of the leaves. On seed stalk, elongated spots are formed. Black dots are also seen on seed.

Control measures

- Reduce leaf moisture by avoiding sprinkler irrigation, if possible.
- Spinach fields should be adequately fertilized.
- Use resistant varieties.
- Apply copper oxychloride (0.3%) as a protectant spray at 10–14 day interval.

Bacterial Diseases

1. Bacterial soft rot: (Erwinia carotovora)

It is a post-harvest diseases, the disease appears on leaves in transit. Water soaked areas develops and rotting occurs in the packed leaves due to lack of aeration and cleanliness.

Control measures

- Follow rotation with maize, beans, small grains and grasses.
- Care should be taken at harvesting and handling to avoid bruising.
- A storage temperature just above freezing (0°C) and a relative humidity below 90 per cent does much to reduce soft rot losses.
- Storage rooms dump tanks and boxes should be disinfected each season with copper sulfate.

Viral Diseases

1. Spinach mosaic

This disease is characterized by light to dark green patches and mosaic symptoms on infected leaves. The leaves are reduced in size, distorted and invariably show chlorotic sectors which are almost white. This infected disease is caused by a strain of cucumber mosaic virus (CMV). This virus is easily transmitted by sap inoculation. The virus is also transmitted by insect vector Myzus persicae in a non-persistent manner.

Control measures

- Removal and destruction of affected plants, control of aphids with malathion @ 0.05 percent, and growing of improved varieties are recommended

Swisschard

Botanical Name: *Beta vulgaris var clicla*

Family: Chenopodiaceae

Chromosome number: 2n=18

Origin: Mediterranean region

Uses

Swiss chard is an all-season leafy vegetable.It can tolerate both frost and high temperature. The tender leaf is eaten as a cooked vegetable. It is commonly steamed with a little turmeric, chilli and salt, or mixed with potato and sometimes cornflour and tomato.

Nutritive Value

Swiss chard is rich in Vitamin A and C. Among minerals, it is rich in calcium and iron.

Variety

SN	Variety	Varietal character	Year	Recommended area
1	Susag	Open pollinated Leaf: dark green, firm Harvesting: 60-80 DAS	2051	All areas

Climate

Swiss chard can grow well in winter and summer. It grows well in full sunshine and its seed germinates at 7°–35°C.For good vegetative growth, optimum temperature is 15° to 35°C. It fetches better prices during late spring to summer when broad leaf mustard and spinach are not available in the market. It flowers in long day conditions.

Soil

Swiss chard can be cultivated in almost all types of soil; however light loam to sandy loam soil with rich organic matter and a high level of fertility and high water holding capacity is best for leaf production. Soil pH range of 5.5to 6.5 is most desirable. For crops grown in the rainy season, sandy or sandy loam, light soil is desirable.

Land preparation

The field for Swiss chard should be well drained in order to hold moisture. Soil should be prepared well with 1–2rounds of deep corrosive plowing followed by 2–3 rounds of light plowing and clod breaking to make soil friable,loose and well levelled. Plowing or digging should be done well to ensure good tillage and decomposition of weedsand prepare the land for transplanting. For transplanting, prepare 15 cm raised beds 1 metre and 2 metre wide,with a 25 cm wide trench between two beds. Two rows can be transplanted in the 1 metre wide bed and four rowsin 2 metre wide bed. Organic manures like FYM should be applied at the time of preparing the main field. Before making beds, all fertilizers except half dose of nitrogen should be thoroughly mixed with soil.

Seed rate and seedling requirements

For one hectare of land, 2–2.5 kg of seeds are required depending on germination percentage and seed vigor.Healthy 60,000 to 70,000 seedlings per hectare are required, including for gap filling.

Transplanting

Seedlings that are 4–6 weeks old with 4–6 true leaves are ready for transplanting.

Moistening the nursery beds before pulling the seedlings out of the soil makes their removal easy and prevents injury to the root system.Transplanting is preferably done in the evening. Soil around the seedling should be pressed and made compactto establish a close contact with roots following irrigation. Transplanting distance is 50 cm row-to-row and 30 cmplant-to-plant. Transplanting and harvesting time varies according to the topography and altitude. Seed sowing, transplanting and harvesting months at different geographical areas are presented below:

Geographical areas	Seed sowing	Transplanting	Leaf harvesting
High hills	February-March	March-May	May-November
Mid-hills	October-November	November-March	December-June
Low hills and Terai	October-December	November-January	December-July

Nutrient management

Swiss chard is a long duration heavy feeder and requires adequate manure and nutrient for profitable yield. Forbest results, FYM 25–30 tonnes/ha or compost should be added to the soil before a week of transplanting during the final preparation of the soil. To supplement the FYM, apply 80 kg of nitrogen, 40 kg of P_2O_5 and 40 kg of K_2O perha. Apply all manure and fertilizer except half dose of nitrogen before bed preparation. Apply the remaining halfdose of nitrogen as top dressing in two batches – first dose, after 30–40 days of transplanting and second dose after 60 days of transplanting. Add nitrogen-rich amendments such as blood meal and mustard cake to improve soil health.

Water management

Just after transplanting, light irrigation is provided with a watering can and there after it is necessary to maintain the proper soil moisture level for a good harvest of leaf. In normal conditions, soil moisture should be 60–80 % of field capacity with an average of 60% field capacity. During dry weather, irrigation should be provided more frequently. A furrow system of irrigation is always better. Building a water harvesting and wastewater collection pond near the cultivated field

ensures water security for irrigation.

Weed management

Shallow hoeing and weeding are essential to keep the field free from weeds and to maintain proper aeration. About 3-4 hand weeding at 15-21 days interval is sufficient. Pre-transplant application of Fluchloralin @ 1.0-1.5 kg/ha effectively controls most of the weed. Herbicides like Propyzamide @ 1.5 kg/ha when applied as pre-planting proved effective for the control of weeds.

Harvesting and yield

The tender leaves of Swiss chard are cooked and eaten as a vegetable. The readiness for leaf harvest is judged by visual observation of the tender leaves. While harvesting, young leaves are broken above the base of the sheath or cut with a sharp knife without injuring the leaf base. Harvesting should not be done when there is dew on the plant. It is better to harvest in the afternoon when the sun is mild. Total leaf yield ranges from 15–20 tonnes/ha.

Cleaning and grading

To market the produce after harvest, leaves are sorted, and diseased, damaged, yellow and undersized leaves are separated. Leaves are graded as small, medium and large, and then made into and small bundles weighing up to half kg and tied with a straw orplastic rope. Cleaning and grading provides a basisfor orderly marketing and enables the consumers toassess the quality of the produce in relation to the price while also providing marketing incentive to the traders.

Packaging and transportation

The bundles should be padded well and tied with ropes and placed in gunny bags for distant markets. For local market, they are often transported on bicycles. If the leaves are packed in bamboo baskets or plastic crates with proper aeration, they stay fresh when they reach the market. The packages should be piled up carefully so that they don’t shake on the journey. Swiss chard leaves produced in high hills are sold in the Terai and large towns of Nepal.

Storage and marketing

Most of the Swiss chard commercially grown in Nepal is harvested and sent to the market within a day or two. Small holder producers who live in the periphery of cities make bundles and carry them to the market in padded bamboo baskets. They sell them either to the local wholesaler or retailers, or directly to consumers in common market areas. If marketing is obstructed or delayed due to transport problems, it can be stored at 10°–12°C and relative humidityof 85–95 % for 2–4 days only.

Plant protection

Black aphids and blister beetle are the two main insects that attack Swiss chard.As the leaves of Swiss chard are harvested continuously, no chemical spray is recommended. To manage aphidsand caterpillars, spray soap water, human or cow urine or neem products.

So far no serious diseases that can cause economic losses have been found in Swiss chard in Nepal. Alternaria leaf spots appear on older leaves. Remove such leaves and bury or burn them.

Cress

Botanical Name: *Lepidium sativum*

Family: Crucifarae

Origin: Europe

Uses

Cress is a cool season leafy vegetable. It can tolerate frost, but cannot tolerate high temperature. The young plants are generally cooked.

Nutritive Value

Cress containsVitamin A and C. Among minerals, it is rich in calcium and iron.

Variety

No any variety of cress has been released yet. Farmers grow local available variety in the locality.

Climate

Cress can grow well in full sunshine as well as in the shade. Its seed germinates at 4°C. For good vegetative growth,optimum temperature is 10°–25°C.

Soil

Cress can be cultivated in almost all types of soil ranging from light sand to clay loam and silt soil; however, light loam to sandy loam soil with rich organic matter and a high level of fertility with high water-holding capacity is best for quality production. It is sensitive to acidity; liming is required in soil with pH below 5.5. Soil with pH range5.5–6.5 is most desirable.

Land preparation

As with spinach, land for cress should be well drained and able to hold moisture. Soil should be prepared well with 1–2 rounds of deep plowing followed by clod breaking to make it friable, loose and well levelled. Irrigationand drainage in the spinach field must be easy. Spinach is sown in flat raised beds during the rainy season and in sunken beds during the dry season. For sowing 15 cm raised beds of 1 metre and 2 metre widths should be made,with a 25 cm wide trench between two beds. Five rows can be sown in 1 metre wide beds and 10 rows in 2 metrewide beds. Organic manures like FYM should be applied at the time of preparing the main field. Before making beds, all fertilizers except half dose of nitrogen should be thoroughly mixed in soil.

Seed rate

For one hectare of land, 10–15 kg of seed is required.

Sowing

In the raised beds or sunken beds, 3–4 cm deep small furrows are made at a spacing of 20 cm and seed is dropped in the furrow. To ensure that seed is dropped properly, it is first mixed with four parts sand or ash. Then cover the furrows with wooden hand planks (dalletho). Plants rows should be thinned to maintain a plant-to-plant distance of 3–4 cm. Broadcasting and planking are also practised.

Nutrient management

Cress is also an organic manure-loving crop and a heavy feeder that requires adequate manure and nutrients for profitable yield. For best results, FYM 15–20 tonnes/ha or compost should be added to the soil before a week of sowing during the final preparation of soil. To supplement the FYM, apply 40 kg nitrogen, 20 kg P_2O_5 and 20kg K_2O per hac. Apply all manure and fertilizer except half dose of nitrogen before bed preparation. Apply the remaining half dose of nitrogen as top dressing in two batches: first after 10–15 days of sowing and second top dressing after first harvest.

Water management

Cress seed requires good moisture for germination. For good germination, pre-sowing irrigation or light irrigation is recommended after sowing. In case of post-sowing irrigation, care should be taken to prevent the soil from forming any crust. Since cress is a shallow-rooted crop, subsequent irrigations are required at 10–15 day intervals. It is necessary to maintain a proper soil moisture level for good harvest. Constructing a water-harvesting and waste water collection pond near the cultivated field ensures water security for irrigation.

Weed management

Weed control is very important in cress because it cannot compete with weeds. Thinning and weeding is done after 10–15 days of germination. During the early stage of growth, weed competes with the crop for nutrient and moisture. Light hoeing and urea top dressing after 10–15 days of germination ensures uniform growth. The field should always be kept free of weed moisture level should be adequate but water logging should be prevented.

Harvesting and yield

Cress becomes ready for harvest in 20–25 days after germination. Harvesting should be done when the stems are tender. Yield ranges from 10–12 tonnes/ha.

Cleaning and grading

After harvest, roots are trimmed for marketing. The leaves are sorted, and

diseased, damaged, yellow and undersized leaves are separated. Bundles are made and tied with a straw or plastic rope. Cleaning and grading is done to provide a basis for orderly marketing.

Packaging and transportation

The bundles are tied with a rope and piled up. They should be properly padded to prevent breakage. The packages should be piled up carefully so that they don't shake on the journey.

Storage and marketing

Cress is harvested and sent to the market within a day to the market. Smallholder producers who live in the periphery of cities make bundles and carry them to the market in padded bamboo baskets. They sell them either to the local wholesaler or retailers, or directly to consumers in the market areas. If marketing is obstructed or delayed due to transportation problems, they can be stored at 10°–12°C and relative humidity of 85–95% for 2–3 days only.

Plant protection

No serious pest attack is found in cress. However, club root is seen in soil with low pH. Application of lime 100–200kg/ha is recommended in acidic soil.

C. Learning process and support materials

Learning process includes the Visual methods, Demonstration method, Practical method, Observation method, Exhibition methods.

D. Assessment

Very Short (Answer question)

1. Write down the scientific name and family of Broad leaf mustard.
2. List out the important leafy vegetable crops cultivated in Nepal.
3. Name any two important varieties of Spinach.
4. List any two major diseases of leafy vegetable crop.

Short (Answer question)

1. Define leafy vegetable crops with examples.

2. Write down the planting and fertilizer requirement of swiss chard.
3. Write any four varieties of Broad leaf mustard.

Long (Answer question)

1. Write the cultivation practices of Broad leaf mustard with respect to, botanical name, climate, planting, manure & fertilizer and harvesting.
2. Write the cultivation practices of Spinach with respect to, family, climate, soil, manure & fertilizer, weeding and disease.

UNIT - 5

Cultivation Practice of Tuber Crops (Potato, Sweet Potato, Yam, Colocasia) 75

A. Objectives

After the completion of this course, the students will be able to:

- Explain about the origin, distribution, cultivars, climate and soil requirement etc. of different tuber vegetable crops.
- Describe about the cultivation practices of different tuber vegetable crops in various aspects.

B. Content elaboration

Tuber vegetables comprise of a large number of plant species, mostly annuals or binneial, of which different parts like root, stem, leaf, flower bud, flower, etc. are consumed either raw as salad or cooked. They are essential items of balanced diet and are rich in nutrients. Most of the tuber crops which are commonly cultivated are :

Potato

Potato is the fourth major food crops of the world after rice, wheat and maize. Being a major source of carbohydrate it is often used as a substitute for cereals and is grown in almost every country.

Botanical name: *Solanum tuberosum L.*

Common name: Alu

Family: Solanaceae

Origin: South America in the central Andean region.

Chromosome number: 2n=48

Uses

Potato has proved its worth in feeding the nation in emergency. It is an important

source of starch. It is a rich source of body building substances such as vitamins (B1, B2, B6 and C), minerals (Ca, P and Fe) and protein. It contains all the dietary substances except fat. It is used as staple diet in many of the countries especially in the hilly areas.

Nutritive value

Table: Nutritive value of potato per 100g.

Energy (kcal)	97	Vitamin-B6 (mg)	0.26
Carbohydrate (g)	22.6	Vitamin-C (mg)	17
Starch (g)	15	Calcium (mg)	10
Fibre (g)	2.2	Magnesium (mg)	3.8
Iron (mg)	0.7	Phosphorus (mg)	40
Fat (g)	0.1	Thiamine (mg)	0.10
Protein	1.6	Sodium (mg)	6
Potassium	421	Riboflavin	0.01

Trade

Potato being a most important food crop after cereals crops in Nepal. It a primarily a stable food crops in most of high hills areas. The area under potato cultivation in Nepal according to MOAD 2073/074 (2016/17) was 195268 ha with production of 2730294 Mt and average yield of 13982 kg/ha

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Kufri Jyoti	• Open pollinated • Introduced from Simla, India • Egg shaped, slightly white, pulp slightly yellow • Resistant to blight	2049 B.S	All areas	20-25 Mt/ha
2	Kufri Sinduri	• Open pollinated • Introduced from Simla,	2049 B.S	Terai and MH	20-30 Mt/ha

		India • Round, red bark, yellow pulp • Resistant to blight and wart			
3	Dejire	• Open pollinated • Introduced from Simla, India • Egg shaped with long, bark red, pulp yellow • Resistant to blight and virus	2049 B.S	Terai and MH	15-20 Mt/ha
4	Janakdev	• Open pollinated • Introduced from IPRC, Lima, Peru • Medium to large size • Long shaped, bark red and yellow pulp	2056 B.S	All areas	25 Mt/ha
5	Khumal seto-1	• Open pollinated • Introduced from IPRC, Lima Peru • Round shaped, bark white and pulp also white	2056 B.S	All areas	25 Mt/ha
6	Khumal red-2	• Open pollinated • Introduced from IPRC, Lima Peru • Round shaped, bark red and pulp white	2056 B.S	Terai	20-25 Mt/ha
7	Cardinal	• Open pollinated • Long shaped, bark red and pulp white		Terai and MH	20-25 Mt/ha

Climatic requirements

Potato is a cool season crop but is only moderately tolerant to frost. Temperature during the growing season has great influence in the yield. Generally, for germination 8^{O}c is ideal. At very low temperature, growth and development is checked. Day temperature of 30 – 35^{0}C and night temperature of 20 – 25^{0}Cis ideal for proper growth and for tuberation 18 – 20^{0}C is ideal. High night temperature is hazardous & sometimes if temperature is above 29^{0}C tubers are not formed.

Soil and soil preparation

Potato can be grown on a wide variety of soil from lights and fairly heavy clay loam and on muck soil. But soil with good aeration drained light textured minerals soil reaction from pH 5 – 7 is ideal.

Soil ploughing and preparation depends upon, soil type, climate, ploughing instruments, virgin or cultivated land etc. but for effective growth and development, physical structure of soil as well as weeds, stubbles, sterilization of soil should be done. Soil preparation generally can be divided into two parts. First 20 – 25 cm deep ploughing and disking and secondly as for necessary, the field is re-ploughed and leveled. If practiced, furrow and ridges are made as per recommended spacing.

Planting:

A. Seed rate and spacing

With line to line to line spacing of 70 cm and plant to plant spacing 23 cm and with 40 gm. per seed with 4 buds, 2.5 tons seed is required for one hac. in order to maintain ideal plant population and higher yield.

B. Planting season

Area	Planting season	Harvesting season
Plain (< 300 m)	Aswin – Kartik	Falgun
	Mangsir	Chaitra
Hills (>300 m)	Bhadra – Mangsir	Mangsir – Falgun
	Poush – Falgun	Baisakh – Jestha

Fertilizers requirements

Potato is usually heavily fertilized since they have a high nutrient requirements and high gross value per area which makes heavily fertilization. 30 tons of production removes 150 Kg N, 60 Kg P & 250 Kg K, 90 Kg CaO, 30 Kg MgO.

Fertilizers application depends upon soil type, soil fertility, temperature, crop rotation, irrigation facilities. In general, 20 – 30 tons FYM, 150 – 200 Kg N, 75 – 100 Kg P, 150 – 175 Kg K is recommended.

Time of application

Full dose of FYM, phosphorous, potassium and half dose of nitrogen at the time of field preparation and remaining half dose of nitrogen at earthing time by side line or point dressing.

Irrigation

Pre sowing or pre emergence irrigation than after second irrigation after 30 days and next irrigation as per necessary.

Moisture availability should be adequate for proper growth and development of tuber and sprouting. Low moisture content results for tuberation, poor quality tuber and poor germination. Production of 1 kg of potato required 300 – 636 Kg of water and more.

Inter- cultural practices

A. Weed management

Weed control practice is prime necessary in order to reduce loss due to weeds as weeds compete with the potato. At early stage of growth when the is small, weed problem severe, so, 1 hand weeding and hoeing when plant is 10 – 15 cm. then small growing weeds are controlled at the time of earthing. Then after the plant can cover the weeds and disorganized the effects of weeds. If necessary, next hand weeding can be done.

B. Earthing

In order to protect growing tubers from radiation, hot, insect, late blight etc. Plant is covered with soil to some extent depending upon the depth of sowing or planting. If sown to great depth, size of small ridge is enough. Earthing is done when plant is 15 – 20 cm tall at proper moisture level.

Harvesting

When the plants are turned yellowish & drying, potato is harvested. Before 7 – 10 days of harvesting, plants are topped at its base or stopped irrigating before 10 – 15 days of harvesting which helps to mature the coat of potato. Potato is harvested with the help of khurpi by destroying the ridges side by side.

Yield

With the modern improved cultivation practices, 350 – 500 qtls of potatoes can be produced.

Grading

Rotted & damaged tubers are assorted. According to the market necessity, they are graded. Grading is done according to their size, like big, medium & small. For grading iron mesh wire with varying size are used.

Post-harvest management

After harvesting & grading, tubers are surface dried & kept in shade in heaps for 10 – 15 days. If the produt is to be marketed early to take benefit of high market price, it is advisable to harvest potato in stage because of high perishable nature of immature tubers.

Value added products

Potatoes can be easily processed into dehydrated and canned products like Chips, Flakes, French fries, Finger chips, Granules, Disc, Cubes, Flour etc. Processing industry is also picking up in the recent past. It is desirable to avoid glut and consequent difficulty of storing large quantities of potatoes during period of high temperature after harvest in the plains.

Physiological disorders

1. Hollow Heart

It is caused by rapid growth of tubers. Tubers become oversized and remain empty with in leading to the formation of cavity in the center with the death of the small area of pith cells. This results in adjacent cracks and hollowness as the center expands during the growth of the potato

Management

- Maintain soil moisture conditions to the optimum level. Avoid over fertilization particularly N.
- Grow those varieties which are less prone to this defect.

2. Black Heart

It is caused by sub-oxidation conditions under potato tuber storage inpiles as the air does not get into the center.It occurs due to higher temperature and excessive moisture resulted inblackening of tissues in the center.The appearance of the tuber affect the consumers otherwise there is nodecay.

Management

- Provide proper ventilation. Keep potato tubers in layers. Do not store tubers in the heap.

3. Greening

There are various factors which increases the glycol alkaloid contents such as mechanical injury, premature harvest, and excessive application of fertilizers or exposure of tubers to sunlight which leads to solan in production which is slightly poisonous.

Management

- Proper earthing up of tubers as the tuberization takes place. Store tubers in darkness after digging up.

4. Knobbiness

It occurs due to uneven growth of tuber cells/tissues. Uneven watering conditions lead to an obstruction in tuber growth. Heavy irrigation after a long dry spell leads to growth of some cells very fast resulting in knobbiness.

Management

- Frequent and optimum irrigation supply is the remedy

5. Cracking

It is due to boron deficiency or uneven water supply

Management

- Application of Borax @ 20kg/ha. Frequent and optimum irrigation supply is the remedy

6. Sun Scalding

It occurs, generally, in the autumn crop when the temperature is high and sunshine is more. Emergence of sprout and leaflets is drastically affected at that time i.e. tip burn. It appears when temperature is more than 30°C.

Management

Water should be passed through the furrows to lower the soil temperature.

7. Translucent End

It is related to environmental stress and occurs due to draught and heat. It is, generally, found at the proximal end of the tuber. Tubers show glossy appearance and are irregular in shape. This also results in decay in storage. These glossy areas are high in sugar and low in total soluble solids

Management

- Avoid excessive nitrogen supply. Maintain 50% moisture in the field.

8. Black Spot

It means the internal browning of potato tubers. It occurs in vascular tissues within 3 days of mechanical injury. Phenoles are related to black spot in potato tubers.

Management

- Genetic make-up of the varieties. Provide proper storage and growing conditions.

9. Freezing Injury

It occurs due to the exposure of tubers to freezing temperature during or after harvest. It takes place at -1.5°C or below temperature. There is discolouration of the tissues and affect the vascular tissues at ring called ring necrosis. When fine elements or cells of vascular ring are affected, then it is called as net necrosis. This leads to unmarketable tubers. Tubers show more damage towards proximal end.

Management

- Avoid exposure of tubers to freezing temperature during storage or harvest.

10. Sprouting

It is often a serious problem in storage

Management

- It can be inhibited by spraying maleic hydrazide @ 1000-6000ppm about 2-3 weeks before harvesting.
- Chemicals like Chloro IPC (N-tetra chloro isopropyl carbonate)@ 0.5% and/or nomyl/amyl alcohol @0.05-0.12mg/ha also help in inhibiting sprouting

Insect pest

1. Cut worms: (Agrotis spp)

They feed only at night and cut the sprouts at ground level. They also attack tubers and make holes thereby reducing market prices.

Control measures

- Drench the plants with chlorpyriphos (0.04 %) where the damage is noticed.
- Use only well rotten Farm Yard Manure.

2. Leaf eating caterpillars : (Spilosoma obliqua, Spodoptera exigua)

The caterpillars of both the species cause damage by feeding on potato leaves.

Control measures

- Spray the crop with deltamethrin (0.0025%).

3. Aphids : (Myzus persicae)

Aphids suck the sap from leaves. Affected plants become weak, leaves become yellow and curl downwards. Aphid secretes honeydew, which gives rise to sooty mould and other fungal diseases.

Control measures

- Spray malathion (0.05%) or oxy-demeton methyl (0.025%).

4. Potato tuber moth: (Phthorimaea operculella)

It is major pest of potato in storage. It can also attack in the field. It bores and makes tunnel into the potato tubers.

Control measures

- Sow healthy insect free potato tubers.
- Use only well rotten Farm Yard Manure.
- Do earthing up carefully, so that the tubers are not exposed in the field to ovipositing female moths.
- Spray the crop with carbaryl (0.1 %).

Diseases

1. Early blight : (Alternaria solani)

The infection appears on lower leaves with necrotic spots having concentric rings. This fungus survives in the soil in diseased plant debris. High moisture and low temperature is favourable for disease.

Control measures

- Follow crop rotation.
- Spray the crop with mancozeb@ 0.2 per cent, 30-35 days after planting and grow tolerant varieties such as Kufri Jeevan.

2. Late Blight: (Phytophthora infestans)

The infection appears at the tips or edges of the lower leaves with circular or irregular water soaked spots. White downy fungus growth appears on the underside of the leaves around the spots. Cloudy weather is conducive for very fast spread of the disease. Later the disease may spread to tubers and initiate rotting.

Control measures

- Plant only healthy disease free seed tubers.
- Spray the crop with mancozeb @ 0.25 per cent well in advance.
- Avoid applying excess irrigation and nitrogen.

3. Black Leg / Soft Rot : (Erwinia spp.)

The bases of shoots develop a blackened shrivelled cortex and its growthis stunted.Leaflets become reddish in colour at the tips. Branches become stiffened and more upright than normal. The affected haulms are jet black in colour at the

soil level. The tubers become watery and upon rotting give off offensive sulphurous odour.

Control measures

- Obtain healthy tubers for planting.
- Collect and destroy affected plants.
- Wash the tubers with chlorinated water before storage and avoid planting too early.

4. Wart disease of potato: (Synchytrium endobioticum)

Affected plants show warty growth protuberances on stems, stolons and tubers. The roots are not affected. The wart consists of distorted, proliferated, branched structures grown together into a mass of hypertrophied tissue. It is difficult to control once it has been established in a field.

Control measures

- Obtain disease free seed for planting.
- Soil treatment with 5 percent Formalin is also effective.

True Potato Seed Technology

The non-availability of good quality seed tuber, virus infiltration, tubers causing degeneration of seed stocks, problem of long transport of seeds from producing areas have enhanced the development of True Potato Seed (TPS) technology in potato.

Varieties:

 HPS-7/13

 TPS/C-3

 92-PT-27

Advantages

 Uniformity in harvested tuber

 Higher yield

 Pathogen free

Following consideration have to be taken for TPS technology

1. TPS has to be sown in nursery bed to produce seedlings. The best substrate for nursery is mixture of 1:1 (FYM:Soil).
2. TPS germinates well when night temperature drops about 200C and shade is provided during daytime in bed. Best sowing time for TPS is October.
3. The seedling planted in nursery bed can either transplanted in main field to produce main crop or alternatively allowed to tuberize in nursery bed and allowed to produce small seedling tubers which is send for planting in next year.
4. The raised seedlings for transplanting in one hectare is about 100g TPS which is to be grown in bed of 50m2 at 10 cm spacing of roe distance and becomes ready for transplanting in 20-25 days.
5. The main crop can be produced from seedling tubers following the standard agronomic practices of potato crop. The suitable intra row spacing are 60x20 cm for 25-30mm size of tuber.
6. The field produced can be used for at least two seasons in potato seed producing areas and one season in other areas.

Sweet Potato

Propagation and Planting Material

It is vegetative propagated through vine cuttings and sprouts or draws produced from tubers.

Propagation through vine cutting

In March- April cuttings (30 cm) are prepared from terminal portion of vines of a mature crop. Each cutting should have at least 4 buds. Cuttings are planted at 60 X 30 cm distance keeping the end buds exposed. Roots are formed in buried portion of cuttings. Vine cuttings are planted during June – July.

Propagation through sprouts

For producing planting materials (sprouts) from tubers two nurseries are needed namely primary nursery and secondary nursery. Selected medium sized healthy

tubers are planted in the well prepared primary nursery beds with the spacing of 45 X 30 cm, 5 – 10 cm deep, 3 months ahead of planting time (June – July). With proper care and irrigation, the sprouts come up from the tubers and they become ready for transplanting in the secondary nursery after about 40 – 45 days. 20 – 30 cm long cuttings are prepared from these sprouts and transplanted in secondary nursery with spacing of 60 X 30 cm. these cuttings attains sufficient growth after 40 – 45 days and are transplanted in the main field.

1. Colocasia

Propagation

It is vegetatively propagated through corms or cormels (size of 40 – 50 cm is used for sowing). Selected sprouted corms are sown in the flat beds or in ridges with spacing 60 X 45 cm and about 5 cm deep. Then bed is mulched with straw. Sowing time is March – April and June- July (for terai). In the hills it is sown in June – July.

2. Yam

Propagation:

It is mostly vegetatively propagated through tubers. Propagation through stem cutting is also possible but tuber production is low.

3. Dill (Sowa):

Its young aromatic foliage used in cooking and its seed (fruits) are marketed as a condiment. Its fruit contain an essential oil, which is used in pharmaceuticals companies for making gripe water and similar preparation to treat flatulence and abdominal pain.

General introduction to some minor & under exploited vegetables:

	Sweet potato	Colocassia	Yam
Climate	Warm & moist season crop optimum temp. 21 – 26^{o}C	Warm season crop cannot tolerate frost	Cannot tolerate frost Optm. Temp. 25 – 30^{o}C
Soil	Sandy loam & pH is 5.2 – 6.7	Clay loam to Clay & pH Is 5.5 – 7	Well drained, loose Friable soil high organic matter.

Varieties	Pusa Saffaid, Pusa Lal, Pusa Sunaheri, Kiran etc.	S-3,S-11, Gauraia, Faizabadi etc.	No improve varieties. Many local varieties of White purple & yellow Flesh colors are available.
Propagation	Propagated from Vine cuttings & Sprouts Produce from tubers.	Propagated from corms & cormels	Mostly propagated Through tubers. Stem Cuttings are also used
Time of planting	Terai: March – April & Sept. – Oct. Mid Hills & low hills: March – July.	June – July March – June	March – May
Field preparation	2 – 3 ploughings & Leveling, planted in flat Beds or ridges.	It can be planted in Flooded & dry condition.	Soil deeply ploughed, Pulverized & leveled. Raised or flat beds are Prepared.
Spacing	60 X 20cm	60 X 45cm	75 – 90 X 75 – 90 cm
Seed Rate	40000 – 50000 cuttings/ha	7.5 – 9.5 qtls/ha,medium Size corms or cormels.	28-30qtls/ha, if tuber Size of 22.5 gm is planted
Manures & fertilizers	20 tons/hac. FYM, 90: 40: 60 kg NPK/hac.	20 – 25 tons/hac. FYM 80: 40: 60 kg NPK/ha c.	20tons/ha FYM, 80: 60: 80 kg NPK/hac.
Intercultural operation	Earthing up should be Done 30 days after Planting.	Straw making is needed For uplands crops.	Stakes are provided for Vines
Yield	100 – 250 qtls/hac.	117 – 140 qtls/hac.	200 – 300 qtls/hac. for Greater Yam (225 gm)
Diseases	Stem rot & black rot	Leaf blight & pythium rot	
Insect Pests	Sweet potato weevil, Leaf eating caterpillar	Colocassia leaf hopper, Leaf Eater.	

Harvesting of sweet potato

The matured crop will be ready after four(120 days) month of planting. However, this time fram may vary from variety to variety. The easy way of identifying the mature crop is when the leaves turns into yellow colour and mature tuber. The crop can be harvested by digging out the tubers.

Harvesting of Yam

Harvesting is done on 8 months after planting and particularly during January - February months. Drying of stem and leaves indicates the harvesting stage in elephant yam.

Harvesting of Colocasia

It is common practice to take out some side cormels twice or so before the final harvesting; itis known as side harvesting or partial harvesting. This practice gives good remuneration to the growers during colocasia shortage period besides increasing the growth and bulking of centralcorms. The final harvesting is done 120-150 days after planting when the foliage becomes yellowand dries.

In areas where leaves are cooked as vegetable, the tubers are kept as propagating material fornext crop. The leaves become ready for harvesting 45-60 days after planting.In the first harvesting the yield is low but subsequently the leaf yield increases with each plucking.

C. Learning process and support materials

Learning process includes the Visual methods, Demonstration method, Practical method, Observation method, Exhibition methods.

D. Assessment

Very Short (Answer question)

1. Write down the scientific name and origin of Potato.
2. List out the important tubers crops cultivated in Nepal.
3. Name any two important varieties of Potato.
4. List any two major diseases of tubers crop.

Short (Answer question)

1. Define tubers crops with examples.
2. Write down the requirement of manure and fertilizer for sweet potato crop.
3. Write any four varieties of Potato.

Long (Answer question)

1. Write the cultivation practices of Potato with respect to, botanical name,climate, method of sowing, seed rate, manure & fertilizer and storage.
2. Write the cultivation practices of Yam with respect to, botanical name, family, climate, manure & fertilizer, weeding and harvesting.

UNIT – 6

Cultivation Practice of Legume Vegetable (Peas, Beans, Cowpea)91

A. Objectives

After the completion of this course, the students will be able to:

- Explain about the origin, distribution, cultivars, climate and soil requirement etc. of different legume vegetable crops.
- Describe about the cultivation practices of different legumes vegetable crops in various aspects.

B. Content elaboration

Legumes vegetables crop comprise of a large number of plant species, mostly annuals or binneial, of which different parts like stem, flower bud, flower, pod etc. are consumed either raw as salad or cooked. They are essential items of balanced diet and are rich in nutrients. Most of the legumes crops which are commonly cultivated are:

Peas

Botanical name: *Pisum sativum L.*

Common name: Matar

Family: Leguminoseae

Origin: Ethiopia

Chromosome number: 2n=14

Uses

Pea is highly nutritive vegetable containing high percentage of digestible proteins (very valuable for the vegetarians) along with carbohydrates and vitamins A and C, also very rich in minerals like Ca and P. It is excellent food for human consumption taken either as vegetable or in soup. Large proportion is processed

(canned, frozen or dehydrated) for consumption in the offseason. Pea being a N fixing legume, recognized as a soil building crop. Its seeds contain trypsin and chymotrypsin which could be used for contraceptive, ecbolic, fungistatic and spermicidal. Pea stem is a nutritive fodder.

Nutritive value

Table: The nutritive value of peas per 100 g of edible portion is given here under:

Energy (kcal)	84	Riboflavin (mg)	0.14
Moisture (%)	78	Niacin (mg)	2.9
Protein (g)	6.3	Ascorbic acid (mg)	27
Fat (g)	0.4	Ca (mg)	26
Carbohydrate (g)	14.4	P (mg)	116
Vitamin A (IU)	640	Fe (mg)	1.9
Thiamin (mg)	0.35		

Classification

On the basis of species, the cultivated pea is divided into two types. The field pea with coloured flowers (*Pisum sativum var. arvense L.*) and garden pea with white flowers (*Pisum sativum var. hortense L.*).

Trade

Pea is commercially cultivated legumes crop in Nepal. It is cultivated in area of 6368.7 ha with production of 53536.7 Mt and yields of 8.4 t/ha.

Variety

SN	Variety	Varietal character	Released Year	Recommended area	Production
1	Sarlahi Arkel	Open pollinated Pod: pointed in both side, 7-8 seed per pod Harvesting: 60-65 DAS	2051	All areas	Fresh pod: 5-7 Mt/ha
2	New line perfection	Open pollinated Pod: straight and green	2051	All areas	Fresh pod: 6-7 Mt/ha

		color Mid to late variety Harvesting: 85-90 DAS			
3	Sikkim local	Open pollinated Pod: light green color Harvesting: 105 -110 DAS	2051	All areas	Fresh pod: 8-10 Mt/ha

Climate

Pea seed can be germinated up to the minimum temperature of 5ºC. The optimum temperature for germination is about 22ºC. Pea can tolerate cold, but severe frost causes considerable injury to the freshly opened flowers. The optimum temperature for better growth and yield is 13-19ºC. High temperature reduces the pod quality as sugars in the seeds changes to hemicelluloses and starch. Temperature above 27ºC shortened the growing period and adversely affects pollination. Germination at high temperature results in tall plants whereas low temperatures at early growth stages promote branching and dwarf growth habit.

Soil

Pea can be grown on many types of soil from light sandy to clay soil. Light soils are good for early crop whereas heavy soils are found suitable for main crop and produce high yield. It is very sensitive to saline and alkaline conditions. Most favourable range of pH is from 5.5 - 6.0.

Planting

For winter crop, seeds are sown in October to middle of November in plains. Pea is cultivated in hills from middle of March to end of May. Seeds can be sown on flat or slightly raised beds either by broadcasting or behind plough in furrows, which are covered by usual planting. It requires a seed rate of

Early varieties: 100-120 kg/ha

Mid-season and late varieties: 80-90kg/ha.

It is generally planted at the spacing of

Early Varieties – 30 cm × 5-10 cm

Main season – 60 cm × 10 cm

Seed inoculation

- Inoculation of seed with Rhizobium culture can be used.
- The culture material is emulsified in 10% sugar or jaggery solution sufficient to moist the seed.
- It is to be mixed thoroughly with seed and dried in shade before sowing.
- This seed inoculation helps in quick nodulation on the roots which in turn fix atmospheric nitrogen.

Seed treatment

The seeds may be treated with fungicides like thiram or captan (3g/kg of seed) or carbendazim (2.5g/kg of seed) to save the crop against Fusarium wilt. If both seed inoculation and fungicide treatments are to be given, then firstly the seeds are treated with fungicide followed by inoculation with Rhizobium culture.

Nutrient management

FYM @ 4-6 mt/ha is to be applied 15 days before sowing the seeds. Nitrogen, phosphorus and potassium should be applied in the ratio of 15:40:10 kg/ha, respectively.Entire quantity of phosphorus, potash and half quantity of nitrogen is to be thoroughly mixed in the soil at the time of field preparation. The remaining nitrogen is to be top dressed at flowering time along with irrigation.

Use of plant growth regulators

- Foliar spray of MH at 25mg/L, before flowering has given best pod yield in pea.
- Seed treatment with cytozyme @ 1 per cent improve the fresh pod yield in pea

Water management

The water requirement of pea is very low and it can be grown even without irrigation. In general, one pre-sowing irrigation is essential for proper germination. Two or three light irrigations at 10-15 days interval especially at flowering, fruit set and at grain filling period are essential for good yield.

Weed management

The useful method of weed control practiced is mechanical or manual. Manual weeding is uneconomical and time consuming. Chemical weed control has been reported to be effective as compared to hand weeding. At the same time, it is cheaper and less time consuming. Application of Lasso @ 0.75 kg a.i/ha or Tribunal @1.87 kg a.i. /ha as pre-emergence application have been recommended under wide range of agro-climatic condition.

Harvesting

The maturity of pea is tested mechanically with a tendrometer. Generally, three to four pickings are taken during the season. Harvesting should be done either in the morning or late in the afternoon. The peas are harvested when the pods are fully green and well developed. The seeds should be near full size and should not have begun to harden. The high quality of pea is associated with tenderness and high sugar content. During maturity, sugar contents decreases rapidly and there is an increase in starch and other polysaccharides and insoluble nitrogenous components such as protein. Picking should be done as soon as green ovules are fully developed and pods still not over mature. Picking should be done either early in the morning or late in the afternoon. Picking during mid-day deteriorates the quality of pea by heat.

Yields

Early varieties give 60-85 q/ha where as main season varieties yields 100-150q/ha green pods per hectare.

Post harvest handling

Green peas loose much of their sugar content unless they are promptly cooled to 0ºC. Hydro cooling is the preferred method for pre cooling. At 0ºC & 95-98% RH, green peas can be stored for 1-2 weeks. If the crop is packed with crushed ice, storage may be extended for 1 additional week. It can be stored better for 2 weeks in cold storage at 0ºC & 85-95 % RH. Temperature at 21.5ºC becomes unfit for sale at the end of 5 days.

Storage

Peas can also be stored in crushed ice for about 2 weeks. The pods will freeze at 10 ºCand 90-95 per cent relative humidity. Fresh unshelled peas may be kept for two weeks at 0ºC.

Insect pest

1. Pea thrips

Pea thrips may be problem in very dry weather. Adult feed inside the flower, while young ones feed on leaves and pods. They lay their eggs in the pods. Mottled patches appear which later turn brown.Yield is severely affected if attack persists.

Control measures

- Spray the crop with cypermethrin (0.0075%) or dichlorovos (0.04%) as soon as the attack is noticed.
- If harvesting coincides with spray, spray immediately after harvest and wait for 10-15 days for another harvest.

2. Pea leaf miner

More serious damage is caused by larvae. They make prominent whitish tunnels in the leaves which interfere with proper photosynthesis activity of plants. The manufacture of the food by leaves is severely affected.

Control measures

- The population of the pea leaf miner is naturally kept under control by a large number of larval and pupal parasitoids which include Braconids and Eulophids.
- Application of oxy-demeton methyl (0.025%) or dichlorvos (0.04%) during the second week of February helps in reducing the population of this pest.

3. Pea pod borer:

Caterpillars feed on foliage and later bore into the pods to eat the developing seeds.

Control measures

- Spray carbaryl (0.1%) on the crop. Repeat after 15 days if attack persists.

Diseases

Fungal Diseases

1. Powdery mildew: (Erysiphe polygoni)

It is characterized by white powdery mass on foliage, pods and stems.It is favoured by hot and dry climate.

Control Measures

- Spray dinocap@ 0.05per cent or wettable sulphur@ 0.2 per cent or carbendazim @ 0.05 per cent. Repeat after 10-15 days if necessary.

2. Fusarium wilt: (Fusarium oxysporum f. sp. pisi)

The disease is characterised by yellowing of lower leaves and stunting of plants. Optimum temperature for development of disease is 25-28ºC.

Control Measures

- Since wilt is soil borne, a long crop rotation is recommended.
- Seed treatment with carbendazim (2.5g/kg seed) for two hours followed by spraying with carbendazim (0.05%) is recommended.
- Avoid early sowing in badly infested soils. Follow three years crop rotation in infested areas.

3. Ascochyta blight: (Ascochyta pinodes, Ascochyta pinodella, Ascochyta pisi)

Infected plants wilt. Roots become brown. On stems and leaves, brown spots are observed.

Control Measures

- Use bold and healthy seed.
- Treat seed with carbendazim (2.5g/ kg seed).
- Spray carbendazim (0.1%) or mancozeb (0.25%) before appearance of flowers on infected plants.
- Repeat after 10-15 days if needed.

Bacterial Diseases

1. Bacterial blight: (Pseudomonas syringae pv. pisi)

The disease affects all the aerial parts of plant. It appears as spots on leaflets which are round, oval or irregular 2-5 mm in diameter and reddish with translucent center having dark brown margins.

Control measures

- Use clean healthy seed. Remove affected plants and weeds.
- Treat seed with Streptocycline @ 0.01 per cent for 1-2 hours.
- Spray the same chemical @0.01 per cent and repeat after seven days if needed.

Viral Diseases

1. Pea mosaic

The diseased plants are pale, weak and dwarf. The young leaves and stipules show general mottling. Light brown discoloured areas are seen on petioles, stems and tendrils.

Control measures

- Control insect vectors carefully, pull out affected plants and burn them
- Grow resistant varieties.

Beans

Beans are important both from nutrition as well as commercial point of view. There are a number of cultivated species of beans, but the most commonly grown in the region are french bean and asparagus bean.

French bean

The French bean is also called kidney bean, haricot bean, snap bean or navy bean. It is one of the most important leguminous vegetables. French bean are of two types: pole type and bush type. Both these crops are grown for their tender green pods, shelled green beans and dry beans. In Nepal they are grown from terai to high hills.

Botanical name: *Phaseolus vulgaris L.*

Family: Leguminosae

Centre of origin: Southern Mexico and Central America

Chromosome number: 2n= 22

Uses

Green immature pods are used for vegetable and are also canned and frozen.

Nutritive value

Table: The nutritive value of French bean per 100 g of edible portion is given here under:

Energy (kcal)	48	Thiamin (mg)	0.08
Energy (kcal)	48	Thiamin (mg)	0.08
Moisture (%)	85.4	Niacin (mg)	0.8
Protein (g)	4.5	Ascorbic acid (mg)	12
Fat (g)	0.1	Calcium (mg)	50
Carbohydrate (g)	7.2	Phosphorus (mg)	64

Climate

French bean is a cool weather crop but can thrive better than cowpea in the higher temperature. The plants drop their blossoms or pods in very hot weather. The best pods are obtained at 15.6°C to 21.1°C temperature.

Soil

It can be grown on all types of soils ranging from low to heavy clays. Sandy and loam soils are preferred for an early crop but heavier soils are good for the mid-season crop. The optimum soil pH is 5.5-6.8. Liming is needed if soil pH is less than 5.5.

Trade

It is cultivated under 2869.8 ha with production of 24953.3 Mt and yields of 8.7 t/ha.

Varieties

SN	Variety	Varietal character	Year	Recommended area	Production
1	Trisul ghiusimi	Open pollinated Mid type vine Pod: 20-25 cm, green, S shape, Seed: coffee brown, eye ring is purple color	2051	All areas	Fresh pod: 6-8 Mt/ha, Seed: 40-50 kg/ropani
2	Kentucky wonder (Ghiu simi)	Open pollinated Pole type vine Leaves: green to dark green Pod: 20-25 cm, large, thick Seed: coffee brown First picking: 70-75 DAS	2051	All areas	Fresh pod: 10-12 Mt/ha, Seed: 60-70 kg/ropani
3	Jhange simi	Plant: bushy type Pod: dark green, 15 cm long First picking: 50 DAS	2051	All areas	Fresh pod: 5-6 Mt/ha
4	Four-season Bean (Chaum-ase simi)				

Planting

Sowing is done in the month of September-October and February-March.About 70-100 kg/ha seed is required for cultivation. The seeds are sown in shallow furrows of 15cm width with a spacing of 75cm. In each furrow, two rows of seeds are sown at a spacing of 25cm in a zigzag manner along the furrows. It can be sown in a single row system with spacing of 45x15cm.

Nutrient management

The field is given deep digging and farmyard manure is applied at the rate of 10 tonnes/ha along with NPK at the rate of 20:50:40kg/ha, respectively. Entire quantity of phosphorus, potash and half quantity of nitrogen is to be thoroughly mixed in the soil at the time of field preparation. The remaining nitrogen is to be

top dressed at flowering time along with irrigation.

Use of PGR

- In beans, the success of pollination, fertilization and fruit set depends on the prevailing weather conditions.
- Certain plant growth regulators like PCPA @ 2ppm, alpha-naphthyl acetomide @ 2-25ppm or beta-naphthoxy acetic acid @ 5-25ppm, when sprayed at prevailing temperature or when normally pods do not set, induce fruit set.
- Thus by spraying some plant growth regulators, early, higher and total yield can be obtained.

Water management

Immediately after sowing, the field has to be irrigated. This is followed by light irrigation on the third day. Thereafter, light irrigation should be given at regular interval of 12-15days.

Weed management

The plots should be kept weed free for proper growth of the plant. Beans are shallow rooted and sensitive to excessive moisture. However, optimum soil moisture should be made available at the time of fruit set and pod development.

Harvesting

The pods are ready for harvest two to three weeks after the first blossom or in about 45 days after sowing. Picking is usually done by hand. Yield 80-100 q/ha in bush type varieties. The pods can be stored for about 15-20 days at 2-4°C with 60-70% relative humidity.

Insect pest

1. Thrips

Thrips may be problem in very dry weather.Severely infested flowers wilt, fade and drop prematurely without bearing fruits.They lacerate the leaf tissue and imbibe the oozing sap.Pale and silvery sheens appear on the affected leaves.Some thrips are also vectors of viral diseases.

Control measures

- Spray the crop with cypermethrin 0.0075% or dichlorvos 0.04% as soon as the attack is noticed.
- If harvesting coincides with spray, spray immediately after harvest and wait for 15 days for another harvest.

2. Mites

These are very small pests and remain mostly on the under surface of leaves. Damage is caused by the larvae, nymphs and adults by sucking the cell sap from under side of leaves, flower buds and flowers. When population is high, it results in bronzing and curling of leaves and discolouration of flowers and leaves. Webbing of leaves, sepals and petals occur which give untidy look to the plants.The infestation is more in dry weather and under poly house conditions.

Control measures

- Remove the old and infested leaves and burn them.
- Try to avoid dry conditions and spray frequently with plain water at least twice a week with sprinkler.
- Observe the plants regularly for mite population and if incidence is noticed, spray the crop with insecticides like profenofos (0.05%) or fenazaquin (0.0025%) or propargite (0.057%).

Diseases

Yellow mosaic, Anthracnose, Phytophthora pod rot, rust, angular leaf spot, ashy stem blight and Rhizoctonia root rot are some of the diseases affecting bean crop.

Control Measures

- The disease can be effectively controlled by spraying copper oxychloride @0.3per cent.
- Root rot can be controlled by drenching captan @0.2per cent.
- Foliar fungal diseases can be controlled by spraying mancozeb @0.25per cent.
- Rust can be controlled by spraying wettable sulphur @0.2per cent and fungicides like hexaconazole (0.05%) etc.

Cow Pea

Botanical name: *Vigna sinensis*

Common name: Bodi

Family: Leguminoseae

Origin: Africa

Chromosome number: 2n=22

Uses

Cowpea is known as drought hardy nature, its wide and droopy leaves keep soils and soil moisture conserved due to shading effect. It is also known as black-eyed pea or southern pea, etc. and has multiple uses like food, feed, forage, fodder, green manuring and vegetable. Cowpea seed is a nutritious component of the human diet, and cheap livestock feed as well. Both the green and dried seeds are suitable for canning and boiling as well.

Nutritive value

Cowpea is the rich source of protein 22-24%, CHO 55-66 %, Iron 0.005%, Calcium - 0.08 – 0.11 %, and essential amino acids (lysine, leucine and phenylalanine).

Variety

SN	Variety	Varietal character	Recommended area	Production
1	Malepatan	• Open pollinated • Less fibrous, pole type • Pod: 25 cm long & light green • Brown seed	Mid Hill	Fresh pod: 5.8-10 T/ha Seed: 1 T/ha
2	Kathmandu local	• Open pollinated, pole type • Pod length: 45-60 cm, light green and seeds red color • First pickling: 60-70 DAS	Terai and MH	5-8 Mt/ha Seed: 800-1000 kg/ha
3	Sarlahi	• Open pollinated, pole type	Terai and MH	5-8 Mt/ha

	local	• Pod length: 25-30 cm, light green and seeds black color • Harvesting: 50-60 DAS		Seed: 800-1000 kg/ha
4	Prakash	• Open pollinated, bush type • Early, high yielding variety • Plant height: 40-50 cm • Bean mosaic virus resistant	Terai	1500 kg grains/ha
5	Akash	• Open pollinated, bush type • High yielding variety • Plant height: 40-50 cm • Mosaic virus resistant	Terai	900-1000 kg grains/ha

Climate

Cowpea is warm weather and semi arid crop, where temperature ranging from 20ºC to 30ºC. Minimum temperature for seed establishment is 20ºC and above 32ºC temperatures development of root is ceased. For maximum production day temperature 27ºC and night temperature 22ºC required. It is sensitive to cold and below 15º C temperature yields adversely affected. It can grow under shade of tree, but can not tolerate cold or frost.

Soil

Well drained loam or slightly heavy soil are best suited. In colder climate somewhat sandy soil preferred as the crop mature earlier in them. It can grow successfully in acidic soil, but not in saline/alkaline soil. In hard soil, one deep ploughing followed by two or three harrowing and planking is sufficient. In normal soil only two harrowing & planking is enough. For summer season crop gives an irrigation immediately after harvesting of winter crop.

Planting

For winter crop, seeds are sown in October to middle of November in the plains. Cowpea is cultivated in hills from middle of March to end of May. Seeds can be sown on flat or slightly raised beds either by broadcasting or behind the plow in furrows, which are covered by usual planting. It requires a seed rate of 20-25

kg/hectare. It is generally planted at the spacing of

Row to row - 30 (Bushing) to 45 cm (spreading)

Plant to Plant - 10 (Bushing) to 15 cm (spreading)

Seed inoculation

- Inoculation of seed with Rhizobium culture can be used.
- The culture material is emulsified in 10% sugar or jaggery solution sufficient to moist the seed.
- It is to be mixed thoroughly with seed and dried in shade before sowing.
- This seed inoculation helps in quick nodulation on the roots which in turn fix atmospheric nitrogen.

Seed treatment

The seeds may be treated with fungicides like thiram or captan (3g/kg of seed) or carbendazim (2.5g/kg of seed) to save the crop against Fusarium wilt. If both seed inoculation and fungicide treatments are to be given, then firstly the seeds are treated with fungicide followed by inoculation with Rhizobium culture.

Nutrient management

FYM @ 4-6 mt/ha is to be applied 15 days before sowing the seeds. Nitrogen, phosphorus and potassium should be applied in the ratio of 15-20:50-60:50-60 kg/ha, respectively.Entire quantity of phosphorus, potash and half quantity of nitrogen is to be thoroughly mixed in the soil at the time of field preparation. The remaining nitrogen is to be top dressed at flowering time along with irrigation.

Water management

For summer crop, irrigation is most critical among all inputs followed by weeding and fertilizer. Generally, crop required 5-6 irrigation depending on soil, prevailing weather conditions etc, at an interval of 10-15 days. The response to irrigation is in order of flowering> pod filling>vegetative. Crop can tolerate flooding upto 2 days at flowering and pod setting thereafter, a marked decrease in yield and its attribute.

Weed management

For higher yield crop should be free from weed upto 25 to 30 day crop stage. It covers the land very soon and kill the weeds by smoothing. Application of pendimethaline @ 0.75 - 1 kg.a.i./ha combined with one hand weeding at 35 days after sowing is beneficial.

Harvesting

Green pods for use as a vegetable can be harvested 45 - 90 days after sowing depending on the variety. For grains, the crop can be harvested in about 90-125 days after sowing when pods are fully matured. The crop should be then dried and threshed , threshed grain should be dried in sun before storage. For fodder, the cutting of the crop depends upon the need and the stage of growth of the component crop sown with it. Generally it should be done 40 - 45 days after sowing.

Yields

A good crop of cowpea yields about 12 - 15 q of grain and 50 - 60 q of straw per hectare. If the crop is raised for fodder purpose 250 - 350 q of green fodder is obtained per hectare

Insect Pests

1. Cowpea pod borer

Nature of Damage

The caterpillar rolls the leaves and web these with the top shoot. Caterpillar bore into the pods and feed on the seeds, if flower and pods are not available larvae feed on foliage.

Control Measures

- Collect and destroy the eggs and young larvae
- The young caterpillar can be killed by dusting 2% methyl parathion @ 25 - 30 kg p er hectare or spray of quinalphos @2 ml/liter of water
- Fix 3 feet stick in the field @10/ha bird parches to attract predatory birds.

2. Hairy caterpillar

Nature of damage

It is a major insect of cowpea. It is cut juvenile plants and eat away all the green matter of the leaves.

Control Measures

- Collect and burn the eggs and larva of insect;
- The young caterpillar can be controlled by spray of Chloropyriphos or Quinolphos @ 2ml/liter of water.

3. Aphids and Jassids

Nature of Damage

The adult and nymphs of these pests suck the juice from the leaves and the damage is more severe when the plants are young. As a result of sucking of sap, the leaves turn brown and crumbled and the plant look sick.

Control Measures

i) Spray of Cypermethrin 25 EC @ 1 ml/ liter or Dimethoate 30 EC @ 1.7 ml/ liter of water.

Diseases

1. Bacterial Blight

Symptoms

The germinating seedling turn brown - red and die. Irregular to round spots, brown in color with chlorotic halos, appear on leaves, and later spread to stem. The stem may break, pods are also infected, leading to shrivelled seeds.

Control Measures

- Grow resistant varieties;
- Use healthy and disease free seeds ;
- In case of severe infection, crop may be sprayed with 0.2 % (2g/liter) copper oxychloride (Blitox).

2. Cowpea Mosaic

Symptoms

It is caused by a virus transmitted by aphids. The affected leaves become pale yellow and exhibit mosaic, vein banding symptoms. The affected leaves become reduced in size and show puckering. Pods are also reduced and become twisted.

Control Measures

- Use healthy seed from healthy crop ;
- For controlling aphids spray Oxydemeton methyl 25 EC (Metasystox) @ 1 ml/liter or Imidacloprid 17. 8 SL @ 0. 2 ml/ liter of water and repeat the spray after 10 days of first spray.

3. Powdery mildew

Symptoms

Powdery mildew is visible in all the aerial parts of the affected plants. Symptoms first start from leaves and then spread to stem, branches and pods. This white growth consists of the fungus and its spores. Affected leaves become twisted and smaller in size.

Control Measures

- After harvest, collect the plants left in the field and burn them;
- The disease can be controlled by spray of wettable sulphur @ 3g/liter or carbendazim @1 g/liter of water

C. Learning process and support materials

Learning process includes the Visual methods, Demonstration method, Practical method, Observation method, Exhibition methods.

D. Assessment

Very Short (Answer question)

1. Write down the scientific name and origin of Pea.
2. List out the important legumes vegetable crops cultivated in Nepal.
3. Name any two important varieties of Cow pea.

4. List any two major diseases of beans crop.

Short (Answer question)

1. Define legume vegetable crops with examples.
2. Write down the requirement of climate and soil for bean crop.
3. Write any four varieties of Peas.

Long (Answer question)

1. Write the cultivation practices of Pea with respect to, botanical name,climate, method of inoculation, manure & fertilizer and marketing.
2. Write the cultivation practices of Cowpea with respect to, botanical name, family,climate, , manure & fertilizer, weeding, harvesting .

UNIT – 7

Cultivation Practice of Fruit Vegetable Crops (Chilies, Capsicum, Tomato, Brinjal, Okra) 110

A. Objectives

After the completion of this course, the students will be able to:

- Explain about the origin, distribution, cultivars, climate and soil requirement etc. of different fruit vegetable crops.
- Describe about the cultivation practices of different fruit vegetable crops in various aspects.

B. Content elaboration

Fruit vegetables comprise of a large number of plant species, mostly annuals or binneial, of which fruit etc. are consumed either raw as salad or cooked. They are essential items of balanced diet and are rich in nutrients. Most of the tuber crops which are commonly cultivated are:

Chillies

Chilli is a tropical vegetable crop commonly used throughout the world as a spice for its pungency and red colour of ripe dried fruits and also for its green fruits for pungency and flavor. The flavor/pungency in chilli is due to capsaicin and oleoresin where as red colour is due to the pigment capsanthin.

Botanical name: *Capsicum annuum var. hortense*

Common name: Khursani

Family: Solanaceae

Origin: Mexico and surroundings of central America

Chromosome number: 2n=24

Uses

Chillies are generally used as a salad, vegetable cooking and in pickle of different fruits and vegetables.

Nutritive value

Table: Nutritive value of chilli per 100 gm

Principle	Nutrient Value	Principle	Nutrient Value
Energy	40 Kcal	Vitamin A	952 IU
Carbohydrates	8.81 g	Vitamin C	143.7 mg
Protein	1.87 g	Vitamin E	0.69 mg
Total Fat	0.44 g	Vitamin K	14 µg
Cholesterol	0 mg	Calcium	14 mg
Dietary Fiber	1.5 g	Copper	0.129 mg
Magnesium	23 mg	Iron	1.03 mg
Manganese	0.187 mg	Phosphorus	43 mg

(Source: USDA National Nutrient data base)

Trade

The area under chilli cultivation in Nepal according to MOAD 2072/073 was 9580.8 ha with production of 95931.2 Mt and average yield of 10 t/ha.

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Pusa Jwala	Open pollinated Fruit slender Fruit: first green and red after ripening Early maturity Harvesting: 60-70 DAT	2051	All areas	
2	Kathmandu local	Open pollinated Late variety, tall spreading Fruit long, dark green when immature and dark red when ripens Resistant to heavy moisture			

3	Karma 747	Hybrid Plant height: 80 cm Harvesting: 70 DAT	2066	Terai and MH	40 Mt/ha
4	Karma	Hybrid Plant height: 80 cm Harvesting: 65 DAT	2066	Terai and MH	60 Mt/ha
5	Nepa hot	Hybrid Plant height: 100 cm Harvesting: 120 DAT	2066	Terai and MH	40 Mt/ha
6	NS 1701	Hybrid Plant height: 90-100 cm Harvesting: 70 DAT	2066	All areas	80-90 Mt/ha
7	Super Tara	Hybrid Plant height: 160 cm Harvesting: 118 DAT	2066	Terai and MH	40 Mt/ha
8	Akash	Hybrid Plant height: 90-100 cm Harvesting: 75-85 DAT	2066	Terai and MH	50-60 Mt/ha
9	Marshal	Hybrid Plant height: 150 cm Harvesting: 115 DAT	2066	Terai and MH	35 Mt/ha
10	Goli	Hybrid Plant height: 100 cm Harvesting: 70-80 DAT	2066	Terai and MH	70-75 Mt/ha
11	Anna No 3	Hybrid Plant height: 20-28 cm Harvesting: 70-75 DAT	2066	All areas	40-44 Mt/ha

Climate

Chillies thrive well in warm conditions and have a long growing season. The plants require a warmer climate than tomatoes and are more sensitive to frost. Temperatures between 5ºC and 15ºC result in poor growth. Temperatures around 24ºC are optimum for most green pepper varieties. Despite the need for warm conditions the plant is sensitive to higher temperatures. Above 32ºC the flowers

are inclined to fall-off and few fruits if any, set at temperatures above 35ºC especially when these temperatures are coupled with dry winds. Fruits that do form at such high temperatures are normally malformed. The fruit is also very prone to sunburn.

Soil

Like most other plants, chillies can be grown successfully on a wide range of soils, but they prefer sandy - loam and loamy soils. Green pepper requires soil pH of between 5.5 and 7.0. The soil must drain well with good water holding capacity. It should also contain an adequate amount of humus and be deeper than 40 cm.

Nursery raising

The seeds are sown in the same way as tomatoes, i.e., in shallow furrows made across the seed beds; about a hundred seeds are sown in each metre - long furrow. Half a kilogram of seed will give sufficient plants for one hectare. Under severe dry or warm conditions light grass mulch will help retain the moisture and as soon as the seedlings appear the grass should be removed. In areas that normally experience frost, sowing can commence as soon as the danger of frost has past, and ground and air temperatures are favourable. The use of seed trays for seedling production is also encouraged.

Planting

Chillies take 7 to 8 weeks from sowing to transplanting. Seedlings should be handled with care when transplanting. Transplanting is done the same way as with tomatoes and preferably on cool days or in the late afternoon. Irrigation should immediately follow transplanting. Single rows 60 cm apart, with the plants 60 cm apart in the rows, make harvesting easier than closer spacing and prevent the plants from being broken in the process.

Nutrient management

Apply FYM @250q/ha, Nitrogen @ 75 kg/ha, Phosphorus @60-75kg/ha and Potassium @ 50 kg/ha. Full dose of farmyard manure, phosphorus and potassium

and half of N should be applied at the time of transplanting. Remaining part of N should be top dressed in two equal parts at an interval of one month each.

Use of growth hormones

Foliar application of NAA (50ppm) at full bloom stage can effectively control flower drop with an increase in yield. Treatment with NAA at 20 ppm at first flower opening followed by two sprays at an interval of 30 days is the most effective in increasing the yield, number of fruits per plant, fruit size and contents of capsaicin, ascorbic acid, carbohydrate, protein and fat of chilli. Planofix (10-20ppm) as foliar spray at flowering stage can reduce flower and fruit drop in chilli.

Water management

Effective irrigation is essential to obtain the best yields of fruit of the right size. The soil must be kept moist to a minimum depth of 45 cm. During the first two weeks after transplanting, the plants should be irrigated twice or three times per week for the transplants to become established, thereafter, once or twice per week depending on climatic conditions and soil type. The water requirement for green pepper is 23.8 mm, which should be applied at an interval of 6 days and 2 days during winter and summer respectively.

Weed management

The normal weed control method followed by farmers in tomato is to give two hands hoeing in the first and third fortnight after transplanting and an earthing up operation during the second fortnight. The application of herbicide is economical. Pre-emergence application of herbicides like Metribuzin at 0.35 Kg/hac, Fluchloralin 1.25 Kg/hac has been found to increase the yield significantly over hand weeding.

Harvesting, Processing and Marketing

A yield of 30 to 70 tons per hectare is considered to be good. Chillies are mainly picked when full-grown but still green. Chillies can be allowed to become red or yellow depending on the consumer preferences. During harvesting, grading and

packing, the fruit should be handled with care. It bruises easily and this should be avoided as it promotes rotting.

Insect pest

1. **Chilly thrips:** can be controlled by spraying Rogor 30 EC@ 1ml/litre of water at fortnight interval.
2. **Pod borer:** Quinalphos @ 4ml/liter of water.
3. **Aphid:** Metasystox can be sprayed.

Diseases

1. Damping off: To control this seed should be treated in formalin before sowing. For this Bavistein @ 2ml/liter.
2. Bacterial leaf spot: Spray Agrimycin @ 200 ppm.
3. Anthracnose: Mancozeb or DM-45 @ 2gm/litre
4. Leaf curl: Roger 30 EC @ 1ml/litre

Physiological Disorders

Blossom End Rot

This is mainly a problem manifests itself as sunken brown and leathery patches on the blossom end of the first few fruit of the season. These patches may eventually turn black and rot, as the damaged skin facilitates the entrance of rot-causing organisms. Blossom End Rot is a physiological problem rather than a disease and is caused by a lack of calcium in the plant. Calcium is rarely deficient in the soil because it is commonly added to adjust pH, so there is usually some other factor at work. Most often it is due to irregular watering inhibiting calcium absorption, but it can also be caused by too much nitrogen or magnesium.

To reduce the incidence of Blossom End Rot, keep the soil **evenly moist** and **well mulched**. Don't give the plants too much nitrogen. If your soil is acidic then lime it, as this will add calcium too. **Foliar feeding** with seaweed or compost tea is a quick way to supply extra calcium. Indeterminate varieties are less commonly affected by Blossom End Rot than determinate varieties. You should **remove affected fruit immediately,**so the plant doesn't waste energy on them (they won't be of any use anyway).

Sunscald

Sunscald occurs in the high heat of summer when humidity is at a peak. Usually the foliage on the plant will help shield it from the most intense rays of the sun, but in some cases, the leaves have defoliated partially due to insects or disease. This leaves the developing fruit vulnerable to the sun and the peppers burn just like you or I would in exposed conditions.

Fruit and Flower Drop

Flower drop (known to some as "blossom drop") is a relatively common problem faced not only by chilli growers but by gardeners growing all kinds of fruit and vegetables. It happens when your plant flowers then each flower falls off without any fruit forming. The possible causes are lack of pollination, lack of Air Flow, over watering, not harvesting pods, unstable temperatures, over feeding, etc.

Capsicum

Sweet pepper or capsicum is gorwn throughout the world for its thick and fleshy fruits having delicate flavor and taste. It is mostly consumed both in green matured and ripe form raw, in salads, cooked, mixed and stuffed vegetables. It is particularly rich in vitamin A and C thus acts as potential antioxidant.

Botanical name: *Capsicum annum*

Common name: Vede Khursani

Family: Solanaceae

Origin: Central and South America (Especially in Brazil.)

Chromosome number: 2n= 24

Uses

Capsicum fruits are consumed in fresh as salad, dried or processed form. More commonly cooked, fried or processed together with other food.

Nutritive value

Table: Nutritive value of capsicum per 100 gm

Principle	Nutrient Value	Principle	Nutrient Value
Energy	31 Kcal	Sodium	4 mg
Carbohydrates	6.03 g	Potassium	211 mg
Protein	0.99 g	Calcium	7 mg
Total Fat	0.30 g	Copper	0.017 mg
Cholesterol	0 mg	Iron	0.43 mg
Dietary Fiber	2.1 g	Magnesium	12 mg
Thiamin	0.054 mg	Manganese	0.112 mg
Vitamin A	3131 IU	Phosphorus	26 mg
Vitamin C	127.7 mg	Carotene-β	1624 µg
Vitamin E	1.58 mg	Carotene-α	20 µg
Vitamin K	4.9 Âµg	Cryptoxanthin-β	490 µg

Trade

The area under cultivation of capsicum in Nepal according to MOAD 2072/73 was 1183.8 ha with 12369.3 Mt production having average yields of 10.4 t/ha.

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	California wonder	Open pollinated Fruit: dark green, uniform Plant height: 30 cm Harvesting: 60 DAT	2051	All areas	200 gm/fruit 12 Mt/ha
2	Sagar	Hybrid variety Plant height: 100 cm Harvesting: 65-75 DAT	2066	Terai and MH	76.8 Mt/ha
3	NS 632	Hybrid variety Plant height: 90-100 cm Fruit: dark green, uniform Harvesting: 65 DAT	2066	Terai and MH	200 g/fruit, 44-50 Mt/ha
4	Bharat	F1 hybrid variety			150 gm/fruit

		Fruit: bell shaped, thick walled, Average length and diameter: 8-10 cm Resistant to tobacco mosaic virus			
5	Chinese giant	Hybrid variety Plants vigorous and prolific bearer Fruit: smooth, thick, sweet flesh and skin is dark green			

Climate

Capsicum is the plant of tropical and sub-tropical region. Grow well in warm and humid climate. Excessive rainfall is detrimental to the crop because it brings about defoliation and rotting of plants.

Soil

It can be grown in all types of soft but sandy loam, clay loam and loamy soils are best. Soil having PH 5.5 to 6.5 is ideal for its cultivation.

Nursery raising

The seed first must be planted in nursery bed. In 10 m^2 nursery bed 3000 plants can be prepared in spacing 10 × 10 cm and 2 cm deep. For this it requires 30 – 50 gm of seed. In 1 ropani 2000 plants are required. After sowing seed, mulching should be provided and light irrigation is given. To minimize infestation of insect, pest and diseases spray DM-45. When the plant attain 8-10 cm in height, having 5-6 leaves, it becomes ready for transplanting.

Planting

Region	**Nursery Sowing**	**Transplanting Time**
Terai	1. November (Poly-house) 2. February 3. May-June (rainfed areas)	1. Jan end or Feb 2. March 3. June-July
Mid Hills	March-May	April-June
High Hills	April	April-May

Nutrient management

Manures and fertilizer requirements in cauliflower depend upon fertility of soil. Accordingly, add 200-250q/ha farmyard manure and it should be mixed thoroughly at the time of field preparation. Application of nitrogen, phosphorus and potash varies with soil type, varieties and place. The requirement of N: P: K is 120-180:75-80:60-75kg /hectare. Half quantity of nitrogen and full quantity each of phosphorus and potash is applied at the time of transplanting. Remaining quantity of nitrogen is applied after 30-45days of transplanting.

Water management

First irrigation after transplanting and subsequent irrigation are at an interval of 5-7 days in summer and 10 – 15 days in winter. Flower bud and flower abscission was increased under short day (day length 12 hour) and high temperature (33-38 0C). To control this NAA@10 ppm at flower initiation stage and 15 days later reduces the flower drop and increase fruit set.

Weed management

The normal weed control method followed by farmers is to give two hand hoeing in the first and third fortnight after transplanting and an earthing up operation during the second fortnight. The application of herbicide is economical. Pre-emergence application of herbicides like Metribuzin at 0.35 Kg/hac, Fluchloralin 1.25 Kg/hac. has been found to increase the yield significantly over hand weeding.

Harvesting, Processing and Marketing

It takes 45-50 days for flowering after transplanting and 20-25 days to become ready for harvest after flowering. For vegetable purpose, they are generally harvested while they are still green but full grown. It can also be harvested at red stage for canning purposes. Multiple harvesting is done. Second and third harvesting gives higher and quality yield. Harvesting can be done up to 2-3 months after fruiting.

Yield

It yields about 15-20 ton and varies according to cultivation practices.

Rainfed condition: 200-400 kg/acre

Irrigated condition: 600-1000 kg/acre

Insect pest

1. **Chilly thrips :** can be controlled by spraying Rogor 30 EC@ 1ml/litre of water at fortnight interval.
2. **Pod borer:** Quinalphos @ 4ml/liter of water.
3. **Aphid:** Metasystox can be sprayed.

Diseases

1. **Damping off:** To control this seed should be treated in formalin before sowing. For this Bavistein @ 2ml/liter.
2. **Bacterial leaf spot:** Spray Agrimycin @ 200 ppm.
3. **Anthracnose:** Mancozeb or DM-45 @ 2gm/litre
4. **Leaf curl:** Roger 30 EC @ 1ml/litre

Physiological Disorders:

Blossom End Rot

This is mainly a problem manifests itself as sunken brown and leathery patches on the blossom end of the first few fruit of the season. These patches may eventually turn black and rot, as the damaged skin facilitates the entrance of rot-causing organisms. Blossom End Rot is a physiological problem rather than a disease and is caused by a lack of calcium in the plant. Calcium is rarely deficient in the soil because it is commonly added to adjust pH, so there is usually some other factor at work. Most often it is due to irregular watering inhibiting calcium absorption, but it can also be caused by too much nitrogen or magnesium.

To reduce the incidence of Blossom End Rot, keep the soil evenly moist and well mulched. Don't give the plants too much nitrogen. If your soil is acidic then lime it, as this will add calcium too. Foliar feeding with seaweed or compost tea is a quick way to supply extra calcium. Indeterminate varieties are less commonly affected by Blossom End Rot than determinate varieties. You should remove affected fruit immediately,so the plant doesn't waste energy on them (they won't be of any use anyway).

Sunscald

Sunscald occurs in the high heat of summer when humidity is at a peak. Usually the foliage on the plant will help shield it from the most intense rays of the sun, but in some cases, the leaves have defoliated partially due to insects or disease. This leaves the developing fruit vulnerable to the sun and the peppers burn just like you or I would in exposed conditions.

Fruit and Flower drop:

Flower drop (known to some as "blossom drop") is a relatively common problem faced not only by chilli growers but by gardeners growing all kinds of fruit and vegetables. It happens when your plant flowers then each flower falls off without any fruit forming. The possible causes are lack of pollination, lack of Air Flow, over watering, not harvesting pods, unstable temperatures, over feeding, etc.

Tomato

Tomato, universally treated as protective food is being extensively grown as an annual plant all over the world. It is a rich source of minerals, vitamins and organic acids. Tomato is also known as poor man's orange.

Botanical name: *Lycopersicon esculentum*

Common name: Tomato

Family: Solanaceae

Origin: Tropical America

Chromosome number: 2n=24

Uses

Tomatoes are used directly as raw vegetables in sandwiches, salad etc. Several processed items like paste, puree, syrup, juice ketchup etc. are prepared on a large scale. Tomato is a very good appetizer and its soup is said to be a good remedy for patients suffering from constipation.

Nutritive value

Table: Nutritive value of tomatoes, red, ripe, raw per 100 gram

Principle	Amount	Principle	Amount
Calories	18	Fat	0.2 g
Water	95 %	Saturated	0.03 g
Protein	0.9 g	Monounsaturated	0.03 g
Carbs	3.9 g	Polyunsaturated	0.08 g
Sugar	2.6 g	Omega-3	0 g
Fiber	1.2 g	Omega-6	0.08 g

Trade

Tomato is the most important vegetable crop in Nepal. It is grown almost in terai and midhills areas of Nepal. The area under tomato cultivation in Nepal according to MOAD 2072/073 was 20046 ha with production of 386824.6 Mt and average yield of 19.3 kg/ha

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Pusa ruby	• Open pollinated • Indeterminate and early variety • High yielding variety • Fruit: slight medium, furrows found, red color • Harvesting: 60-65 DAT	2046	All areas	50-75 gm/fruit 20-25 Mt/ha
2	Roma	• Open pollinated • Determinate type • Fruit: egg shaped, smooth and less seeds • Harvesting: 60-75 DAT	2051	All areas	60-80 gm/fruit 20-25 Mt/ha
3	Monopresc os	• Open pollinated • Medium maturity, popular	2046	All areas	75-100 gm/fruit

		in Nepal, indeterminate • High yielding variety • Fruit: globe like uniformly red color and firm with less seeds • Harvesting: 80-90 DAT			30-35 Mt/ha
4	NCL-1	• Open pollinated • Fruit: peach like, slightly round, thick skin, mildly red • Harvesting: 65-75 DAT	2046	All areas	60-75 gm/fruit 20-25 Mt/ha
5	Coimbatore 1	• Open pollinated variety • Determinate type • Fruit: round with yellow color • Released from TNU, India			
6	Srijana	• First hybrid variety in Nepal • Fruit: heart shape, red pointed tip, • Plant height: 4.5-5 m • Resistant to bacterial wilt	2066	Terai and MH	60-80 gm/fruit 105-110 Mt/ha
7	Dalila	• Hybrid • Plant height: 120 cm • Harvesting: 60-70 DAT	2067	All areas	30 Mt/ha
8	Swuraksha	• Hybrid • Plant height: 40-50 cm • Harvesting: 75-80 DAT	2067	Terai and MH	80-90 Mt/ha
9	Madhuri	• Hybrid • Plant height: 115 cm • Fruit: egg shape, attractive red • Harvesting: 80 DAT	2067	Terai and MH	120 Mt/ha
10	NS 2535	• Hybrid • Plant height: 35-40 cm	2067	Terai and MH	140-150 Mt/ha

		• Harvesting: 75-80 DAT			
11	Jamuna	• Hybrid • Fruit: attractive red, 100/plant, • Plant height: 115 cm • Harvesting: 85 DAT	2067	Terai and MH	120 Mt/ha
12	NS 719	• Hybrid • Plant height: 48-55 cm • Harvesting: 75-80 DAT	2066	Terai and MH	90 Mt/ha
13	Nova	• Hybrid • Plant height: 140 cm • Harvesting: 110 DAT	2066	Terai and MH	152 Mt/ha
14	Marina	• Hybrid • Plant height: 150 cm • Harvesting: 105 DAT	2066	Terai and MH	113 Mt/ha
15	Eureka	• Hybrid • Plant height: 160 cm • Harvesting: 102 DAT	2066	Mid Hill and Terai	94 Mt/ha
16	VL 443	• Hybrid • Plant height: 135 cm • Harvesting:104 DAT	2066	Terai and MH	140 Mt/ha
17	Opel	• Hybrid • Plant height: 180 cm • Harvesting: 50-90 DAT	2066	All areas	56 Mt/ha
18	NS 53	• Hybrid • Plant height: 35-40 cm • Harvesting: 80-85 DAT	2066	Terai and MH	90-100 Mt/ha
19	Sens	• Hybrid • Plant height: 165 cm • Harvesting: 107 DAT	2066	Terai and MH	115 Mt/ha
20	Other varieties	Gaurav, CL cross, BL, CL 1131,			

Climate

Tomato is a warm season crop and can be grown between 10°C – 30°C. The optimum range of temperature is 21°C – 25°C. Tomato is neither tolerant to frost nor to waterlogged condition.

Soil

Soil which is well drained, fairly fertile, rich in organic matter with fair moisture holding capacity is ideal. For early crop, a sandy loam soil is best, however for higher yield, heavy soils rich in organic matter are preferred. Tomato performs well in soil having pH 6.0 – 7.0. It is moderately tolerant to acid soils (pH 5.5).

Nursery raising

A net area of about 225m^2 may be required to raise the seedlings for one hectare land. Generally the nursery beds are prepared in the size of 7.5 m long, 1 m width and 10 – 15 cm height. Well decomposed farmyard manure is properly mixed into top soil of the bed at the rate of about 3 Kg/m^2. For raising good and healthy seedlings, treatment of the seeds with fungicides like Captan or Cerasan or Thiram @ 2 g/Kg seed is essential. Similarly, the seed beds are also treated with hot steam or ½ liter of 40% formalin/sq. m soil. Soon after fumigation, the beds are covered with polythene for 24 hours. If the fumigation is not done in the nursery bed, solarization should be done to minimize the attack of insects, pests and diseases. For solarization, cover the nursery bed with a transparent plastic sheet (during the day hours) for 10 days.If there is insufficient time to wait for nursery, formalin dust can also be used. Prepare a mixture of formalin dust and well rotten FYM in the ratio of 15:85, mix them well and spread the mixture on the beds @ 400 – 500 g/m2. The spread material is then mixed into the soil up to 5 – 6'' depth and the seeds are sown. If beds are not sterilized, drench with 0.2% Brassicol or Captan. The seeds are sown in beds either broadcasted or in row, at a distance of 7.5 cm between the rows. After sowing, the rows are covered with thin layer of compost. Thereafter, the beds are irrigated with a rose can. Light watering is required daily in the evening. Nowadays the nurseries are being raised in low tunnels and low cost polyhouse. Use of transparent plastic sheet as low tunnel provides an ideal

condition for successful raising of seedling than the conventional methods. The utility of low cost polyhouse for raising of seedlings in winter months facilitates transplanting in short time for spring planting in plains. The beds are covered with straw or polythene sheets until the seed germinates. Every week, if required a fungicide such as Dithane M-45 or Difolation 0.25% should be sprayed to reduce the post emergence damping off.

Planting

The tomato can be grown almost throughout the year in the country. The number of crops grown varies from region to region. About 400 – 500 gm seeds are normally needed for raising crop in one hectare. 125 – 175 gm hybrid seeds are required for planting of one hectare land.

Table: Scheduling of time for tomato cultivation.

Area	Season	Time of nursery sowing	Transplanting
Plains	Autumn/winter Late autumn	January July – August	February August – Sept.
Frost free area	Spring/summer	Late November	January
Hills	Spring/Summer	March – April	April – May

Nutrient management

The quantity of nutrient applied in the field depends upon several factors such as cultivar, soil and growing condition, irrigation and season etc. For successful crop, application of about 20 tons FYM, 90 – 100 Kg N, 60 – 70 Kg P2O5 and 50 – 60 Kg K2O per hectare is required. One third of Nitrogen and entire dose of Phosphorus, Potash and FYM should be applied during field preparation. The remaining dose of Nitrogen should be applied in equal doses i.e. 25 – 30 and 45 – 50 days after transplanting. Application of urea (1.25%) as a foliar spray gave better plant growth, fruit yields and quality. Similarly application of 20 – 30 Kg/hac of Borax and 0.5% Zn is beneficial for yield and good quality of fruits.

Water management

Tomato plants require adequate moisture throughout their growth period. First irrigation is required soon after transplanting. When the plant are small, frequent

watering is necessary in the root zone. Irrigate the crop at an interval of 3 – 4 days during summer and 10 – 15 days during winter to maintain the soil moderately wet. A long spell of drought followed by sudden heavy irrigation may cause cracking of fruits.

Weed management

The normal weed control method followed by farmers in tomato is to give two hand hoeing in the first and third fortnight after transplanting and an earthing up operation during the second fortnight. The application of herbicide is economical. Pre-emergence application of herbicides like Metribuzin at 0.35 Kg/hac, Fluchloralin 1.25 Kg/hac.has been found to increase the yield significantly over hand weeding.

Use of Plant Growth Regulators

Use of plant growth regulators in tomato has been found beneficial for yield, quality, earliness, cold and high temperature fruit setting and to develop resistance to TLCV (Tomato Leaf Curl Virus).

- Seed treatment with β-napthoxy-acetic acid (BNOA) at 25 – 50 ppm, Gibberellic acid (GA3) at 5 – 20 ppm and chlorophenoxy acetic acid at 10 – 20 ppm were reported to improve in growth and yield of tomato.
- Seedlings soaked for 24 hours in NAA at 0.1 ppm showed higher fruit set, early maturity and increased total yield.
- The foliar application of PCPA (Parachlorophenoxy acetic acid) 50 – 100 ppm at the flowering stage increase the fruit set at low and high temperatures.

Pruning and Training

Pruning and training are generally followed in indeterminate type of tomatoes. Pruning besides removing the unwanted growth of plants, improves the size, shape and other qualities of fruits. Pruning also breaks the apical dominance, eliminates the crown set and enhances the plant vigor. Apart from pruning in indeterminate tomato, early and total yield and quality are increased to a greater extent by training. The plants are trained with wires, strings or stakes.

Harvesting, Processing and marketing

In indeterminate cultivars, fruits can normally be harvested 70 – 100 days after planting while determinate cultivars may begin fruiting at 70 days depending on the environmental condition. Fruit harvesting should be at the right stage, which depends upon the purpose of fruit utilization.

Green stage: the fruits are fully developed but are green and suitable for sending to distant markets.

Pink stage: Some of the portion is red or pink and the fruit is not fully ripe. It is most suited for local markets.

Ripe stage: The major portion of the fruit is red and the softening begins. It may be picked up for home or table use.

Full ripe stage: The fruit develops maximum color and turns soft. It is suited for processing purposes.

Fruits are normally picked up at an interval of 4 – 5 days in summer whereas for winter crop picking should be at weekly interval. On an average, yield of open pollinated varieties ranges from 20 – 25 tons/hac. Hybrid varieties may yield up to 50 tons/hac. or more under normal conditions.

Tomato fruits at mature stage could be stored successfully at 12 – 13°C in polythene bags of 100 gauze thickness for 4 – 5 weeks. Usually bamboo basket and wooden boxes of various size and shape are used for packing of tomatoes. Wooden boxes are generally used for packing for long distance markets. Use of polythene for pre-packing of tomatoes could reduce the physiological losses in weight and increase in shelf-life.

Disorders of tomato

1. Blossom end rot

Water soaked spots appear at the point of attachment and enlarge rapidly. This disease occurs due to reduced soil moisture especially at fruit development stage. This disease also occurs due to calcium deficiency. Any cultural practices, which conserve soil moisture and spraying of calcium help in controlling diseases.

2. Puffiness

The affected fruits are light in weight and the fruits are cut open the large hollow cavity are noticed. The fruits are some what angular in shape and surface is flattened. Puffiness is associated with poor pollination and abortion of ovules due to adverse environmental conditions particularly high and low temperature.

3. Cracking

Cracking of the surface of fruits at the stem end is the common occurrence and often results in large losses. The cracks are of two kinds; one which radiates from the stem end and other develops concentrically around the shoulder of the fruit. Radial cracking is more common and causes greater loss than concentric cracking. Besides these, cuticular cracking is also often found on the skin of fruits. There are 3 factors responsible for cracking;

- Long drought period followed by heavy rain or irrigation.
- Boron deficiency (soil application of borax @ 15 – 20 Kg/hac. or spraying of borax (2.5%) 2 – 3 times at fruiting stage.
- Genetic factors (Use resistant cultivars like Sioux, Manalucie, crack proof)

4. Cat face

The damaged fruits are distinguished by the distortion of the blossom end rot and have ridges, furrows, indentations and blotches. The cause of cat face is unknown but some scientists reported it might be some genetic factors.

5. Sun injury

The fruit surface exposed to the sun may become yellow or develop brown burnt areas. This may be reduced by the use of varieties with abundant foliage so as to cover the fruits with leaves.

6. Fruit and Flower drop:

Flower drop (known to some as “blossom drop”) is a relatively common problem faced not only by chilli growers but by gardeners growing all kinds of fruit and vegetables. It happens when your plant flowers then each flower falls off without any fruit forming. The possible causes are lack of pollination, lack of Air Flow,

over watering, not harvesting pods, unstable temperatures, over feeding, etc.

Insect pest

1. Tomato fruit worm (Heliothis asmigera)

Moths are brown to yellowish brown in color. Caterpillar are green in color. They attack during October – March. They roll over the leaves and find their way to fruits where they cut holes. Pest is controlled by picking the fruits and spraying of contact insecticides like Carbaryl 0.2% and Inchlodrophos 0.25%.

2. Jassids (Empoasca devestan)

Jassids suck the sap from the leaves causing curling of leaves. Sprays of Eldrin, Parathon are effective in controlling.

3. Whitefly (Bemisia tabaci)

They are minute white pigmented insects which suck sap of plants.

Control measures are discussed in leaf curl disease control.

4. Nematodes

Three species Meloidogyne incognita, M. aerenaria and M. javanica are common in tomato. Symptoms consist of discoloration to pale than normal unthrifty development, dwarfness and wilting. The disease can be controlled by use of resistant varieties like P-120, Nematax, Anahu, Arkisen, VNF-8, FMH-2, S-120, Hisar Lalit etc. Use of dichloropropan dichloropropane mixture (DD) @ 2801/hac and Dimethoate are recommended. (Nodules are formed on the roots.)

Diseases

Bacterial Diseases

1. Bacterial wilt

C.O:- Pseudomonas solanacearum

It is the most serious disease in tropical as well as temperate regions. Lower leaves may drop before wilting. Plants are stunted with yellow leaves. The disease is known to be soil borne. Use of resistant varieties (Arka Alok, Arka Vardhan,

RT-1, BT-10, BRH-2), crop rotation and application of oil cake, neem cake are the control measures for controlling the disease.

Fungal Diseases

1. Damping off

C.O:- Pythium ultimum, Rhizoctonia solani, Phytophthora parasitica.

The stem of the seedling decays at the soil surface and finally it collapses due to shrinking of tissues of stem near the ground. Seed treatment with Cerasan or Copper Oxychloride @ 2 g/Kg and spraying of seedlings with Captan or Phytolon are effective in controlling post-emergence damping off. The disease is more serious when excess of water is supplied and temperature is high.

2. Late blight

C.O: *Phytophthora infestans*

Brown to purple black lesions occurs in the leaflet, petiole, fruit and stem. Application of Dithane Z-78 is effective at early stage.

3. Fusarium wilt

C.O: *Fusarium oxysporum f sp lycopersici*

This disease is common in warm humid climate. Optimum temperature of 28°C is suitable for fungi growth. Fungus is a soil inhabitant. Symptoms consists of clearing of veinlet, dropping of petiole, yellowing of lower leaves leading to death of plant at later stage. Crop rotation, use of resistant varieties (Marglobe, Pant Bahar, Rutgers) is sure and effective control.

4. Early blight

C.O: *Alternaria solani*

The fungus is soil borne. Circular angular dark brown spots appear on leaves, stem and fruit. Concentric circles of 2 – 5 mm in diameter are formed at advanced stage. Seed treatment in hot water at 52 – 55°C and spray of Diathane Z-78 or M-45 and Zineb are helpful in controlling the diseases.

5. Septoria leaf blight

C.O: *Septoria lycopersici*

This disease may occur on plants of any age and appear as water soaked spots, the centre of which later turn gray surrounded by darker margins. Clean cultivation, crop rotation and spraying or dusting with copper compounds helps to control this disease.

Viral Diseases

1. Tomato mosaic virus

This diseases cause mild mottling of foliage. Sometimes leaf blade is reduced to fern like appearance. Yellow chlorosis is more prominent. Fruits are also distorted. This disease spreads through debris of infected plants through soil and mechanical means. This disease can be controlled by use of resistant varieties, proper sanitation and avoiding contact by smokers.

2. Leaf curl virus

This disease is more serious during autumn crop. This disease is characterized by curling of leaves, reduction in leaf size, excessive branching and stunted plant growth. The virus spread through a vector whitefly (Bemisia tabaci). The disease can be checked by control of whitefly by spraying of insecticide like Rogor and Dimacron 8 – 10 days interval. Use resistant varieties like H-24.

Brinjal

Brinjal or egg plant is a hardy crop and a very good source of income for small and marginal farmers. Brinjal is eaten as fresh vegetable when it is fairly young. Brinjal is used in various curry recipes and also consumed as pakoda and bharta.

Botanical name: *Solanum melongena*

Common name: Bhanta/ Baigun

Family: Solanaceae

Origin: South East Asia

Chromosome number:2n=24

Uses

Brinjal is eaten as fresh vegetable when it is fairly young. Brinjal is used in various curry recipes and also consumed as pakoda and bharta

Nutritive value

Brinjal fruits are a good source of calcium, phosphorus, iron and vitamins. Edible portion of the fresh fruit per 100 g provides moisture 92.0 gram, protein 1.4 g, fat 0.3g, minerals 0.3g, fibre 1.3g, and carbohydrate 4.0 g. Mineral contents per 100g of edible portion are Ca 18mg, Mg 16mg, Fe 0.9mg, Na 3mg, Cu 0.17mg, S 44mg, Cl 53mg, Mn 2.4mg. A small quantity of iodine is also present. The vitamins present are Vitamin A 124 microgram, Thiamin (B1) 0.4 mg, riboflavin (B2) 0.11 mg, nicotine acid (niacin) 0.9 mg, vitamin C 12 mg, choline 52 mg. Brinjal is a rich source of vitamins and minerals and is also reported to stimulate intra-peptic metabolism of blood cholesterol

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Nurki	• Mid type plant stem • Leaf: out spiny • Fruit: 15-20 cm long, soft, 4-5 fruit/bunch, • Harvesting: 60-65 DAS	2066	All areas	
2	Pusa purple long	• Early variety • Fruit: purple color, 20-25 cm long, cylindrical • Harvesting: 70-80 DAS	2066		
3	Sarlahi green	• Late season variety • Fruit: 25-30 cm long, light green color, • High yielding variety			

		• Harvesting: 80-90 DAS			
4	NS 797	• Hybrid variety • Plant height: 50-60 cm • Harvesting: 70-75 DAS	2066	Terai and MH	20-24 Mt/ha
5	Arkakesha v	• Hybrid variety • Plant height: 50-60 cm • Harvesting: 55-60 DAS	2066	Terai and MH	20-24 Mt/ha
6	Anna 806	• Hybrid variety • Plant height: 50-55 cm • Harvesting: 75-80 DAS	2066	Terai and MH	30-40 Mt/ha
7	Runako	• Hybrid variety • Plant height: 30-40 cm • Harvesting: 60-70 DAS	2066	All areas	10 Mt/ha

Climate

Brinjal is susceptible to severe frost. Seed germination is high at temperatures between 23°C and 28°C. Optimum temperature for growth and fruiting is 21° to 37°C day temperature and 18° to 20°C night temperature. Soil temperatures below 15°C retard crop growth and gradual rise of temperature from 21° to 37°C results in increased crop growth; further rise in temperature reduces growth and beyond 40°C fruiting is poor and the fruit dies. Brinjal is a day neutral crop, and if optimum temperature and nutrition is provided, it can be cultivated in any season.

Soil

Brinjal can be cultivated in almost all types of soil; however, well-drained loam soil rich in organic matter with high water holding capacity is best. For rainy season crop, light loam to sandy loam is best. Brinjalgrows well in slightly acidic soil with pH range 5.5 to 6.

Planting

Egg plants bear fruit for a long time, up to two years in warm areas. Land should be prepared well to make the soilsuitable for the deep root system. The field should be well drained and be able to hold moisture. Soil should be thoroughly prepared with at least 30 cm deep corrosive plowing/digging followed by 2–3 rounds of light plowing and clod breaking to make soil friable, loose and well levelled. Transplanting beds and trenches should be made for irrigation and excess water drainage. The bed width may vary depending on the cultivation season. For spring and autumn plantation, make 125 cm wide beds with 25 cm wide trenches for two-row planting, and for rainy season 75 cm wide ridges and 25 cm wide trench for one-row planting. For protected production in plastic houses, the beds and trenches should be made to adjust two rows in the central beds and single rows in two side beds.

Nutrient management

Brinjal is a heavy feeder crop. Therefore a balance application of manure and fertilizers is very important for successful crop production. Further the brinjal being a long duration crop requires a good amount of manure and fertilizers. Well rotten farmyard manure or compost (200-250 q/ha) should be incorporated at the time of field preparation. The crop should be supplemented with 100-120 kg nitrogen and 50-60 kg each of phosphorus and potash hybrid requires more amount of fertilizers. Full dose of phosphorus and potash and half of N is applied at the of final field preparation before transplanting and the remaining quantity of N as urea is applied in two to three splits after 30, 45 and 60 days of transplanting in the farm of top dressing.

Water management

Egg plants require adequate moisture throughout their growth period. The critical periods of moisture requirement are immediately after transplanting, after top dressing, after weeding and earthing up, during flowering and fruit initiation. First irrigation is done just after transplanting with a watering can and thereafter it is necessary to maintain proper soil- moisture level for good fruiting and harvest.

Water requirement varies according to soil type. Sandy and silt soil needs more irrigation; loam soil needs less irrigation. Under normal conditions, soil moisture should be between 50 to 80% of field capacity with an average of 60% field capacity. After irrigation and heavy rain, draining of excess water is mandatory otherwise bacterial and fusarium wilt will attack the crop. Spring and wintercrop needs irrigation at 5–7 day intervals during summer and 10–15 day intervals during winter to ensure that the soil is moderately wet. Egg plants are planted in beds; furrow irrigation is more beneficial. In water scarce areas, drip irrigation with mulch is better than other irrigation systems. Wastewater and runoff collection ponds shoud be constructed near the cultivation area and collected water should be applied by drip. Too much irrigation leads to bacterial and fusarium wilt.

Weed management

The weeds should be controlled as soon as they seen, either by traditional method of hand weeding and hoeing or by application of herbicides. Frequent shallow cultivation should be done at regular intervals so as to keep the field free from weeds and to facilitate soil aeration and proper root development. The most serious weed in brinjal is the *Orabanchae sp*. It is root parasite and it should be controlled carefully .Gap filling should be done wherever needed during evening hours followed by irrigation .Pre- plant soil incorporation of Fluchloralin (1- 1.5 kg/ha) or Oxadiazon (0.5 kg/ha) and pre-planting surface spraying of Alachlor (1-1.5 kg/ha) control the weeds of brinjal successfully.

Harvesting and yield

Fruit should be harvested at the right stage when the seed inside is tender. Generally egg plants are harvested when the fruit is tender. They should be shapely, waxy, firm and shiny. Fruit is ready for harvest within 7–10 days of flowering. Egg plants are picked with an upward twist, which leaves a part of the stem attached to the fruit. To harvest without damaging the plant, it is better to cut the peduncle with secateurs. Pulling the fruit away from the plant may cause the plant to come out of the soil. Tender fruits are harvested at 3–4 day intervals in summer and weekly intervals during late autumn and winter. Harvesting should be

done when there is nodew on the crop, preferably in the afternoon.

The yield of egg plant varies according to the variety. Early and short durational varieties yield 20–30 tonnes/ha whereas late and long durational varieties yield 35–40 tonnes/ha. Hybrids yield up to 40–80-tonnes/ha.

Storage and marketing

In Nepal there is no organized cold storage for fresh vegetables including egg plants. However, if marketing is obstructed or delayed due to transport problem, egg plants can be stored in low temperature and evaporative cool storage. Pre-cooling is necessary for storing fruits. Egg plants can be stored successfully at 8°–10°C in 85–95% humidity in crates or open polythene bags of 100 gauge thickness for 4–5 days. Most of the egg plants commercially grown in Nepal are harvested and sent to the market within a day or two. The produce is sold to the local market or collected at a collection centre and sent to a whole sale market through marketing agents or cooperatives. The producer groups or cooperatives and even individual producers should have prior contact with the marketing agents or traders for organized marketing.

Insect pest

The major insects that attack egg plants are stem and fruit borer, cutworms, white fly and leaf miner. Among diseases, damping off of seedlings, early and late blight, phomopsis blight, bacterial wilt, fusarium wilt, root knot nematodes and different leaf curl viruses are the important ones.

Major insects and their management

1. Fruit borer

The larva enters the tender twigsand feeds on them and causes wilting. It also bores the fruitand damages the fruit, making Itinedible.

Control

- Collect infested twigs and bored fruits and bury them.
- Keep the trap of Lucien cultures to attract the males and reduce their population.
- Before fruiting, spray Malathion or rogor 2ml/litre of water.

- During fruiting, pick the fruits that are ready and then spray nuvan @ 2ml/litre of water.

2. **Red mites:** These insects colonize the underside of leaf and suck the sap. Leaveslook burnt

Control

- Before fruiting, spray malathion or rogor.
- During fruiting, pick all the fruits that are ready and then spray nuvan.
- After spraying pesticide, wait for seven days (in case of nuvan) and 21 days (in case of rogor) before picking the fruit.

3. White fly

Adult whitefly (*Bemicia tabaci*) livesunder the surface of the leaf. Youngones are small and cannot move. Both adults and young ones suck the sap and leaves turn yellow. They transmit viral diseases.

Control

- Gitimal or botanical extracts or servo can reduce the attack of white fly.
- Natural enemies and predator wasps eat it.
- Spray cow or buffalo urine mixed in 10 parts of water to drive them away.
- Use yellow sticky traps to attract the insects.

4. Leaf Minor

The insect mines inside leaves and eats chlorophyll, and the leaves dry up and become grey.

Control

- To control the insect, spray urine or neem product.
- Spray rogor 2ml/litre of water at weekly intervals.

1. Cutworms

The base of the seedlings andnewly transplanted crops are cut off and the plants topple down. Caterpillars eat young leaves and growing tips.

Control

- Collect larvae and kill them.
- Spray multineem @ 2 ml/litre of water.

Major diseases and their management

1. Damping off

This disease is caused by *Pythiumaltimum, Rhizoctonia solani, and Phytopthora parasitica*. It leads to pre-emergence damping off, which kills the seedling at the initial stage of germination. In post emergence damping-off, the cortical tissues of the hypocotyls shrink and darken rapidly and the seedlings die.

Control

- Change the nursery site every year/season.
- Spray 50 ml (40%) formalin mixed in 10 litres of water per square metre bed and cover the beds for two weeks.
- Seed treatment with Trichoderma or captan or thiram or bavistin or ceresin @ 2–3g/kg seed.
- Spraying copper oxychloride+captan or phytolan controls post-emergence damping off.
- Spraying Mancozeb (0.25%) and Cabondazim (0.05%) also controls the incidence.

1. Leaf spot

This disease is caused by *Alternariasolani*. Circular round brown spotsappear on the older leaves.

Control

- Spray Dithane M 45 @ 2g/litre of water at weeklyintervals.

2. Phomopsis blight

Caused by *Phomopsis vexans*.Occurs at the seedling stage as wellas in transplanted crop. Small circular spots develop in leaves. Later, the leaves turn grey with a light coloured centre. Pale to light brown sunken spots develop on the old fruits. Individual spots expand and coalesce to cover the entire fruit or most

part of the fruit.

Control

- Use healthy seeds collected from healthy fruits and healthy field.
- Grow resistant varieties like Pusa Bhairav and Florida market.
- Give hot water treatment to seeds at 50° C for 30 minutes.
- Seed treatment with carbendazim @ 0.25%.

3. Early Blight

This disease is caused by soil bornefungi *Cercospora capsici*. Circular,angular dark brown spots appear on leaves, stems and fruits. Sunken large dark brown leathery spots appear on green fruits and stems. At a later stage, fruits rot and decay.

Control

- Long-term crop rotation should be followed with non-solanacious crops.
- Use resistance varieties if available.
- Seed treatment with baviatin @ 3g/kg seed.
- Spray crop with Dithane Z 78, Dithane M 45 (0.2%) or bavistin (0.1%) three times at 15-day intervals.

4. Late Blight

The disease is caused by*Phytopthera capsici*. Disease occurson the foliage at any stage of the crop. Brown to purple black lesions occur in the leaflet, petiole, fruit and stem. Fruits decay and drop. At a later stage, plants die. The disease appears at low temperature and high humidity.

Control

- Plant disease resistant varieties.
- Maintain a wider transplanting distance, i.e., 75 x 75 cm.
- Provide aeration and sunshine to the entire plant by pruning, training and removing the older leaves that touch the soil.
- Apply a high dose of FYM or compost.
- Spray dithane M 45 (0.2%), Ridomil (0.2%), bavistin (0.1%) or Crinoxyl

gold 2g/litre of water twice at seven days' interval.

5. Anthracnose

Anthracnose is caused by *Colletotrichum capsici*. At first, anthracnose generally appears on the leaves as small and irregular yellow, brown, dark-brown or black spots. Infected fruit has small, water soaked, sunken, circular spots that may increase in size up to 1.2 cm in diameter. As it ages, the centre of the older spots turns blackish and emits gelatinous pink spore masses.

Control

- Proper seed and planting materials selection. Sow only disease-free seeds.
- Proper field sanitation and seed treatment
- Transplant only healthy seedlings.
- Remove and destroy infected parts but don't let them touch other plant parts, especially when these are wet.
- Harvest unripe but mature fruits.

Okra

Okra is an important annual vegetable crop in tropical and subtropical parts of the world. It is mainly used for its tender green fruits as vegetable. It is a rich source of iodine, calcium, sulfur and sodium. Its tender fruits also contains vitamin-A, C, thiamine and riboflavin. Besides it also has dietary fibres, proteins and carbohydrate.

Botanical name: *Abelmoschus esculentus* (L.)

Common name: Bhindi

Family: Malvaceae

Origin: Ethiopia

Chromosome number: 2n=130

Uses

It is grown for its green, tender and nutritive fruits which are cooked in curry and are also used in soups besides being processed as canned and frozen.

Nutritive value

Okra nutrition value fresh, raw pods, value per 100 g.

Principle	Nutrient Value
Energy	33 Kcal
Carbohydrates	7.03 g
Protein	2.0 g
Total Fat	0.1 g
Cholesterol	0 mg

(Source: USDA National Nutrient data base)

Trade

Okra is cultivated in area of 10781.4 ha with production of 22101.6 Mt and yields of 11.3 t/ha.

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Parbati	• Early open pollinated • High yielding variety • Fruit: mid green and fleshy • Plant height: 50-60 cm • Harvesting: 50-60 DAS	2051	All areas	2o Mt/ha
2	Arkaana mika	• Open pollinated	2067	All areas	
3	Red bhindi	• Open pollinated • Fruits: red color, long, slender type, and less seeds • Harvesting: 50-55 DAS			
4	Pusa swami	• Open pollinated • Fruits: dark green, 10-12 cm long, • Purple pigmentation in the			

		stem and heavy leaves • Harvesting: 60 DAS			

Climate

It is a warm season crop, sensitive to fluctuating environment and grows luxuriantly in warm and humid weather. The optimum temperature for better seed germination should be atleast 18ºC, optimum being 25-30ºC. Optimum temperature for its better growth is 24-27ºC and temperature above 42ºC causes flower drop. A temperature range of 30-35ºC is desirable for improved pollination and subsequent seed setting.

Soil

Okra grows best in light soils ranging from sandy loam to loam though it gives good crop in heavy soil with efficient drainage facility during rainy season. The soil should be well drained as it is sensitive to water logging. The most ideal pH range for its cultivation is 6.0 to 6.8.

Planting

Okra should be planted in well pulverized field by ploughing first with soil turning plough and afterwards with 4 to 5 ploughing. It requires a seed rate of 15-20 kg/ha (Spring-summer crop) and 10-12 kg/ha (Rainy season). Seed germination can be enhanced by soaking the seed in water for 12-24 hours or GA3 at 10 and 50 ppm or immersing the seeds for 5 minutes in pure acetone it is generally planted at spacing 30-45cm × 15 cm(Spring-summer) and 60cm × 20-30 cm (Rainy season)

Nutrient management

FYM @200-250 quintals per ha should be applied at the time of field preparation. In addition, apply 60-75 kg N, 50-60 kg phosphorus (P2O5) and 50-60 kg potassium (K2O) kg per hectare depending upon the fertility status of the soil. Apply half of nitrogen and full dose of phosphorus and potassium at the time of sowing and remaining nitrogen can be top dressed after one month of sowing.

Water management

Pre-sowing irrigation is necessary especially in spring-summer crop which ensures adequate germination and uniform crop stand. Then, next irrigation is to be provided after seed germination and the subsequent irrigations at 4-5 days interval during summer crop. Drainage of water is required as per frequency and intensity of rains during monsoon season.

Weed management

Weeds cause more than 50% reduction in the marketable yield of okra. Frequent weedings are necessary to keep the crop weed free. First weeding may be done at 15-20 days and second at 40-45 days after sowing to keep the crop weed free at critical stages. Pre-emergence application of Pendimethalin @1 kg ai/ha or Alachlor @ 4litres/ha or Fluchloralin @ 2.5 litres/ha + 1 hand weeding is effective to keep crop weed free.

Harvesting, Processing and marketing

The fruits attain marketable maturity in about 45-60 days after sowing. Only tender and small fruits (6-10cm long) should be harvested preferably in the evening or morning. Frequent pickings are necessary for getting better quality fruits and handsome prices in the market. Delayed harvesting though increase yield but reduce the quality and profit margin, and even sometimes the entire produce is rendered unfit for marketing. For export purpose, dark green fruits about 6-8cm long should be harvested.

Post-harvest management

For local markets, fruits are cooled and packed in jute bags or baskets, covered or stitched and then water is sprinkled over the bags, which helps in cooling as well as maintaining the turgidity of fruits thereby saving the produce from bruises, blemishes and blackening. For export, 5-8 kg size perforated paper cartons are ideal wherein pre-cooled fruits are packed and transported preferably in refrigerated vans.

Storage

Fresh okra fruits can be stored at 7-9ºC at 70-75% relative humidity for a couple of days without much loss of colour, texture or weight. Fruit can be stored for 2

weeks at 8-10ºC at 90% relative humidity.

Insect pest

1. Fruit borer

The insect larvae are light yellow with black spots. They bore into the shoots during vegetative stage and feeds inside as a result of which the shoots droop down and dry-up. In the later stages, it infests the fruits which become disfigured and show holes.

Management

- Grow tolerant varieties like Perkins Long Green, Varsha Uphaar.
- Remove and destroy damaged shoots and fruits.
- Application of carbaryl (0.1%) and malathion (0.05%) is effective.

2. Flower feeding beetle/ Blister beetle

Beetles feed on pollen, petals of flowers and flower buds, thus affecting fruit set adversely.

Management

- Hand collection and destruction of beetles.
- Application of 0.1% carbaryl or 0.05% malathion or 0.01% cypermethrin is effective.

3. White fly

It causes chlorotic spots on leaves. The insects secrete a sticky substance known as honeydew, which covers leaves and flowers. As a result, the sooty mould develops and plant growth is reduced.

Management

- Plants affected by viral disease must be uprooted and destroyed.
- Monitoring the adult population with yellow sticky traps for early prediction and timely application of insecticide.
- Spray triazophos (0.04%) or lambda-cyhalothrin (0.004%).

Diseases

4. Powdery Mildew

White powdery growth on both sides of the leaf. The diseased leaves drop off from the plant.

Management

- The disease can be controlled effectively by spray Sulfex (0.2%) or dinocap (0.05%) at 10 days interval.

5. Cercospora Leaf Spot

There is appearance of spots in the leaf with grey centers and red borders. When the disease is severe, complete defoliation occurs.

Management

- Seed treatment with is effective to manage the disease.
- Spray mancozeb (0.2%) or Captan (0.2%) or carbendazim (0.1%) at the appearance of the disease incidence to check the infection.

6. Yellow Vein Mosaic Virus

The veins of diseased leaves become yellow resulting in homogenous interwoven net work of yellow veins. In extreme cases, the infected leaves become totally yellow or cream colour. Infected plants remain stunted and bear very few deformed and small fruits. The disease causes heavy loss in yield if the plants get infected within 20 days after germination. It is transmitted by white fly.

Management

- Disease incidence can be reduced by checking the development of insect vector by the application of 4 to 5 foliar sprays of recommended insecticides.
- Infected plants must be removed from the field
- Grow resistant varieties like P-8, Varsha Uphar, Arka Anamika, and Parbhani Kranti.

7. Root rot (Fusarium solani)

Severely infected plants die as their roots turn dark brown. The fungus perpetuates in the soil or in the infected plants debris.

Management

- Seed treatment with carbendazim @ 3g/kg of seed
- Soil drenching with carnebdazim @ 0.1%,
- Follow long crop rotation.

C. Learning process and support materials

Learning process includes the Visual methods, Demonstration method, Practical method, Observation method, Exhibition methods.

D. Assessment

Very Short (Answer question)

1. Write down the scientific name and family of Tomato.
2. List out the importance fruit vegetable crops cultivated in Nepal.
3. Name any two importance varieties of Brinjal.
4. List any two major diseases of okra.

Short (Answer question)

1. Define fruit vegetable crops with examples.
2. Write down the requirement of weeding and irrigation on fruit vegetable crop.
3. Write any two varieties of Capsicum and Chilli.

Long (Answer question)

1. Write the cultivation practices of okra with respect to, botanical name,climate, method of propagation, manure & fertilizer and curing process.
2. Write the cultivation practices of tomato with respect to, botanical name, family, climate, manure & fertilizer, training and pruning.
3. Write the cultivation practices of capsicum with respect to, botanical name, soil, method of propagation,harvesting and marketing.

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UNIT – 8

Cultural Practices of Bulb Crops (Onion, Garlic) 149

A. Objectives

After the completion of this course, the students will be able to:

- Explain about the origin, distribution, cultivars, climate and soil requirement etc. of bulb crops.
- Describe about the cultivation practices of different bulb crops in various aspects.

B. Content elaboration

Bulb crops comprise of two different species, such as onion and garlic, which are mostly annuals, of which bulbs are consumed either raw as a salad or cooked. They are essential items of balanced diet and are rich in nutrients. Most of the root crops which are commonly cultivated are:

Onion

The onion is a hardy cool-season biennial but usually grown as annual crop. The onion has narrow, hollow leaves and a base which enlarges to form a bulb. The bulb can be white, yellow, or red.

Botanical name: *Allium cepa L.*

Common name: Pyaz

Family: Alliaceae

Origin: South East Asia

Chromosome number: 2n=16

Uses

The green leaves and immature and mature bulbs are eaten raw. Used in preparation of sauces, soups and seasoning of food on account of its special characteristic pungency. Also used in processed form e.g. flakes, powder and pickles.

Nutritive value

Table: Nutritive value of onion per 100gm.

Particulars	Green	Bulb	Particulars	Green
Moisture (%)	87.6	86.6	P (mg)	-
Protein (g)	0.9	1.2	Fe (mg)	7.5
Fat (g)	0.2	0.1	Vitamin-A (IU)	992
Carbohydrates(g)	8.9	11.1	Thiamine(mg)	0
Energy (kcal)	41	50	Riboflavin(mg)	0.01
Ca (mg)	50	47	Vitamin-C(mg)	17

Trade

Onion is one of the most important bulbs vegetables crops grown in Nepal. It is cultivated under 20070 ha with production of 238590.7 Mt and yields of 11.9 t/ha.

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Nuwakote local	• Open pollinated • Short day type • Bulb red, flattish round, chocolate color • Low yield with good keeping quality			
2	Pusa red	• Short day type • Bulb: red, flat, less pungent, • Good keeping quality			
3	Red Creole	• Open pollinated • Bulb: flat dark red and medium • Harvesting: 160-180	2046	Terai and MH	175 gm/bulb

		DAT			
4	NS 53	• Hybrid • Bulb: medium, flattish spherical, red color with pungent taste • Plant height: 40-50 cm • Harvesting: 60-65 DAT	2067	Terai and MH	20 Mt/ha
5	Cass	• Hybrid • Plant height: 50-55 cm • Harvesting: 250 DAT	2066	Terai and MH	60 Mt/ha
6	Venus	• Hybrid • Plant height: 80-85 cm • Harvesting: 300 DAT	2066	Terai and MH	45 Mt/ha
7	Winter silver	• Hybrid • Plant height: 80-85 cm • Harvesting: 300 DAT	2066	Terai and MH	45 Mt/ha
8	Agrifound Dark Red	• Harvesting: 100-110 DAT		Terai and MH	200-250 q/ha
9	Agrifound Light Red	• Harvesting: 160-165 DAT		Terai and MH	300 q/ha
10	Nasik Red				

Climate

Onion does best under mild climate without extreme of heat and cold. It does not perform well in excessive rainfall. Before bulbing, temperature between 12.8-23ºC is required whereas 20 to 25ºC for at least 10 hours per day is required later for proper bulb development. About 70 per cent relative humidity is good for this crop. Very low temperature in the beginning result in bolting while sudden rise in temperature favours early maturity of the crop resulting into small sized bulbs. Onion bulbs more quickly under warm temperature than at cool temperature.

Soil

Onion grows well on light loam, sandy loam or clay loam, deep friable and fertile soil rich in organic matter. The soil should be well drained. The optimum soil pH should be 5.8 to 6.5.

Nursery raising

Generally onion seeds are sown in nursery bed with special care and managements. The appropriate bed size is prepared and seeds are sown in nursery beds. Before sowing the seed are soaked in water for 12hrs to facilate the proper seed germination. The seed rate of 8-10 kg/ha is required and sowing times are as;

Region	Nursery Sowing	Transplanting Time
Low Hills or terai	1. Mid November 2. Jan-Feb (Kharif onion)	1.December-January 2. July –August (for sets)
Mid Hills	Mid October –Mid November	December
High Hills	April	May -June

Planting

Seedlings become ready for transplanting in 8-10 weeks time. Seedlings must be about 15-20cm in length at the time of transplanting.The onion seedlings are planted at a spacing of 15-20 cm between rows and 5-10 cm between plant-to-plant.

Nutrient management

Apply well rottened Farm Yard Manure @200-300q, nitrogen @ 60-150kg, phosphorus@ 35-150 kg and Potassium@ 25-120kg per hectare depending on the soil test, cultivar and growing season. FYM is applied at the time of field preparation. Apply 50 per cent nitrogen and entire quantity of phosphorus and potash before transplanting or bulb sowing. Remaining half nitrogen is top dressed 5-6 weeks after transplanting.

Water management

Just after transplanting and subsequently irrigation is given as per need of the crop and critical stages. Irrigation should be stopped 15-20 days before uprooting the bulb or before commencement of maturity. Onion needs very careful and frequent irrigation as it is a shallow rooted crop. Water requirement of the crop at the initial growth period is less and increases during later growth stages. Irrigation is to be applied at an interval of 10-15 days in cool weather and at a week interval during hot weather. Bulb formation and bulb enlargement stages (70-100 days after transplanting) are the critical for water requirement. Insufficient moisture tends to slow down bulb growth while over supply causes rotting. A dry spell may cause splitting of the outer scales.

Weed management

Onion is a closely planted and a shallow rooted crop and hence hand weeding is difficult which may damage the crop. Therefore, use of chemical weedicides at initial growth stage followed by 1-2 hand weeding is beneficial. The critical period of crop-weed competition is between 4-8 weeks. Apply Trifluralin @ 0.75-1.0 kg/ha or Alachlor (Lasso) @ 2 litres/ha or Pendimetalin (Stomp) @ 3 litres/ha as pre-transplant application in 750 litres of water. Soil incorporation of nitrofen @ 1.2-2.0 Kg/ha as post plant application is recommended at 25-30 days after transplanting. Three weedings are sufficient to harvest, economic crop if performed at 30, 50 and 75 days after transplanting.

Harvesting

Onions are ready for dry bulbs harvesting when the tops get dried (or neck fall stage) and bulbs are mature. Harvesting at this stage results in higher yield, longer storage life of bulbs and less neck rot. The green onions can be harvested from the time they reach pencil size up until bulbing begins. To hasten the maturity process, the tops can be rolled down with a light weight roller when about 10 per cent of the tops have fallen naturally. It is desirable to leave 1.5-2.0 cm of the tops attached to the bulb as it helps to close neck and reduce storage loss.

Curing

Onion bulbs should be adequately cured because, curing or drying of bulbs is an important process to remove the excess moisture from the outer skin and neck of onion. This helps in reducing the infection of diseases and minimizes shrinkage due to removal of moisture from the interiors. This is, further, an additional measure for the development of skin colour. Bulbs are either cured in field or in open shades before storage. Onions are considered cured when neck is tight and the outer scales are dried until they rustle. Bulbs are cured in field for 3-5 days in wind row method. Then bulbs are placed in shade and cured for 7-10 days to remove field heat. This shade curing improves bulb colour and reduces losses during storage.

Grading

Onions are graded into big, medium and small size as per market demand. Thick necked, bolted, doubles, injured and decayed bulbs are picked out and rest are graded into different size.

Storage

At all temperatures, there is a gradual loss in weight of onion. The onion bulbs can be stored at temperatures of 23.9-29.4ºC or higher for 5-6 months without sprouting and without excessive loss in weight. A temperature of 0ºC and a relative humidity of 65-70 percent has been recommended for successful storage.

Physiological disorders

Bolting

It means emergence of seed stalk prior to time of bulb formation and adversely affects the formation and development of bulbs.

Possible Reasons

- Transplanting of aged seedlings
- Early sowing of seeds in the nursery beds, which result in the formation of small sets.
- Late transplanting of seedlings

- Restricted or poor vegetative growth also leads to bolting.
- Sharp fluctuations in temperatures at bulb initiation stage.
- Low temperature (10-12°C) for prolonged period.
- Poor supply of nitrogen in nursery and field.

Correction

- Time of planting should be adjusted in such a way that the crop may expose to moderate temperature at bulbing.
- Sowing of nursery at proper time
- Transplant healthy and 6-7 weeks old seedlings.
- Supply recommended dose of nitrogen.

Sprouting

An important disorder in storage of onion and garlic and results in huge losses. It is associated with excessive moisture at maturity and supply of nitrogen.

Correction

- Adjust time of planting in such a way that harvesting can be done in dry period.
- Stop irrigation as soon as bulbs reach maturity.
- Spray iron sulphate or borax @ 500-1000 ppm 2-3 weeks prior to harvesting.

Insect pest

1. Onion thrips: (Thrips tabaci)

Affected leaves show silvery white blotches which later become brownish. Spring summer crop is affected much by thrips. A long spell of dry weather is favourable for its rapid multiplication.

Control measures

- Collect the debris, affected leaves, weeds and destroy them.
- Follow crop rotation.
- Grow resistant varieties like Nasik Red and Spanish White.
- Apply malathion (0.05%) or phorate 10 G (1 kg /ha).

2. Borer: (Helicoverpa armigera)

Larvae attack leaves, flower and flower stalks.

Control measures

- Collect and destroy affected flower and flower stalk and apply deltamethrin (0.0025 %).

3. Onion maggots: (Hylemyia antiqua)

It attacks the tender portion of the bulb. They remain hiding in the base of the plants or in the cracks of the soil, where they also lay eggs. Affected plants become yellow to brown.

Control measures

- Soil application of phorate10G (25 kg/ha) and spray of malathion (0.05 %) can be done.
- Follow crop rotation.

4. Mites

These are very small pests and remain mostly on the under surface of the leaves. Affected plants become pale yellow. Crop infested with mites gives sickly appearance.

Control measures

- Expose infected bulbs to sun for about two days and dust the crop with malathion dust (20-25 kg/ha).

5. Bulb or stem nematode: (Ditylenchus dipsaci)

It is one of the important seed borne nematodes. Seedlings become pale white, twisted and stunted in growth. Leaves become thick and swell, resulting in splitting of the epidermis. Bulbs also carry nematodes. Tips of the leaves become necrotic. Cracks appear in the bulb.

Control measures

- Provide good drainage, obtain and use healthy seeds, follow long crop rotation and sow resistant varieties.

Diseases

Fungal Diseases

1. Downy mildew: (Peronospora destructor)

The first sign of the disease is the formation of elongated patches on leaves varying in size. These areas become covered with white to purplish fruiting bodies. Often, leaves fold over the affected area and the leaf tips wither away. Bulbs do not attain full growth and are often soft and immature. Cool temperature and presence of water is required for disease initiation.

Control measures

- Before sowing, treat the bulbs with mancozeb (0.25 %) followed by spray with the same fungicide at the same concentration.
- Regular sprays of metalaxyl + mancozeb (0.25%) checks this disease.

2. Onion smut: (Urocystis cepulae)

This disease is more prevalent in temperate regions. The fungus survives in the soil. Dark brown streaks are seen on the leaves and stem. The bending and twisting of earlier infected leaves also occur. The linear black lesions most commonly appear near the base of the bulb and grow up to the fourth scale deep.

Control measures:

- Seed treatment with thiram or captan (3g/kg seed) checks seed borne infection.
- Also treat the soil with formaldehyde (1:7) before sowing.

3. Purple blotch: (Alternaria porri)

It is very destructive under favourable conditions.The first spot usually appears on the oldest leaves. In the beginning they are small, elongated, sunken and whitish, generally with purple centre. These blotches later on enlarge, coalesce and are covered with the black fruiting bodies.

Control measures

- Seed treatments with captan or thiram (2.5g/kg seed), proper crop rotation,

adequate drainage in the fields and fungicidal application of mancozeb (0.25%) have been found very effective.

4. Black mould: (Aspergillus niger)

The infection starts from the top or any other injured portion.The affected tissue becomes water soaked and at first a white mould develops between thescales.This follows development of black spores on the stalk which can be seen with naked eyes and the mass remains on exterior of the scales and can easily be rubbed off.

Control measures

- Avoid bulb injury during various operations and sort out any bulb showing wound, green and thick neck, doubles etc.
- Allow only perfect bulbs for storage. Also clean the stores properly and check for sufficient ventilation, and temperature should be below 15^{o}C.

5. Stemphylium leaf spot: (Stemphylium vesicarium)

Purple coloured long spots appear on stems and leaves.

Control measures

- Spray of metalaxyl + mancozeb (0.25%) as soon as the symptoms appear.
- Repeat after 15-20 days if needed

Bacterial diseases

1. Soft rot: (Erwinia carotovora pv. carotovora)

The disease is characterized by water soaked soft rot on inner scales of bulbs. Sometimes bulb appears healthy from outside but if cut open, 1-2 scales are found infected.

Control measures

- The disease can be managed by applying streptocycline (200 ppm), and the use of resistant varieties.

Viral disease

1. Onion yellow dwarf virus

Short yellow streaks appear at the base of the first leaf emerging through the neck

of the bulb. The leaves fall over and present an abnormal appearance. Flower stalks of the infected plant show yellow streaks extending upwards from the base. Later the streaks coalesce. The stalk becomes yellow throughout, and get twisted and curled in a characteristic manner. The leaves turn yellow, become crinkled and drop underdeveloped, although they are usually well shaped.

Control measures

Indexing of virus free material, production of virus free stock of bulbs in areas where disease is absent and rouging out infected and volunteer onion plants will control the disease.

Garlic

Garlic is the second most widely cultivated bulbs crops after onion. It is frost hardy, bulbous perennial erect herbs of 30-100 cm in height with narrow flat leaves and bears small white flowers and bulbils.

Botanical name: *Allium sativum L*

Common name: Lasun

Family: Amaryllidaceae

Origin: Central Asia

Chromosome number: 2n=16

Uses

The green leaves, and immature and mature bulbs are eaten raw. It is used in preparation of sauces, soups and seasoning of food on accounts of its special characteristic pungency. Also used in processed form e.g. flakes, powder and pickles.

Nutritive value

Table: Nutritive value of garlic per 100 gm.

Principle	Amount	Principle	Amount
Calories	149 Kcal	Vit C	31.2 g
Carbohydrates	33.06 g	Sodium	153 mg

Protein	6.36 g	Potassium	401 mg
Fat	0.5 g	Calcium	181 mg
Fiber	2.1 g	Iron	1.70 mg
Vit A	9 IU	Magnesium	25 mg

(Source: USDA National Nutrient data base)

Trade

Garlic is grown in most of hills and terai belts of Nepal. It is grown under the area of 8116 ha with production of 56668 Mt (MOAD 2073/74)

Variety

Generally farmers used a local available variety based on their climate and topography. No any improved variety of garlic has been released yet.

Climate

It is a winter season crop requiring cool and moist atmosphere (12-18ºC) during growth and relatively dry weather (20-25ºC) during bulbing and 25-30°C at bulb maturity. It is a frost hardy plant. Low temperature and short days are congenial for proper bulb formation and hence the pre-requisites for higher yield. Adequate vegetative growth promotes bulb formation

Soil

Soil should be friable, fertile, well drained and have an abundant supply of humus. A heavy soil is not desirable that bakes and crusts after irrigation. Loam soils are best suited to it. The soil pH should be in the range of 6-7. It is sensitive to high acidity and alkalinity.

Sowing time

Low Hills or terai	October-November
Mid Hills	September-October
High Hills	April

Planting

Vegetatively propagated by cloves. Healthy cloves should be selected and 500-700 kg/ha of bulbs are required. Bulbs are separated into single segment i.e. cloves at planting time.

Planting methods

1. Dibbling

Cloves are dibbled 5-7.5 cm deep keeping their growing ends upwards.

2. Furrow planting

Cloves are dropped in the furrows by hand and covered lightly by loose soil.

Nutrient management

Apply well rottened Farm Yard Manure @200-300q, nitrogen @ 60-150kg, phosphorus@ 35-150 kg and Potassium@ 25-120kg per hectare depending on the soil test, cultivar and growing season. FYM is applied at the time of field preparation. Apply 50 per cent nitrogen and entire quantity of phosphorus and potash before transplanting or bulb sowing. Remaining half nitrogen is top dressed 5-6 weeks after transplanting.

Water management

In general, irrigation at an interval of 8-10 days during vegetative growth and 10-15 days during bulb formation and development. Critical stages are bulb formation and bulb enlargement.

Weed management

Garlic is a closely planted and a shallow rooted crop and hence hand weeding is difficult which may damage the crop. Therefore, use of chemical weedicides at initial growth stage followed by 1-2 hand weeding is beneficial. The critical period of crop-weed competition is between 4-8 weeks. Apply Trifluralin @ 0.75-1.0 kg/ha or Alachlor (Lasso) @ 2 litres/ha or Pendimetalin (Stomp) @ 3 litres/ha as pre-transplant application in 750 litres of water. Soil incorporation of nitrofen @ 1.2-2.0 Kg/ha as post plant application is recommended at 25-30 days after transplanting. Three weedings are sufficient to harvest economic crop if performed at 30, 50 and 75 days after transplanting.

Harvesting

Crop is ready for harvesting when the tops turn yellow or brownish and shows

signs of drying up and begins to fall over. Bulbs are taken out along with tops manually.

Curing

Bulbs are cured in field for one week. The bulbs are covered along with the tops of each other to avoid damage from the sun. Then, these bulbs are cured in shade for 7-8days either with tops or after cutting tops, leaving 2.5cm of the stalk. Roots are also trimmed leaving 1cm of root.

Storage

Thoroughly cured bulbs keep fairly well in ordinary ventilated room. Cold storage at 0-2.2^{o}C and 60-70% RH is congenial. The storage life is prolonged and loss in weight is reduced by spraying maleic hydrazide @ 2000-3000 ppm, 2-3 weeks before harvesting.

Insect pest

1. Onion thrips: (Thrips tabaci)

Affected leaves show silvery white blotches which later become brownish. Spring summer crop is affected much by thrips. A long spell of dry weather is favourable for its rapid multiplication.

Control measures

- Collect the debris, affected leaves, weeds and destroy them.
- Follow crop rotation.
- Grow resistant varieties like Nasik Red and Spanish White**.**
- Apply malathion (0.05%) or phorate 10 G (1 kg /ha).

1. Mites

These are very small pests and remain mostly on the under surface of the leaves. Affected plants become pale yellow. Crop infested with mites gives sickly appearance.

Control measures

- Expose infected bulbs to sun for about two days and dust the crop with malathion dust (20-25 kg/ha).

Diseases

2. Purple blotch : *(Alternaria porri)*

It is very destructive under favourable conditions. The first spot usually appears on the oldest leaves. In the beginning they are small, elongated, sunken and whitish, generally with purple centre. These blotches later on enlarge, coalesce and are covered with the black fruiting bodies.

Control measures

- Seed treatments with captan or thiram (2.5g/kg seed), proper crop rotation, adequate drainage in the fields and fungicidal application of mancozeb (0.25%) have been found very effective.

3. Downy mildew: *(Peronospora destructor)*

The first sign of the disease is the formation of elongated patches on leaves varying in size. These areas become covered with white to purplish fruiting bodies. Often, leaves fold over the affected area and the leaf tips wither away. Bulbs do not attain full growth and are often soft and immature. Cool temperature and presence of water is required for disease initiation.

Control measures

- Before sowing, treat the bulbs with mancozeb (0.25 %) followed by spray with the same fungicide at the same concentration.
- Regular sprays of metalaxyl + mancozeb (0.25%) checks this disease.

C. Learning process and support materials

Learning process includes the Visual methods, Demonstration method, Practical method, Observation method, Exhibition methods.

D. Assessment

Very Short (Answer question)

1. Write down the scientific name and family of onion.
2. List out the important bulb crops cultivated in Nepal.
3. Name any two important varieties of onion.

Short (Answer question)

1. Define bulb crops with examples.
2. Write down the requirement of curing for bulb crop.
3. Write any four varieties of onion.

Long (Answer question)

1. Write the cultivation practices of onion with respect to, botanical name, climate, method of propagation, manure & fertilizer and curing process.
2. Write the cultivation practices of garlic with respect to, botanical name, family,climate, , manure & fertilizer, weeding and irrigation.

UNIT – 9

Cultivation practices of Cucurbitaceous (Bitter gourd, Bottle gourd,Cucumber, Muskmelon, Watermelon, Pointed gourd, Pumpkin, Squash) 165

A. Objectives

After the completion of this course, the students will be able to:

- Explain about the origin, distribution, cultivars, climate and soil requirement etc. of cucurbits crops.
- Describe about the cultivation practices of different cucurbits crops in various aspects.

B. Content elaboration

Cucurbits form an important and a big group of vegetable crops cultivated extensively in our country. They are either used as salad (cucumber), or for cooking (all the gourds) or for pickling (cucumber, bitter gourds) or as desert fruits (melons). Most of the root crops which are commonly cultivated are:

Bitter Gourd

Bitter gourd is a most important summer season vegetable crops in Nepal. It grown almost all the midhills and terai belts of Nepal.

Botanical name: *Momordica charantia*

Common name: Karela

Family: Cucurbitaceae

Origin: Tropical Asia

Chromosome number: 2n=22

Uses

Bitter gourd is mainly used as cooked vegetables. It is also used for making pickles and has a medicinal value for blood pressure.

Nutritive value

Table: Nutritive value of bitter gourd per 100 gm

Principle	Amount
Water	58.25 g
Energy	12 Kcal
Protein	0.52 g
Total Fat (lipid)	0.11 g
Ash	0.44 g
Carbohydrate	2.68 g
Total dietary Fiber	1.2 g
Total Sugars	1.21 g

Trade

Bitter gourd is also a most popular summer season vegetable crops in the country. It is cultivated under 10082.2 ha with production of 132350.1 Mt and yields of 13.1 t/ha (MOAD 2072/73).

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Pusa Domausami	Open pollinated variety Fruits dark green, long and medium thick			
2	Hariyo karela	Open pollinated Early variety Fruit green, yellow after ripening, 20-25 cm long, smooth and ridges Harvesting: 90-100 DAT	2051	Terai and MH	20-25 Mt/ha
3	NS 433	Hybrid Plant height: 155-160 cm Harvesting: 40-50 DAT	2066	Terai and MH	40-50 Mt/ha

4	Ganga	Hybrid Plant height: 250-300 cm Harvesting: 40-45 DAT	2066	Terai and MH	24 Mt/ha
5	Palee	Hybrid Plant height: 700 cm Harvesting: 45 DAT	2067	Terai and MH	50 Mt/ha
6	Sambridhi	Hybrid Plant height: 250-300 cm Harvesting: 40-50 DAT	2066	Terai and MH	35.8 Mt/ha
7	Seti 444	Hybrid Plant height: 250-300 cm Harvesting: 40-50 DAT	2066	Terai and MH	27 Mt/ha
8	Komal	Hybrid Plant height: 250-300 cm Harvesting: 40-50 DAT	2066	Terai and MH	35.6 Mt/ha
9	NS 434	Hybrid Plant height: 155-160 cm Harvesting: 40-50 DAT	2066	Terai and MH	40-50 Mt/ha

Climate

It is a warm season crop and can withstand cold better than the other cucurbits, but it is quite susceptible to extreme frost. Bitter gourd thrives best in warm humid regions. Temperature 18°C causes poor germination of seeds, stunting of growth resulting in poor yield. Optimum temperature range for seed germination and growth and development is 25-30°C. Temperature above 36°C causes poor development of pistillate flowers leading to poor yield. Long days and high temperature increases the number of staminate flowers and reduces the number of pistillate flowers.

Soil

The crop can be raised in almost all types of soils but sandy loam and silt loam

soils are most preferred. Proper drainage of soil is quite essential. A pH range of 6.5-7 is ideal.

Planting

Bitter gourd is also cultivated both through direct seeded as well as transplanted in field after seedling preparation in polybags. It if sown during the summer season i.e., April-May in high hills and January- June in midhills and terai. It requires a seed rate of 4 kg/ha and planted at the spacing of 1.5m x 1-0.75m.

Nutrient management

Application of well rottened FYM @ 25 ton, nitrogen @ 100 kg, phosphorus@ 50 kg and Potassium@ 50 kg per hectare depending on the soil test, cultivar and growing season. Full dose of FYM, P_2O_5, K_2O and 1/2 N should be applied at the time of sowing and the remaining N should be applied in two split doses at the time of vining (25-30 DAS) and at full blooming (50-60 DAS). Bitter gourd is comparatively shallow rooted crops hence respond well to top dressing. High nitrogen under high temperature conditions promotes staminate flowers resulting in low fruit set and yield. So fertilizer dose should be adjusted according to the season of cultivation

Water management

It is shallow rooted crops and roots are mostly concentrated at the top 60 cm soil layer. First irrigation is given immediately after sowing. Critical stages of irrigation are flower bud development and early fruit development when irrigation is necessary. During summer, the crop should be irrigated at 3-4 days interval but in rainy season one irrigation per week is sufficient

Weed management

Weeds are quite competitive with crop especially in early stages. Frequent hoeing and weeding of young plants promote healthy growth and heavy fruiting.

Harvesting and storage

The marketable fruits are bright green in colour during immature stage and with the passage of time the green colour fades to a slight whitish yellow or whitish

green. First picking starts 65-70 days after sowing depending upon the variety, sowing time, soil type and management practices. Regular harvesting at shorter intervals increases the number of fruits in the vine and irregular harvesting may delay the successive fruit production. The harvested fruits cannot be kept for longer time in ambient conditions so needs to be sent to market as soon as possible.

Sprinkle water over the fruits to maintain the freshness for some time at initial stages. The fruits can be kept in poly propylene bags for extending the shelf life. The fruits can be stored in cold storage at 0.6-1.7°C and 85-90% relative humidity for four weeks.

Bottle gourd

Bottle gourd was independently domesticated in both old and new worlds. So the bottle gourd has been bihemispheric distribution and the fixed place of origin is not known.

Botanical name: *Lagernaria siceraria*

Common name: Lauka

Family: Cucurbitaceae

Origin: Southern Africa.

Chromosome number: 2n=22

Uses

Bottle gourd is mainly used for cooking purpose. Beside this they are used for the treatment of digestive disorder. It is a great food to consume during the summer season.

Nutritive value

Table: Nutritive value of bottle gourd per 100 gm

Principle	Amount
Water	110.83 g
Energy	16 Kcal

Energy	68 kJ
Protein	0.72 g
Total Fat (lipid)	0.02 g
Ash	0.5 g
Carbohydrate	3.93 g
Total dietary Fiber	0.6 g

Trade

Bottle gourd is the important summer season vegetable crops that grown under 8611.5 ha with production of 129798.1 Mt and yield of 15.1 t/ha.

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Pusa summer prolific long	Open pollinated 45-50 cm long fruit, pale green		Terai and MH	10-15 Mt/ha
2	Pusa summer prolific round	Open pollinated 30-40 cm long fruit, pale green White green and round at the end		Terai and MH	10-12 Mt/ha
3	Kaveri	Hybrid Plant height: 150-160 cm Harvesting: 45-50 DAT	2066	Terai and MH	44-56 Mt/ha
4	N. S. 421	Hybrid Plant height: 150-160 cm Harvesting: 45-50 DAT	2066	Terai and MH	40-50 Mt/ha

Climate

Bottle gourd is a summer and rainy season crop. It can withstand cold climate but not the frost. Optimum temperature range for growth and development is 24°-27°C. A soil temperature of 18-22°C promotes good growth and ensures better

yield. Short days, comparatively low night temperature and high relative humidity increase the intensity of pistillate flowers in the vine.

Soil

It can be grown in all type of soils. But best growth occurs in soil having pH range of 6-7. Soil moisture is important for rapid growth and it should be at least 10-15% above the permanent wilting point.

Planting

Seed are sown directly in the field or can be transplanted after preparation of seedling in polybags. Bottle gourd is general sown during the summer season i.e., April-May in high hills and January- June in midhills and terai. It requires a seed rate of 3-6 kg/ha and planted at the spacing of 2-3m x 1-1.5m.

Nutrient management

Application of well rottened FYM @ 25 ton, nitrogen @ 100 kg, phosphorus @50 kg and Potassium @ 50 kg per hectare depending on the soil test, cultivar and growing season. Full dose of FYM, P2O5, K2O and 1/2 N should be applied at the time of sowing and the remaining N should be applied in two split doses at the time of vining (25-30 DAS) and at full blooming (50-60 DAS). Bottle gourd is comparatively shallow rooted crops hence responds well to top dressing. High nitrogen under high temperature conditions promotes staminate flowers resulting in low fruit set and yield. So fertilizer dose should be adjusted according to the season of cultivation.

Water management

During summer season the crop should be irrigated at 3-4 days intervals but in rainy season one irrigation per week is sufficient, depending upon the occurrence of rain. The crop must be irrigated during the critical stages i.e., flowering and fruit setting. Over irrigation during vegetative and early flowering stages may cause excessive vine growth resulting in more staminate flowers in the vine.

Weed management

Weeds are quite competitive with crop especially in early stages. Frequent hoeing and weeding of young plants promote healthy growth and heavy fruiting. It should

continue till the vines interfere with the normal field operations. Pre emergence application of Linuron @ 0.5 kg/ha, alachlor @ 2.5 kg/ha or Diuron @ 1.25 kg/ha effectively check the weed population in the field.

Harvesting stage

- Proper stages of harvesting can be judged from.Fruit size.
- If the gentle press of finger penetrates the epidermis.
- Plugging the fruit which shows fine tender flesh and quite immature seed.
- Presence of hairs on the fruit.

Harvesting and storage

The fruits generally take 12-15 days after fruit set to reach the marketable stage when the fruits are tender. These are harvested with knife by cutting the peduncle. Under normal cool and shady conditions fruits can be kept for 3-5 days. In cold storage conditions the fruits can be stored for 2-3 weeks at a temperature of 8-10°C.

Cucumber

Cucumber is one of the most popular cash vegetable crops and is widely cultivated in the country. It is a trailing or climbing annual, bearing elongated, thick cylindrical fruits of varying sizes and forms.

Botanical name: *Cucumis sativus*

Common name: Kakro

Family: Cucurbitaceae

Origin: India

Chromosome number: 2n=14

Uses

Cucumbers have been grown for food and medicinal purposes since ancient times, and they have long been part of the Mediterranean diet. Depending on the type, cucumber can be sliced in a salad or eaten whole as a snack or to clean the palate after a meal. They can be consumed with or without the skin.

Nutritive value

Table: Nutritive value of cucumber per 100 g.

Principle	Amount	Principle	Amount
Energy (k cal)	15 Kcal	Riboflavin (mg)	0.033
Moisture (%)	95	Niacin (mg)	0.098
Protein (g)	0.65	Ascorbic acid (mg)	2.8
Fat (g)	0.11	Ca (mg)	16
CHO (g)	3.63	P (mg)	147
Vitamin A (IU)	105	Fe (mg)	0.28
Thiamins (mg)	0.027	Calcium (mg)	16

(Source: USDA National Nutrient data base)

Trade

Cucumber is an important summer season vegetable crops grown under 9396.8 ha with production of 159041.8 Mt and yields of 16.9 t/ha.

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Bhaktapur local	• Local • Fruits milky white color, cylindrical, 20-25 cm long • The most attractive fruits • Harvesting: 60-70 DAT	Released: 2051	Terai and MH	
2	Kusle	• Open pollinated • Fruit light green, 15-25 cm long, White in distal end	Released: 2051	All areas	

		• Early variety • Harvesting: 75-80 DAT			
3	Ninja 179	• Hybrid • Fruit: 15-25 cm long • Harvesting: 45 DAT	2067	Terai and MH	
4	Japanese long green	• Open pollinated • Extra early variety • Fruit size: 30-40 cm long and light green • Maturity at: 45 DAT		HH and MH	
5	Sita 888	• Hybrid • Plant height: 280 - 300 cm • Harvesting: 34 DAT	2066	Terai and Mid Hill	66 Mt/ha
	Sahini 1	• Hybrid • Plant height: 280-300 cm • Harvesting: 36 DAT	2066	Terai	68 Mt/ha
6	Sahini 2	• Hybrid • Plant height: 280 - 300 cm • Harvesting: 37 DAT	2066	Terai and Mid Hill	68 Mt/ha
7	Malika 999	• Hybrid • Plant height: 280 cm • Harvesting: 37 DAT	2067	Mid Hill	58 Mt/ha
8	Majesty	• Hybrid • Plant height: 300 cm • Harvesting: 42 DAT	2066	Terai and Mid Hill	50-70 Mt/ha
9	Garima	• Hybrid • Plant height: 300 cm • Harvesting: 45-48 DAT	2066	Terai and Mid Hill	55 Mt/ha

10	Sanjay	• Hybrid • Plant height: 270-300 cm • Harvesting: 35-37 DAT	2066	Mid Hill	61 Mt/ha

Climate

Cucumber is basically a warm season crop but is successfully grown in tropical, sub-tropical and temperate regions. Optimum temperature range for growth and development is 18-24°C. Seed germinate well at 25°C day temperature. Low temperature causes stunting of growth and poor germination of seeds. Long days and high temperature above 30°C increases the number of staminate flowers and reduce the number of female flowers in the vine.

Soil

A well-drained sandy loam soil rich in organic matter with good drainage having pH range of 6.5-7.5.is best preferred for cucumber production.

Planting

Sow the seeds during June or January to April at 2.5 kg/ha after treating with Trichoderma viride 4 g or Pseudomonas fluorescens 10 g or carbendazim 2g/kg on one side of channel giving a spacing of 0.6 m between hills. Thin the seedlings to two per hill.The seeds are sown on both sides of the beds of width 2.5 metre at a distance of 60 cm. Sow two seeds at one place to ensure good stand.

Nutrient management

Application of well rottened FYM @ 25 ton, nitrogen @ 40 kg, phosphorus@ 25 kg and Potassium@ 25kg per hectare depending on the soil test, cultivar and growing season. Apply half nitrogen along with full P and K and farm yard manure as basal dressing and the remaining nitrogen should be top dressed in two split doses i. e. 25-30 days after sowing and 50- 55 days after sowing.

Water management

Apply irrigation at the initiation of first true leaf during spring summer and at its

expansion during the rainy season. Irrigation at regular intervals of 4-5 days after is very important for spring summer crop. Irrigate the field subsequently at 5-6 days interval during summer season and as and when required during the rainy season. The crop must be irrigated during the critical stages i.e., flower bud development and early fruit development stages. Over irrigation during vegetative and early flowering stages may cause excessive vine growth resulting in more staminate flowers in the plant. Ridge and furrow method is the best method.

Weed management

Frequent hoeing and weeding of young vine promote healthy growth and quality fruits. When the vine starts spreading weeding may not be needed in between the rows or ridges, since the vine growth can smoother the weeds. The pre emergence application of fluchloralin (Basalin) @ 1.25 kg a.i/ha can check the weed population.

Harvesting and storage

The size of fruit should be the indicator of the proper maturity. It should be harvested at tender stage. If the harvesting is delayed dark green skin colour turns to brownish yellow. In small fruited types length of the fruit at edible maturity stage is around 8-12 cm. The cucumbers cannot stand much in transportation. They can be stored for two weeks at 10-11.7°C temperature with 92% relative humidity in the storage. It is better to consume the fruit fresh and immediately after removal from the storage.

Physiological disorder

1. Preponderance of staminate flowers:

The plants are monoecious in sex form hence staminate and pistillate flowers are borne separately in the same plant and the fruit yield depends upon the number of pistillate flowers. Preponderance of staminate flowers is caused due to

- Excessive nitrogen application
- High temperature conditions
- Long day length

- Over irrigation

Control measures

- Avoid excess use of fertilizers and irrigation.
- Apply nitrogenous fertilizer at proper dose.

Muskmelon

Botanical name: *Cucumis melo*

Common name: Kharbuja

Family: Cucurbitaceae

Origin: Northeastern Africa

Chromosome number:2n=24

Uses

Musk melons are consumed as fruit where as sometimes used as vegetable.

Nutritive value

Musk melon is a rich source of Vitamin A and Vitamin C. It contains about 90% of water and 9% Carbohydrates.

Variety

In musk melons no any variety has been released in Nepal.

Climate

Muskmelon grows well and develops, the best flavour and more sweetness under hot and dryclimate. It is predominantly a warm season crop, but can resist the mild frosts. High temperature,sunlight and dry winds at the ripening stage result in better quality fruits. High humidity andrains lower the sugar content and facilitate the incidence of downy mildew. It requires anoptimum temperature range of 70°-80°F with minimum of 65°F and maximum of 90°F. The croptakes about 85-100 days from date of sowing to maturity.

Soil

It grows well in deep, fertile and well-drained soil. It gives best results when grown on well drained loam soil. Soil having a poor drainage capacity is not

suited for Muskmelon cultivation. Follow crop rotation as continuous growing of the same crop on same field leads loss of nutrients, poor yield and more disease attack. pH of soil should be in between 6-7. Alkaline soil with high salt concentration is not suitable for cultivation.

Planting

Sow seeds in polythene bag of 15cm x 12cm size with thickness of 100 gauge in last week of January or first week of February. Fill polythene bag with equal proportion of well rotten cow dung and soil. Seedlings are ready for transplantation by end of February or first week of March. Transplantation is done for 25-30 days old seedling. Apply irrigation immediately after transplantation.

Nutrient management

Apply Farm Yard Manure or well decomposed cowdung@10-15tonnes per acre. Apply Nitrogen@50kg, Phosphorus@25kg and Potash@25kg in form of Urea@110kg, Single Super Phosphate@155kg and Muriate of Potash@40kg per acre. Apply whole amount of Phosphorus, Potash and one third amount of Nitrogen before sowing seed. Apply remaining dose of Nitrogen near vines base, avoid touching it and mixed well in soil during initial growth period. When crop is of 10-15 days old, for good growth of crop along with good quality, take spray of 19:19:19+Micro-nutrients@ 2-3gm/Ltr of water. Prevent flower drop and increase yield up to 10% take spray of Humic acid@3ml + MAP(12:61:00)@5gm/Ltr of water at flowering stage. Spray Salicylic Acid(4-5 tabs of Aspirin Tablet 350mg)/15Ltr water at initial flowering, fruiting and maturity stage, One or two times with 30days interval. After 55days of sowing spray 13:0:45@100gm + Hexaconazole @25ml/15Ltr water for fast development of fruits and protection against powdery mildew. 65days after sowing to increase in fruit size, sweetness and colour take spray with 0:0:50 @1.5kg/acre using 100gm/15Ltr of water.

Water management

Apply irrigation, every week in summer season. At time of maturity give irrigation only when needed. Avoid over flooding in muskmelon field. During

application of irrigation, do not wet the vines or vegetative parts, especially during flowering and fruit-set. Avoid frequent irrigation in heavy soil as it will promote excessive vegetative growth. For better sweetness and flavor, stop irrigation or reduce watering 3-6days before harvesting.

Weed management

Keep bed weed free during early stage of growth. In absence of proper control measures, weed can cause yield loss of 30%. 15-20days after sowing carry out intercultural operations. Depending upon severity and intensity of weeds, two to three weeding are required.

Harvesting and post harvest management

Harvesting should be done when fruits turn to yellow. Harvest other variety depending upon market distance. For long distance markets, harvest fruits at mature green stage where as for local markets harvest at half-slip stage. A slight depression of the stem end indicates half-slip stage.

Post-harvest management

After harvesting do precooling to reduce field heat. Grading is done on basis of size of fruit. Muskmelons harvested at partial slip can be held for up to 15 days at 2° to 5°C at 95% relative humidity whereas Muskmelons harvested at full slip can be held for 5 to 14 days at 0° to 2.2°C at 95% relative humidity.

Watermelon

Botanical name: *Citrullus lanatus*

Common name: Tarbuja

Family: Cucurbitaceae

Origin: South Africa

Chromosome number:2n=24

Uses

It is a common man's fruit, delicious, nourishing and exerts a cooling effect in hot summer months.

Nutritive value

It is a rich source of lycopene and beta carotene, the powerful antioxidants.

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Laxmi 747	• Hybrid • Plant height: 400-500 cm • Harvesting: 70-75 DAT	2066	Terai	20.5 Mt/ha
2	Laxmi 767	• Hybrid • Plant height: 400-500 cm • Harvesting: 75-80 DAT	2066	Terai	20.5 Mt/ha
3	Asahi Yamato	• Hybrid Japanese variety • Mid season variety • Produce medium size fruit • Harvesting: 95 DAT			
4	Sugar baby	• Hybrid American variety • Fruit round shape, deep pink • Harvesting: 85 DAT			

Climate

Watermelon requires a relatively hot, dry climate and a long growing season preferably with warmer days and cooler nights. It cannot withstand frost or very low temperatures. For seedgermination optimum moisture and soil temperature between 25-30°C is needed. The plantgrowth is optimum under 28-30°C while the fruiting is better at 24-27°C. Higher temperatures are beneficial during ripening.

Soil

Watermelon grows well in deep fertile and well-drained soil. It gives best results when grown on sandy or sandy loam soil. Soil having a poor drainage capacity is

not suited for watermelon cultivation. Follow crop rotation as continuous growing of the same crop on same field leads loss of nutrients, poor yield and more disease attack. pH of soil should be in between 6-7.

Planting

Seeds are sown in polythene bag of 15cm x 12cm size with thickness of 100 gauge in last week of January or first week of February. Fill polythene bag with equal proportion of well rotten cow dung and soil. Seedlings are ready for transplantation by end of February or first week of March. Transplantation is done for 25-30 days old seedling. Apply irrigation immediately after transplantation.

Nutrient management

Apply Farm Yard Manure or well decomposed cowdung@8-10tonnes per acre. Apply Nitrogen@25kg, Phosphorus@16kg and Potash@15kg in form of Urea@55kg, Single Super Phosphate@100kg and Muriate of Potash@25kg per acre. Apply whole amount of Phosphorus, Potash and one third amount of Nitrogen before sowing seed. Apply remaining dose of Nitrogen near vines base, avoid touching it and mixed well in soil during initial growth period.

When crop is of 10-15 days old, for good growth of crop along with good quality, take spray of 19:19:19+Micro-nutrients@ 2-3gm/Ltr of water. Prevent flower drop and increase yield up to 10% take spray of Humic acid@3ml + MAP(12:61:00)@5gm/Ltr. of water at flowering stage. Spray Salicylic Acid(4-5 tabs of Aspirin Tablet 350mg)/15Ltr water at initial flowering, fruiting and maturity stage, One or two times with 30days interval. After 55days of sowing spray 13:00:45@100gm + Hexaconazole @250ml/150Ltr water for fast development of fruits and protection against powdery mildew. 65days after sowing to increase in fruit size, sweetness and colour take spray with 00:00:50 @1.5kg/acre using 100gm/15 Ltr. of water.

Water management

Apply irrigation, every week in summer season. At the time of maturity give irrigation only when needed. Avoid over flooding in watermelon field. At the time of applying irrigation, should not wet the vines or vegetative parts, especially

during flowering and fruit-set. Avoid frequent irrigation in heavy soil as it will promote excessive vegetative growth. For better sweetness and flavour, stop irrigation or reduce watering 3-6 days before harvesting.

Weed management

Keep bed weed free during early stage of growth. In absence of proper control measures, weed can cause yield loss of 30%. 15-20days after sowing carry out intercultural operations. Depending upon severity and intensity of weeds, two to three weeding is required.

Harvesting, Processing and marketing

If tendril near stem gets dried also whitish color of fruit which touch to ground get yellowish then assume that fruit is ready for harvesting. On thumping melon if it sounds hollow (usually as a dull thump or thud) then it is ready for harvest and immature fruit sounds dense. Dont pick immature fruits as they ripe only when attached to vine. Immature fruit don't have rich sugar content or color. To harvest ripe fruit, cut stem 1" from fruit with a pair of sharp pruners or knife. Fruit can be stored in a cool, humid environment.

Post-harvest management

Grading is done on the basis of size of fruit. It can be store for 14 days at temperature of 15°C. Do not store watermelon with apples and banana as it developed off flavor along with the softening of fruit.

Pointed Gourd

Pointed gourd is a popular tropical vegetable grown throughout the country. This vegetable is native to Indian subcontinent. This vegetable is also known as parwal.
Botanical name :

Common name: *Trichosanthes dioica*

Family: Cucurbitaceae

Origin: India

Chromosome number: 2n=22

Uses

These vegetables can be cooked alone or with combinations of other vegetables or meat.

Nutritive value

Table: Nutritive value of pointed gourd per 100 gm

Principle	Amount
Water	92 g
Energy	20 Kcal
Protein	0.7 g
Total Fat (lipid)	0.2 g
Minerals	0.5 g
Carbohydrate	2.2 g
Total dietary Fiber	3 g
Carotene	153 mg

Trade

This is most important cucurbitaceae crop cultivated in Nepal. The area under its cultivation is 1955.5 ha with production of 22443.5 Mt and yields of 11.5 t/ha.

Variety

There is no any recommended variety of pointed gourd in Nepal. However some cultivars that are grown are

- Long white strips
- Green long
- Green round: very small size and not much production
- Green round white strips: not so productive

Climate

This is perennial plant grows best in warm to hot humid climates and does not tolerate frost and extreme cold conditions. Dry tropical weather after monsoon is preferred. The pointed gourd plants require temperature is 30° C to 35° C for optimum growth and yield.

Soil

Well drained sandy loam to clay soil is suitable for cultivation of pointed gourd. The optimum soil pH range of 6 to 6.5 is best for its cultivation. This crop does not grow well in heavy soils but in alluvial light soils.

Propagation

The pointed gourd is usually propagated through either vine cutting or root suckers. Seed propagation is not feasible as the germination is very poor in this process. Apart from this inability of finding gender (male or female) of the flower caused the low yield.

Field preparation

These vegetables are perennial in nature and remained 3-4 years continuously in one place for regular bearing. So, to obtain a good yield, it is necessary that soil should be sandy or sandy loam with full of organic matter. Soil pH should be in between 6.0 to 7.5. Soil of poor fertility status, may also be used for cultivation if nutrients are supplied in adequate quantity. Field preparation starts in the month of May-June by 2-3 deep ploughings. After ploughing, field should be left open so that weeds, insects are destroyed due to heat. In the month of July, 2-3 ploughings should be done by harrow or cultivator followed by planking. At the time of last ploughing, 20-25 tonnes well decomposed FYM or compost must be added in the field.

Trench and pits preparation

After field preparation in the month of June-July, trenches are opened at the distance of 2 m for pointed gourd. Trenches should be 30 cm in depth and 40-50 cm in width. This way, pits are opened having size of 30 × 30 × 30 cm or 45 × 45 × 45 cm and 50 × 50 × 50 cm for pointed gourd that depends upon variety. Pointed gourd is generally planted at the distance of 1.5-2 x1.5-2 m that helps on the training methods of vines

Male female ratio

Pointed gourd is a dioecious plants plant so the only one sex is determined in a single plants. If all plants are in field to be found as males, then total yields would

be zero. Hence, maintaining the male female ratio is very important in its cultivation. To get maximum yields in the pointed gourd cultivation a female: male ratio of 9:1 should be maintained.

Nutrient management

Apply well rotten farm yard manure of 20-25 ton/ha at the time of land preparation and fertilizer @ 60-80:40:40-60 kg N:P:K/ha should be applied. Nitrogen should be applied in split doses.

Water management

First irrigation should be given immediately after planting. Subsequent irrigation should be carried at 3 to 4 days interval. Again watering the crop depends on the soil type and moisture condition of soil. To get good quality of vegetables, irrigate the crop at the alternate days interval at the time of flowering and fruiting. Irrigation is not required in rainy season. In case of heavy rains of flooding makes sure to avoid water logging by providing proper drainage in the field

Weed management

Weed control and hoeing should be carried during the initial stage of crop growth. Weeds can be removed either manually or mechanically. To conserve moisture and facilate aeration around the root area, hoeing should be done. In flat bed cultivation of pointed gourds, due to trailing habit and long crop duration, weeding operation will be difficult during rainy season and summer. On post shoot emergence, spray herbicides like Gramaxone (1 % a.i) per hectare along with mulching to control the weeds and to ensure higher yields.

Training

In pointed gourds training for effective pollination and plant growth that leads to early flowering and higher yields, vines should be trained on trellis system. The trellis is generally 2 meter in height. Usually vines are trained on the vertical trellis by tying with wires. Aerial supports include bowers (horizontal netted wire support which is 2.5m above the ground level). In the bower type, structure made with wood or concrete pillars should be erected first in the field.

Harvesting and marketing

Generally pointed gourds vines start fruiting in about 120 to 140 after transplanting typically in Febaury month and continues till September. These vegetables can be harvested about 15-18 days after pollination before reaching full maturity. Weekly harvesting is preferred in this crop. Generally yields depends on the crop management, variety cultivated and plant population. In the pointed gourd cultivation an average yield of 15to20 ton/ha can be achieved. Local market is the place where these vegetables can be transported.

Pumpkin

Pumpkin is a vining cultivar and produces large plants with one or more long vines that spread about six metres on the ground; both the root and side vine develop from the nodes.Pumpkin is a popular vegetable during summer and rainy season. It is also served at feasts and ceremonies. Pumpkin can be stored for a long time on the roofs of houses.

Botanical name: *Cucurbita moschata*

Common name: Farsi

Family: Cucurbitaeace

Origin: America

Chromosome number:2n=2x=40

Uses

Pumpkin is grown for tender shoots and both tender and matured fruits.The delicate leaves and shoots are cooked and eaten as leafy greens.

Nutritive value

The immature fruits are rich in Vitamin B and C and mature fruit contains Vitamin A in the form of carotene.

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Jante Farsi	• Local variety • White patches appear in the lamella between vines • Slightly round in shape			
2	Madale Farsi	• Local variety • White patches appear in the lamella between vines. • Slightly spherical in shape			
3	Sonar 022	• Hybrid variety • Stem length: 400-600 cm	2066	Terai and MH	55 Mt/ha

Climate

Pumpkin requires a long and warm growing season. It can be grown in relatively cooler climate unlike other cucurbits. Short-days, long-night temperature and high relative humidity is best for pumpkin production. The plants can be grown successfully at temperatures between 25° and 30°C. Above 40°C and below 15°C the growth of the plant will be very slow and the yield is low. It does not tolerate frost.

Soil

Pumpkin prefer deep well-drained loamy soil with ample organic matter content. They grow well in nearly neutral soil with pH range 5.5 to 7.0. They do not perform well in acidic soil it. If pH is below 5.5, agricultural lime 200 to 300 kg/ha should be applied based on soil test report.

Planting

Pumpkin is sown directly from February to June in all geographical locations. They are sown in beds maintaining 2x2 metres at the two edges of the beds, and vines trail inside from both sides of the bed.

Nutrient management

Pumpkin requires a balanced dose of NPK fertilizer and some amount of micronutrients.At the time of soil preparation, a total of 25–35 tonnes of FYM, 40 kg of N, 80 kg of P2O5 and 40 kg of K2O/ha have to be applied as basal dose. The remaining 40 kg of N is applied as top dressing after 40–45 days of sowing. The application method is similar to that of other cucurbits.

Deficiency of micronutrients, especially calcium, is prominent in pumpkin. Micronutrient formulations available under different commercial names can be applied as basic doses and foliar sprays. While using such formulations, instructions on the container label should be read carefully and precaution must be taken. In general application of multiplex or agromin 3 ml/litre of water promotes uniform fruiting and harvest. During fruit setting, applying miraculan or hitculan @ 1 ml/litre of water twice at 15 days' interval gives the best results. If soil pH is below 5.5, application of 100–200 kg of agricultural lime/ha improves fruiting and soil pH.

Besides, application of Jholmal at weekly intervals until a month before harvest helps replace the use of chemical fertilizers and controls diseases and insect pests.

Water management

Pumpkin is a deep-rooted crop. The critical periods of moisture requirement are immediately after transplanting or sowing. After transplanting, plant should be regularly watered for up to 4 days till the plant is established. The critical periods for irrigation are after top dressing, after weeding, during flowering and during fruit initiation if there is no rain and the field is dry. Water requirement varies according to soil type and season. Sandy soil needs more irrigation whereas loam soil needs less irrigation. During dry summers,furrow irrigation at 3–4 day intervals is necessary. As pumpkin are planted in beds, furrow irrigation is more beneficial. In water scarce areas, drip irrigation with mulch is better than other irrigation systems. Wastewater and runoff collection ponds shoud be constructed near the cultivation area and collected water should be applied by drip. Rainy season crop does not need irrigation but drainage is necessary

Weed management

Field should be kept weed free during the early stage of the crop. Weeding should be done after 10–15 days of transplanting/sowing. Soil around the base of the plant should be kept loose and friable. Weeds compete with the crop for nutrient and moisture. Second weeding and top dressing of urea should be done after 25–30 days of transplanting with a shallow earthing-up operation. Another hand weeding after 45 days of transplanting is recommended.

Mulching

Generally pumpkin are not provided any staking. When stakes are not used, organic mulches like straw and dry grasses are placed below the vines and fruits to prevent soil fungus from attacking the fruits and to reduce the soil temperature during hot summers. Black or white polythene mulching and transplanting is emerging as a weed control and moisture retention technology; it reduces weeding cost and prevents soil structure deterioration.

Harvesting, Processing and marketing

The maturity standards for pumpkin depend on the purpose for which the fruit will be harvested and market demand. If it is to be consumed as a vegetable, it is better to harvest it at a tender stage, as this will increase the total yield. If Nepali pumpkins are being harvested for storage and for seed extraction or export, they should be harvested at the fully matured stage once their colour changes from green to brown. The fully matured fruits of pumpkin can be stored for a long time, from autumn through winter till summer.Pumpkin are picked by manually breaking the peduncle, which leaves a part of the peduncle attached to the fruit. To harvest them without damaging the plant, it is better to cut the peduncle with secateurs; this also facilitates handling. Pulling the fruit away from the plant may cause the vine to break. Harvesting should be done when there is no dew on the crop. Generally afternoon harvest is recommended. Regular harvesting will increase the fruit yield.The yield of pumpkin varies according to the variety and season. Pumpkin yields 15–25 tonnes/ha depending on harvesting stage and techniques.

Post-harvest management

Cleaning and grading

Pumkin should be harvested and handled with care to avoid damaging the fruit. After harvest, remove all fruits that are insect-affected, cracked, crooked, diseased and deformed. Foreign materials stuck to the fruits such as soil particles, leaves, etc. must be washed off and the fruit should be dried in an airy and shady place. Fruits should be graded based on their size and shape.

Packaging and transportation

Fruits are carefully packed in bamboo baskets, wooden boxes or plastic crates with proper padding to prevent injuries in transit. In Nepal they are usually packed in gunny bags; however it is not an ideal option. Sometimes they are packed in gunny bags and transported in mini trucks, delivery vans, trucks and on the roofs of public buses. Often the bags open during the journey and the fruits spill out and get damaged by the time they reach the market.

Storage and marketing

Matured pumpkins are stored in an open, airy place at normal temperature for up to six months and sold when the market price is high.

Squash

Summer squash is an annual bush or vine. They generally produce stems with shortened internodes and set fruits in close succession. The fruits are harvested for consumption before the seed and skin harden. Bush squash cannot be eaten as a vegetable when it is matured.

Botanical name: *Cucurbita Peppo*

Common name: Jukini farsi

Family: Cucurbitaeace

Origin: America

Chromosome number:2n=2x=40

Uses

Summer squash is grown for tender fruits only**.**

Nutritive value

The edible 100 g of fresh fruit contains Vitamin A beta-carotene 13 mg and Vitamin C 18 mg. Among minerals it contains phosphorus 24 mg, calcium 25 mg, iron 0.9 mg and traces of magnesium and potassium.

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Asare squash	• Open pollinated • Fruit cylindrical, smooth • Non-branched stem • Harvesting: 50-60 DAT	2051	Terai and MH	
2	Zucchini (Grey and black)	• Hybrid variety • Plant height: 25-30 cm • Harvesting: 50-55 DAT	2066	Terai and MH	110 Mt/ha
3	Long green	• Hybrid variety • Harvesting: 53-58 DAT	2066	Terai and MH	25 Mt/ha
4	Davinch	• Hybrid • Plant height: 40-50 cm • Harvesting: 60-75 DAT	2066	Terai and MH	105 Mt/ha
5	Honey desert	• Hybrid • Harvesting: 90-95 DAT	2066	Terai and MH	18 Mt/ha
6	Anna 101	• Hybrid • Plant height: 36-50 cm • Harvesting: 50-60 DAT	2066	Terai and MH	40-50 Mt/ha

Climate

Squash is a warm season crop. It is mainly cultivated during spring and summer. It cannot tolerate frost. The optimum temperature for growth and fruiting is 20° to 30°C. Seed germination is poor at temperatures below 20°C. Temperatures below 10°C retard crop growth.

Soil

Squash prefers deep well-drained loamy soil with ample organic matter content. They grow well in nearly neutral soil with pH range 5.5 to 7.0. They do not perform well in acidic soil it. If pH is below 5.5, agricultural lime 200 to 300 kg/ha should be applied based on soil test report.

Planting

For early crops, in the Terai and low hill basins, squash seedlings prepared under low plastic tunnels are transplanted when outside minimum temperature reaches above 9°C and frost is gone. Similarly in the mid hills seedlings are transplanted during late winter for spring and summer harvest. For rainy season crop, seed is sown directly with the pre-monsoon shower. The transplanting/sowing and fruit picking times for squash are presented in the box below :

Location, Geographical	Transplanting and picking month
Terai - production in plastic houses under protected conditions	November-December (December-March)
Terai to low hill basins up to 600 metres (river beds)	December-January (March-June)
Mid hills 600–1,500 metres (spring to summer crop)	December-January (March-June)

Note: Months inside the parentheses are fruit picking months

Nutrient management

Squash requires a balanced dose of NPK fertilizer and some amount of micronutrients.At the time of soil preparation, a total of 25–35 tonnes of FYM, 40 kg of N, 80 kg of P_2O_5 and 40 kg of K_2O/hac. have to be applied as basal dose.

The remaining 40 kg of N is applied as top dressing after 40–45 days of sowing. The application method is similar to that of other cucurbits.

Deficiency of micronutrients, especially calcium, is prominent in pumpkin. Micronutrient formulations available under different commercial names can be applied as basic doses and foliar sprays. While using such formulations, instructions on the container label should be read carefully and precaution must be taken. In general application of multiplex or agromin 3 ml/litre of water promotes uniform fruiting and harvest. During fruit setting, applying miraculan or hitculan @ 1 ml/litre of water twice at 15 days' interval gives the best results. If soil pH is below 5.5, application of 100–200 kg of agricultural lime/ha improves fruiting and soil pH.

Besides, application of Jholmal at weekly intervals until a month before harvest helps replace the use of chemical fertilizers and controls diseases and insect pests.

Water management

Squash is a medium-rooted crop. The critical periods of moisture requirement are immediately after transplanting or sowing. After transplanting, plant should be regularly watered for up to 4 days till the plant is established. The critical periods for irrigation are after top dressing, after weeding, during flowering and during fruit initiation if there is no rain and the field is dry. Water requirement varies according to soil type and season. Sandy soil needs more irrigation whereas loam soil needs less irrigation. During dry summers,furrow irrigation at 3–4 day intervals is necessary. As squash are planted in beds, furrow irrigation is more beneficial. In water scarce areas, drip irrigation with mulch is better than other irrigation systems. Wastewater and runoff collection ponds shoud be constructed near the cultivation area and collected water should be applied by drip. Rainy season crop does not need irrigation but drainage is necessary

Weed management

Field should be kept weed free during the early stage of the crop. Weeding should be done after 10–15 days of transplanting/sowing. Soil around the base of the plant should be kept loose and friable. Weeds compete with the crop for nutrient

and moisture. Second weeding and top dressing of urea should be done after 25–30 days of transplanting with a shallow earthing-up operation. Another hand weeding after 45 days of transplanting is recommended.

Mulching

Generally squash are not provided any staking. When stakes are not used, organic mulches like straw and dry grasses are placed below the vines and fruits to prevent soil fungus from attacking the fruits and to reduce the soil temperature during hot summers. Black or white polythene mulching and transplanting is emerging as a weed control and moisture retention technology; it reduces weeding cost and prevents soil structure deterioration.

Harvesting, Processing and marketing

Squash is one of the earliest crops to arrive in the market in spring and summer. Squash fruits become ready for harvest in about 7 days after fruit set. The picking should be done at 2–3 day intervals in order to maximize fruit yield. If earlier fruits are allowed to become larger in size, the new fruits will not set but will drop. Squash are picked by manually breaking the peduncle, which leaves a part of the peduncle attached to the fruit. To harvest them without damaging the plant, it is better to cut the peduncle with secateurs; this also facilitates handling. Pulling the fruit away from the plant may cause the vine to break. Harvesting should be done when there is no dew on the crop. Generally afternoon harvest is recommended. Regular harvesting will increase the fruit yield. Squash yields 20–30 tonnes/ha depending on harvesting stage and techniques.

Post-harvest management

Cleaning and grading

Squash should be harvested and handled with care to avoid damaging the fruit. After harvest, remove all fruits that are insect-affected, cracked, crooked, diseased and deformed. Foreign materials stuck to the fruits such as soil particles, leaves, etc. must be washed off and the fruit should be dried in an airy and shady place. Fruits should be graded based on their size and shape.

Packaging and transportation

Fruits are carefully packed in bamboo baskets, wooden boxes or plastic crates with proper padding to prevent injuries in transit. In Nepal they are usually packed in gunny bags; however it is not an ideal option. Sometimes they are packed in gunny bags and transported in mini trucks, delivery vans, trucks and on the roofs of public buses. Often the bags open during the journey and the fruits spill out and get damaged by the time they reach the market.

Storage and marketing

Squash fruits at the marketable stage can be stored for 3–4 days in a cool place at the optimum temperature of 10°–12°C and relative humidity of 75–85%.

Insect pest of Cucurbits

1. Fruit fly (Bacterocera cucurbitae)

This is a major pest of majority of cucurbits especially that of bitter gourd, snake gourd, pointed gourd, muskmelon, oriental pickling melon, watermelon, tinda and pumpkin. Adult fly has reddish brown body with transparent and shiny wings, bearing yellow-brown streaks. It lays eggs singly or in clusters of 4-12 in flower or developing fruits or ripening fruits with the help of sharp ovipositor of females. Eggs hatch in 2-9 days and maggots feed on internal contents of fruits causing rotting. Pupation is in ground at a depth of 1.5-15.0 cm. Infestation is more during rainy season.

Control measures

- Collect and destroy affected fruits by dipping in hot water or insecticide solution. Do not leave infested fruits on gourd.
- Use light trap and poison baits during night. Spray a bait solution containing 200 g gur or sugar and 20 ml Malathion 50 EC in 20 1 of water as coarse droplets on lower surface of leaves.
- Spraying on under surface of leaves of maize plants grown in rows at a distance of 8-10 m in cucurbit field is also effective as flies rest on such tall plants.

- Hang baits containing sex attractants like pheromones or protein hydrolysate with Furadan granules. Hanging coconut shells with pieces of fully ripened fruits of "Mysore poovan" banana or toddy or molasses along with Furadan granules also attract and kill fruit flies.

2. Red Pumpkin Beetle (Aulacophora foveicollis)

Beetle attacks most of cucurbits especially melons, bottle gourd, pumpkin, cucumber, water melon etc. Bitter gourd is not seen attacked by beetle. Beetles eat the leaf lamina causing defoliation particularly at cotyledon stage of crop. Grubs feed on underground stem and root portion of plants causing holes / galleries and result in drying up of plants.

Control measures

- As insects pupate in the soil, deep ploughing soon after the crop exposes and kills grubs and pupae.
- Application of Furadan 3 G granules 3-4 cm deep in soil near base of just germinated seedlings will take care of young seedlings from attack of beetle.

3. Epilachna beetle (Epilachna seplima)

Epilachna beetle is a serious pest of bitter gourd and snake gourd. Adult flies feed on foliage causing holes and defoliation. A large number of yellow coloured thorny grubs are seen on under surface of leaves and feed on chlorophyll resulting in skeletonisation of leaves.

Control measures

- Mechanical control by way of collection and destruction of egg masses and grubs are very effective as they are seen as a colony.
- It can also be controlled by spraying Carbaryl (0.2%) or Metacystox (0.15%).

4. Aphids (Aphis gossypii)

Aphids suck sap from leaves of cucurbits like ash gourd, snake gourd, mush melon, water melon, cucumber etc. causing crinkling of leaves. It also transmits mosaic virus.

Control measures

- Spraying Malathion (0.1%) or tobacco decoction

5. Leaf hopper (Amrasca biguttula biguttula)

During summer months, jassids cause heavy loss to bitter gourd crop. Green coloured hopper and its nymphs are seen in large numbers on under surface of leaves and suck sap causing typical hopper burn symptoms.

Control measures:

- Initially neem oil garlic mixture at fortnightly interval is effective for control of hopper.
- Spraying of Acetaf, Imidachloprid etc. control hoppers effectively.

6. Red spider mites (Tetranychus sp.)

Larvae, nymphs and adults of mites lacerate leaves from under surface and suck sap resulting in production of white patches between veins in Cucurmis melo. Infested leaves turn yellow and fall of prematurely. In severe cases, intense webbing occurs giving a dusty appearance to under surface of leaves.

Control measures:

- Mites can be controlled by spray of neem oil garlic mixture or Kelthane or Dicofol on under surface of the leaves.

7. Leaf miner (Lyriomyza trifolii)

This polyphagous pest causes characteristic white twisting lines in ash gourd, Cucurmis sativus and Cucurmis melo. Severe leaf mining accelerates leaf drop and retards growth and yield of plants. Mated females puncture leaves and lays eggs in leaf tissues. After hatching, larvae start feeding in palisade mesophyll cells of leaves while moving inside. Mines start from margins of leaves and progress towards centre. Yellow larvae can be seen at the end of mines. Larval duration is 4-6 days. When larva is ready to pupate, it cuts a semicircular slit on leaf surface and fall down on ground. Larvae emerge from leaves during early morning before 8.00 a.m.

Control measures:

- For control of miner, trap adults to yellow cards applied with adhesives.
- Burning infesteddried leaves will help in reduction of population.
- Spraying neem oil garlic mixture early in morning before sunrise will be an effective control.

Diseases of cucurbits

1. Fusarium wilt (Fusarium oxysporum)

Fusarium wilt is a serious disease water melon, musk melon, bottle gourd etc. In young seedlings, cotyledons drop and wither. Older plants wilt suddenly and vascular bundles at the collar region show brown discolouration.

Control measures

- Cultivation of resistant varieties and crop rotation with resistant crops are viable methods for overcoming the disease.
- To some extent, the disease can be checked by hot water treatment of seeds at 55^{o} C for 15 minutes and by drenching soil with carbendazim.

2. Collar rot (Rhizoctonia solanii) / Pythium rot (Pythium sp.)

Characteristic symptom of the disease is appearance of dark brown water-soaked lesions girdling the base of stem at soil level followed by death of plants. It is more serious under water logged conditions and during rainy seasons.

Control measures:

- Treating seeds with Thiram @ 3 g/kg of seed before sowing, sowing of seeds on raised beds, drenching vines with Redomyl (0.2%) or Carbendazim (0.1%) are recommended for control of the disease.

3. Powdery mildew (Sphaerotheca fuliginea)

This disease is more destructive in pumpkin, squashes, bottle gourd, melon and cucumber, that too, during rain free periods. Symptoms appear as white to dirty grey spots or patches on leaves which become white powdery as they enlarge. Powdery coating covers entire plant parts and causes defoliation.

Control measures

- Fortnightly spray of Karathane (0.5%) or Calixin (0.05%) or Carbendazim

(0.1%) are recommended for control of powdery mildew.

4. Downy mildew (Pseudoperonospora cubensis)

Disease is prevalent in areas of high humidity, especially during rainy season, on crops like bitter gourd, snake gourd, melon, bottle gourd and ridge gourd. Symptoms appear as water soaked lesions on under surface of leaf lamina and angular spots on upper surface corresponding to the water-soaked lesions on under surface. Disease spreads very fast.

Control measures:

- Plucking and destruction of affected leaves and spraying Dithane M-45 (0.2%) on under surface of leaves give effective control.

5. Anthracnose (Colletotrichum lagenarium)

This disease is endemic in warm and humid conditions where rainfall and humidity are high. Cucurbits like watermelon, bottle gourd, cucumber and snake gourd are more susceptible to disease. Different types of symptoms are observed on leaves, petioles, stem and fruits. Symptoms on young fruits appear in the form of numerous water soaked depressed oval spots, which coalesce covering large areas. Under humid conditions, pink masses of spores can be seen in centre of these spots. Pink gummy exudation may also be seen on lesions due to exudation of spores. Symptoms on vines occur as brownish specks which grow into angular to circular spots. Girdling of affected portion leads to general blight symptoms.

Control measures:

- Clean cultivation and crop rotation minimize disease incidence.
- Treating seeds with Carbendazim @ 25 g/kg of seed and spraying crop at 10 days intervals with Indofil M-45 (0.35%).
- Benomyl or Carbendazim (0.1%) gives effective control.

6. Alternaria blight and fruit rot (Alternaria cucumerina)

This is a serious disease under warm and humid conditions in crops like musk melon, water melon, bottle gourd, snake gourd, cucumber and pumpkin. Symptoms appear as yellow spots on leaves which turn brown and finally turn black on aging. They usually start from margins and produce concentric rings.

Severely affected vines look like burnt charcoal.

Control measures:

- Use of disease free seeds, clean cultivation and crop rotation are effective for control of disease.
- Spray of 0.25% Indofil M-45 at 10-15 days interval is effective for disease control.

7. Mosaic

Viral diseases are causing extensive damage to different cucurbits like pumpkin and squashes, water melon, ridge gourd, bitter gourd, ash gourd, melon, cucumber and coccinia. Viral diseases are becoming serious due to intensive and continuous cultivation of a crop with indiscriminate use of plant protection chemicals. Several viruses like aphid transmitted cucumber mosaic virus, watermelon mosaic viruses like aphid transmitted cucumber mosaic virus, watermelon mosaic virus, mechanically transmissible tobacco virus group, non-sap transmissible but white fly transmissible yellow vein mosaic virus etc. cause malformation and damage to plants. Symptoms expressed by host plant vary with virus and crop. Mosaic mottling, curling and twisting of leaves, shortening of internodes, stunted growth are common symptoms and vegetative growth, flowering and productivity are adversely affected once crop is infected.

Control measures

- Complete control of the diseases is not possible.
- Adoption of practices like collection of seeds from healthy virus free plants, seed treatment with hot air (70^{o} C for 2 days) or hot water (55^{o} C for 60 minutes).
- Clean cultivation and removal of alternate hosts particularly weeds, avoiding relay cropping of susceptible crops, prophylactic spray of organic pesticides.
- Control of vectors by spraying insecticides, use of biocontrol agents, cultivation of tolerant/resistant varieties, avoiding cropping during mosaic prone season and areas, either alone or in combination have to be tried for

raising a mosaic free crop.

- Selection of methods for control of viral diseases should be based on intensity of infection, mode of transmission, etc.

C. Learning process and support materials

Learning process includes the Visual methods, Demonstration method, Practical method, Observation method, Exhibition methods.

D. Assessment

Very Short (Answer question)

1. Write down the scientific name and origin of cucumber.
2. List out the important cucurbits crops cultivated in Nepal.
3. Name any two important varieties of bitter gourd.
4. List any two major diseases of cucumber.

Short (Answer question)

1. Define cucurbitaceous crops with examples.
2. Write down the requirement of interculture operation for cucurbits crop.
3. Write any three varieties of sponge gourd and water melon.

Long (Answer question)

1. Write the cultivation practices of bitter gourd with respect to, soil, method of propagation, manure & fertilizer and trailing process.
2. Write the cultivation practices of cucumber with respect to, botanical name, family, climate, manure & fertilizer, training and pruning.
3. Write the cultivation practices of pointed gourd with respect to, botanical name, soil, method of propagation,harvesting and marketing.

UNIT – 10

Cultivation practices of Perennial crops (Asparagus) 202

Asparagus

A. Objectives

After the completion of this course, the students will be able to:

- Explain about the origin, distribution, cultivars, climate and soil requirement etc.
- Describe about the cultivation practices of asparagus crops in various aspects.

B. Content elaboration

Asparagus is a herbaceous perennial and is grown in large areas in countries like USA, Germany, Spain and France, while Nepal contribution is meager. Asparagus appears early in the spring and when once established will produce for over many years. It is cultivated for its tender shoots, commonly known as spears. These spears are considered as a delicacy in preparation of soups, and other vegetable products. It starts yielding a sizeable crop after about three years and with good care given an economic yield for about 10-15years and the yield goes on increasing for 6-7 years, then remains uniform up to about 12 years, after which it gradually declines.

Botanical name: *Asparagus officinalis L.*

Common name: Kurilo

Family: Liliaceae

Origin: Asia

Chromosome number: 2n=20

Uses

The tender shoots called “spears‟ are used as vegetable and in preparation of soup. It is also eaten as salad. The canned and frozen spears are also used as processed

foods. The tender shoots contain a white crystalline substance, asparagine, which is used in medicine as diuretic in cardiac dropsy and chronic gout. It has good potential as fresh vegetable.

Nutritive value

Table: Nutritive value of asparagus per 100 gm

Principle	Nutrient Value
Energy	20 Kcal
Carbohydrates	3.38 g
Protein	2.20 g
Total Fat	0.12 g
Cholesterol	0 mg
Dietary Fiber	2.1 g

(Source: USDA National Nutrient data base)

Trade

It is cultivated under the area of 135 ha with production of 1526.5 Mt and yields of 11.3 t/ha.

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Marry Washington 500 W	Open pollinated Plant height: 35-40 cm Harvesting: 210 DAT	2066	All areas	

Climate

Asparagus grows well in cool regions, where the day temperature ranges between 24.0- 29.7°C, during the entire growing season accompanied by adequate moisture supply. Asparagus spears are hardy and are seldom injured by cold winters. The crop should be protected from freezing.

Soil

Asparagus can be grown on nearly all kinds of soils, but deep soils preferably 2.4 m or more, well drained and friable to accommodate the plant's extensive root system.

Whereas clay soils, with poor permeability, should be avoided. For heavy yields the soil should be well drained, deep and loose, such as sandy loams and soils with high organic matter. Poorly drained and wet soils should be avoided, similarly light sandy and gravely should also be avoided as they have low moisture holding capacities.

Planting

Asparagus can be propagated through seeds, seedlings and crowns but most commonly followed practice is through seeds only. It requires about 3-4 kg seed for cultivation in one hectare. It is planted during March-May in hills and July-November in plains.

Methods of planting

There are three methods of planting

a) Crown planting

Use only certified crowns for planting as they may carry several diseases.Plant asparagus crowns (roots plus plant buds) so that the top of the crown is 15 cm below the soil level. Depth of planting is critical, if planted too shallow, asparagus will produce a large number of small spears that are not commercially salable. If planted too deep, spears will be very large, but will be few in number. Plant crowns 30 cm apart in the row with the buds upright, and 150 cm between rows to have 21,750 crowns per hectare. Cover crowns with 5-7.5 cm of soil after planting. As plants grow, gradually fill in the rest of the furrow with 2.5-5 cm of soil in 3-5 cultivations, but do not completely cover plants. The furrow should be completely filled by July of the first year. Plant before the buds begins to appear in the spring. Both direct seeded and transplanted asparagus can be planted in single or double rows with 5 foot spacing between beds. Single rows should be

planted on top of "W" shaped beds.

b) Direct seeding methods

Seeds should be placed 5 cm apart in the row, 2 to 2.5 cm deep. Single row seedlings require 2.5-3.4kg of seed per hectare and double row seeding require 4.5 to 6.8 kg seeds per hectare. Asparagus seeds germinate best at 24°C. Direct seeding is preferred when the soil temperature is at least 16°C.

c) Seedling transplant method

Asparagus seedlings can be grown successfully in peat pots, plastic pots, trays, peat pellets or seedling type trays. Seedling growth and survival are usually better with larger cells up to 5x5 cm seedling cells. Most of the artificial soil media produce a good transplant. Good growth above the crown and good root system development require planting the seed not more than 1.25 cm deep. Transplanting of seedling is preferred after the threat of frost but before temperatures get above 32°C. Favourable conditions usually occur in April and May.

Nutrient management

Apply chicken manure @75-125 quintals per hectare or Farm Yard Manure@150 to 250 quintals per hectare as basal dose. In addition, during succeeding years, apply 80-120kg of nitrogen, 80-100kg of phosphorus and 60-80kg of potassium per hectare twice in a year. Make one application of N, P and K just before first appearance of spears in the spring in early March. Apply the same amount of fertilizer at the conclusion of the harvest season in mid-May. Apply the fertilizer to the top of the soil or with very shallow incorporation.

Use of plant growth regulators

- Abscissic acid appears to promote sink strength or encourage phloem uploading.
- Gibberellic Acid promotes growth of asparagus buds.
- Butyric Acid supports spear emergence.

Water management

Adequate moisture should be maintained for good germination and early seedling

growth. Do not let asparagus plants become dry while they are establishing a root system during the first two months. Water stress during this early stage can reduce yields. After the root system is established, irrigation is needed only during extreme drought.

Weed management

Weed control in asparagus production is very important. Timely cultivation is a critical part of any asparagus weed control program, especially during the first two years. The first year asparagus should be cultivated at least once in a month until September or 6 times. The number of cultivations may be reduced by using herbicides. Remove all weeds that are present after harvest. Use only very shallow disking (2.5 to 5 cm) to remove these weeds. Deeper disking will damage crowns and can drastically reduce yield.

Harvesting

The first cutting of spears usually starts from third season or after the completion of two full growing seasons. The green asparagus which is the greater portion of the crop, cut 2.5 - 5 cm below the surface of the soil. Asparagus is usually harvested every day during the main season, but if the weather is cold, every other day or even every third day and if it is very hot twice a day.

Blanching

Mounding the soil to a height of 25-30 cm over the rows is practiced to blanch the young spears and get “white asparagus‟ for canning. After harvest, the spears should be held in a cool shaded place and sprinkled with water to prevent shriveling and wilting. A single irrigation sprinkler over the boxes works well. Asparagus should be hydro cooled before packing.

Marketing

When preparing asparagus for market, spears should be uniform in length. Tie in bunches of 500-1000g or pack loose in a carton. Asparagus loses edible quality rapidly and should be cooled as soon as possible. After bunching, place the butts of the spears in damp peat moss or blotter paper in a crate or carton. Pack 6.8 or

13.6 kg in special pyramid-shaped crates.

Storage

Asparagus can be stored for 2-3 weeks at 95 per cent relative humidity and at 0-2°C. Spears stored in wet tissue paper looked fresh and firm after 13 or 16 days of storage.

Insect pest

1. Asparagus beetle

Asparagus beetles and their larvae attack on spears and ferns.

Control measures

- Spray carbaryl (0.1%) to control this insect.

2. Army worms

Army worms can be especially bad on young ferns.

Control measures

- These can be controlled by deltamethrin (0.0025%) or carbaryl (0.1%).

3. European asparagus aphid

It can be a problem occasionally. The blue-green aphid forms colonies in August or September. When the aphid forms colonies, it causes "Christmas tree" or bonsai effect. The new fern becomes shortened or stunted and new needles look like they are clustered. The entire plant takes on a blue green colour.

Control measures

- It can be controlled with a spray of malathion (0.05 %) or oxy-demeton methyl (0.025 %).

Disease

1. Crown rot and root rot

Asparagus is affected by two Fusarium species. The first is Fusarium oxysporum pv. asparagi which causes crown rot; and the second onebis Fusarium moniliforme which causes root rot. The crown rot fungus is found in most soils

but at very low levels. If asparagus crowns are planted that have crown rot they will not produce spears for more than 4 to 7 years, and this is not profitable.

Control measures

- Do not plant asparagus in soil in which asparagus has been grown in the last 5 years.
- Do not purchase crowns grown in soil where asparagus was grown in the last 5 years.
- Purchase only certified crowns, keep asparagus growing rapidly to reduce crown rot disease by following the recommended management practices.
- The root rot pathogen may be spread through asparagus seed. Make sure to treat seeds for producing crown.

2. Cercospora blight : (Cercospora asparagi)

Symptoms include small, oval and grey to tan lesions (spots) with reddish brown borders on the needles and small branches. It causes the needles to fall from the mature fern. It can be identified by the browning of needles. The disease occurs when the humidity and temperature are very high.

Control measures

- An integrated approach of several cultural practices will help provide partial control.
- Schedule overhead irrigations to allow thorough drying of the foliage before nightfall, or use drip or furrow irrigation to keep foliage dry.
- Wider row spacing will increase the air movement to dry foliage and delay canopy closure.
- Rows should also be planted in a north-south direction to take advantage of prevailing southerly winds in drying foliage burning.
- Disposal of infested residue in the spring delays blight appearance by about one week.
- There are no known asparagus varieties resistant to Cercospora blight.

3. Soft rot: (Erwinia spp.)

Harvested asparagus is susceptible to bacterial soft rot.

Control measures

- Management is based on avoiding injuries and immediately cooling harvested spears.
- Wash water and water used for hydrocooling should contain chlorine.

4. Rust: (Puccinia asparagi)

It is not a common disease. Rust causes small brown rusty pustules on spears and fern branches.

Control measures

- The most effective way to control asparagus rust is to plant resistant varieties.

C. Learning process and support materials:

Learning process includes the Visual methods, Demonstration method, Practical method, Observation method, Exhibition methods.

D. Assessment

Very Short (Answer question)

1. Write down the scientific name and family of asparagus.
2. Name any two important varieties of asparagus.
3. List any two major diseases of asparagus.

Short (Answer question)

1. Define perennial crops with examples.
2. Write down the requirement of climate and soil for asparagus crop.

Long (Answer question)

1. Write the cultivation practices of asparagud with respect to, botanical name,climate, method of propagation, , method of harvesting and marketing.

UNIT – 11

Cultivation practices of Spices (Ginger, coriander, cumin, cardamom, turmeric) 210

A. Objectives

After the completion of this course, the students will be able to:

- Explain about the origin, distribution, cultivars, climate and soil requirement etc of spice crops.
- Describe about the cultivation practices of different spice crops in various aspects.

B. Content elaboration

Spice crops comprise of a large number of species, mostly annuals and some are perrenial of which different parts like stem, leaf, flower bud, flower, etc. are consumed either raw as a salad or cooked. They are essential items of balanced diet and are rich in nutrients. Most of the cole crops which are commonly cultivated are:

Ginger

Ginger is one of the world's most important spice crops. Its characteristic pungency, aroma and flavor are due to the presence of oleoresins and volatile oils. Ginger has immense medicinal value. It warms and softens stomach, cures pains, cough and chest disorders. It acts as analgesic, anti-arthritis, anti- helminthic, anti-ulcer and potential anti-oxidant.

Botanical name : *Zingiber officinale*

Common name : Aduwa

Family : Zingiberaceae

Origin : Indo- Berma region

Chromosome number : 2n = 22

Uses

Ginger is used widely as spice crops which increase the taste and appearance of cooking vegetables. Besides this it is used as colouring agent for cooking rice.

Nutritive value

Table : Nutritive value of ginger per 100gm

Principle	Nutrient Value
Energy	80 Kcal
Carbohydrates	17.77 g
Protein	1.82 g
Total Fat	0.75 g
Cholesterol	0 mg
Dietary Fiber	2.0 g

(Source: USDA National Nutrient data base)

Trade

Ginger is mostly grown rhizome crops in Nepal. It is grown under an area of 22649 ha with production of 279504 Mt (MOAD 2073/74)

Variety

The cultivars of ginger are generally named after the place when they are grown. Two types of cultivars are available i.e., white and yellow which are good for dry ginger and used for soft drink manufacture. In Nepal two types of ginger are available they are fibre less and fibrous. Some of common variety grown in Nepal are Kooperkot -1,2.

Climate

Ginger requires tropical, subtropical and humid climate for its commercial production. It is grown successfully at sea level to 1500 m. above mean sea level and optimum elevation is 300- 900 m. in hilly areas where the climatic conditions are different than plains in terms of rainfall and temperature. It can be grown both under rain fed and irrigated conditions. A well distributed annual rainfall of 1500-

3000mm. during growing season and dry spells before land preparation and harvesting is required for good growth and yield of the crop. The favorable temperature range is 19-28°C, temperature lower than 13°C induces dormancy, higher than 32°C can cause sunburns and poor relative humidity is also unfavourable. The foliage and rhizomes are also destroyed by frost resulting in poor storability. Cold climate during resting period does not affect the crop. It thrives well under partial shade hence can be grown as an inter crop.

Soil

It can be grown in all types of soils but ideal on is sandy loam soil, light, loose, friable, well drained and at least 30 cm. depth. The rhizome growth is better in slightly acidic soils (pH 6.0- 6.5) than the neutral soils. Mostly grown as rain fed, though irrigation is useful. However, it is very sensitive to water logging, frost and salinity. It is tolerant to draught and wind.

Land preparation

The land is ploughed 3-4 times to bring the soil to fine tilth. Compost or well rotten FYM should be applied at the time of field preparation and mixed thoroughly. Beds of convenient size about 3.0m length, 1m width and 15 cm height are prepared with channels of 30-45 cm. to avoid stagnation of water. The alignment of the channels should be in such a way that during rainy season these should act as drains for excess water and before and after rainy season as irrigation channels.

Seed rate

The ginger seed is very costly input and involves about 50% of the total cost of production. Seed rate vary with the size or weight of the seed bits and may be 15-20 q/ha. Bit size may be 15- 150 g or 3-10 cm in length or with 2-8 eyes. Seed bits of 20-25 g having 2-3 eyes are generally. Before sowing treat the seed with a mixture of Diathane M-45 (0.25%) + Bavistin (0.10%) + Chlorpyriphos (0.2%) for one hour and dry in shade for 24 hrs. as a safeguard against soft rot and to induce early sprouting. Rhizomes for seed are also treated in hot water at 48°C for 20 minutes before planting. Soaking seed rhizomes in water for 24 hours, 10 days

prior to planting results in good sprouting.

Planting

Ginger can be sown on ridges or furrows or flat beds, however flat sowing on raised beds is preferred. Depending on the seed rhizome size and weight, agro-ecological situation etc. the spacing of 20x25 cm is recommended. Seed bits is placed 3-5 cm deep in the soil. It is planted during first fortnight of April to first fort night of may.

Nutrient management

Ginger is very exhaustive and long duration crop thus requires considerable amount of manure and fertilizers. The general recommended dose is 25-30 ton FYM, 75:50:75 kg NPK/hac. The FYM should be applied by broadcasting during land preparation. Full dose of phosphorus and potash along with 1/3 N should be applied as basal dose. Remaining N should be splitted in two equal doses i.e. one month after germination and rest one month after the second split. The beds are to be earthed up after each top dressing with the fertilizers. Application of neem cake @ 2t/ha at the time of planting helps in reducing the incidence of rhizome rot and increases the yield. Overdoses of nitrogen should be avoided as it induces more tenderness leading to proneness to rhizome rot.

Mulching

It is an essential operation in ginger to enhance sprouting, conserves soil moisture, maintains optimum temperature and prevents weeds, evaporation, runoff of soil due to heavy rains. Preferably locally available material like green or dry grass/leaves, paddy straw, cane trash, sarkanda etc. can be used. Generally 20-25 t/ha is recommended. The first mulching is done at the time of planting or just after planting. It is to be repeated at 40 and 90 days after planting, immediately after weeding, hoeing, earthing up and application of fertilizers. Under low shade mulching may be reduced without affecting the yield.

Water management

A good soaking irrigation is given immediately after planting. Thereafter, irrigate

at weekly interval. The number of irrigations may be varied with the soil types. 15-20 irrigations are given for clayey soil and about 40 for the sandy loam soils. During the period of rhizome development and maturity, frequent irrigations are necessary.

Weed management

The initial growth of turmeric is slow and weed management during this period is must. The pre emergence application of Simazine @ 1.5l/ha or Basalin @ 2.0 l/ha applied immediately after planting can effectively control the weeds.

Harvesting

Depending upon the varieties, the crop matures in 8-9 months. Main season of harvesting falls in January to April. Maturity indication is complete yellowing and drying up of plants. Above ground parts are cut close to the ground level. Field is irrigated 3-4 days in advance of harvesting the crop. The crop is harvested by ploughing or digging. Rhizomes are gathered by hand picking and cleaned.

Diseases

Rhizom rot

Plants from infected rhizomes are stunted and yellow, lower leaves dry out and turn brown then eventually all aboveground shoots dry out completely. Plant collapse is very slow (up to several weeks).Diseased rhizomes show a brown discolouration, are normally shriveled in appearance and eventually decay leaving the outer shell intact with only fibrous internal tissue remaining.The disease is spread unintentionally by the use of infected seed pieces from the previous crop, although these may appear normal and healthy. Hence, selecting clean material based on appearance may not be sufficient to control the disease.

Control

- Discard all seed pieces showing any cracking injury or rot.
- Dip seed pieces in hot water at 50ºC for 10 minutes if incidence of root knot was high in previous crop. • Dip seed pieces in Ridomil MZ (0.2%) or Topsin M (0.2%) for 20 minutes and allow to air dry prior to planting.

- Keep land free from weeds at all times.
- Destroy all crop refuse especially if disease was present.
- Prepare land for planting well ahead of time and allow to burn.

Coriander

Coriander is an important condiment grown in almost all the kitchen garden. Its seeds, young plants or leaves are used for flavoring or garnishing the foods, curries and soups. The seeds are also considered as appetizer, digestive, carminative, tonic, antipyretic and diuretic.

Botanical name: Coriandrum sativum

Common name: Dhaniya

Family: Apiaceae

Origin: Southern Europe and Northern Africa to South Western Asia.

Chromosome number: 2n=22

Uses

Coriander is used widely as spice crops which increase the taste and appearance of cooking vegetables.

Nutritive value

Table: Nutritive value of ginger per 100gm

Principle	Nutrient Value
Energy	95 Kcal
Carbohydrates	3.67 g
Protein	2.13 g
Total Fat	0.52 g
Dietary Fiber	2.8 g

(Source: USDA National Nutrient data base)

Variety

SN	Variety	Varietal character	Year	Recommended area	Production
1	Lotus	• Open pollinated	2066	All areas	5-10

		• Plant height: 15 -25 cm • Harvesting: 25-35 DAS			Qntl/ha
2	Suravi	• Open pollinated • Plant height: 20-25 cm • Harvesting: 35 DAS	2066	All areas	16-20 Qntl/ha

Climate

It is a tropical plant cultivated in winter season. It requires frost free climate at the time of lowering and seed formation. Dry and moderately cool weather is congenial for increasing the seed yield. Heavy rains are harmful to the crop.

Soil

It can be grown on wide range of soils. However well drained sandy loam soils rich inorganic matter are quiet ideal.

Land preparation

The land is ploughed 3-4 times to bring the soil to fine tilth. Compost or well rotten FYM should be applied at the time of field preparation and mixed thoroughly.

Planting

Sowing time : Last week of October.

Seed rate :10-15 kg/ha (irrigated conditions)

25-30 kg/ha (un irrigated conditions)

Spacing : 30 x 10 cm

Nutrient management

The general recommended dose is 15 ton FYM, 60:30:20 kg NPK/hac. The FYM should be applied by broadcasting during land preparation. Full dose of phosphorus and potash along with 1/3 N should be applied as basal dose. Remaining N should be splitted in two equal doses i.e. one month after germination and rest one month after the second split.

Water management

Depending upon the climatic conditions, soil type and variety, 4-5 post sowing

irrigations are given. The first irrigation is given 35-40 days after sowing and the second one 60-70 days after sowing.

Weed management

Two weedings and hoeing one each after 30 and 60 days of sowing are recommended. Preplant application of Treflan (Trifluralin) @ 0.75 kg/ha or Stomp 30 EC (Pendimethalin) @1.0 kg/ha can effectively control measures the weeds.

Harvesting

The crop is raised for green leaves and seed purpose. For the green leaves fully developed succulent leaves are nipped off along with stem after 75 days of growth. For seed purpose the crop is harvested when 50% seeds turn yellow. After drying the seeds are separated by beating with sticks and winnowing.

Yields

It yields about 25 q/ha (irrigated) and 7-8 q/ha (rainfed crop)

Insect pest and Disease

No any serious pest and disease has been observed in coriander.

Cumin

It is an important spice used in Nepali kitchens for flavoring various food preparations. The flavor of cumin seeds is due to the presence of a volatile oil. Cumin seeds are gray green, oblong, ridged and thicker in the middle with pointed ends, somewhat resembling caraway or fennel seeds in appearance.

Botanical name: *Cuminum cyminum*

Common name: Jeera

Family: Apiaceae or Umbelliferae

Origin: Eastern Mediterranean

Chromosome number:2n=14

Uses

Use in flavoring various food preparations. The flavor of cumin seeds is due to the

presence of a volatile oil,used in various ayurvedic medicines.

Nutritive value

Cumin seeds are extensively used in various ayurvedic medicines also especially for the conditions like obesity, stomach pain and dyspesia. Nutritional value of cumin seeds is as follows: 17.7% protein, 23.8% fat, 35.5% carbohydrate and 7.7% minerals.

Variety

1. RZ 19

A tall variety of cumin with erect stems, pink flowers and bold pubescent grains; tolerant to wilt as well as blight; matures in 120–140 days with an average yield of 5.6 q/ha.

2. RZ 209

An erect-growing variety of cumin with pink flowers and bold, grey, pubescent grains, resistant to wilt and blight diseases; matures in 140–150 days with an average yield of 6.5 q/ha.

3. GC 1

An erect-growing variety of cumin with pink flowers and bold, linear, oblong, ash brown colour grains; tolerant to wilt disease; matures in 105–110 days with an average yield of 7.0 q/ha.

Climate

Moderate sub-tropical climate is ideal for cumin cultivation. Moderately cool and dry climate is best. Cumin crop does not stand high humidity and heavy rain falls.

Soil

Well-drained, loamy soils that are rich in organic matter are best for cumin cultivation. For commercial cultivation of cumin, a field in which cumin crop has not been taken up at least during last 3 years should be selected.

Planting

Seed propagation is commercially practiced. Ideal time for sowing cumin seeds is November – December. A seed rate of 12–15kg/ha is sufficient. It is sown by broadcasting and line sowing. The seeds are sown 10cm deep.

Nutrient management

10–15 tons of farmyard manure/ha is added at the time of land preparation. Afterwards, a dose of 20kg P2O5/ha should be applied at the time of sowing, 30 kg N/ha may be applied as top P2O5 dressing either in single dose 30 days after sowing or in 2 equal splits.

Water management

A light irrigation is done soon after sowing and there after second irrigation should be applied 8–10 days after first irrigation. Depending upon the soil type and climatic conditions the subsequent irrigations may be given at 15–25 intervals. Last heavy irrigation must be given at the time of seed formation. Avoid irrigation at the time of active seed filling because it increases the incidence of powdery mildew, blight and aphid infestation.

Weed management

Weed is a severe problem in cumin cultivation. Weeding at 30 and 60 days after sowing is necessary. Thinning should also be done during first hoeing and weeding to remove the excess plants. Chemical weed control by the application of herbicides may also be practiced. Application of pre-emergent Terbutryn or Oxcadiazone @ 0.5–1.0kg/ha or pre-plant Fluchloralin or pre-emergent Penimethalin @ 1.0kg/ha is very effective.

Harvesting, Processing and marketing

Field is cleaned and wilt affected plants are uprooted before harvesting. Harvesting is done by cutting the plants with sickle. The plants are stacked on clean threshing floor for sun-drying. After drying, seeds are separated by light beating with sticks by winnowing. An average yield of 5 q/ha is obtained under proper management. Improved varieties may yield up to 7 – 8 Q/ha.

Post-harvest management

Fresh seeds are sun dried and then cleaned using gravity separators. Clean seeds are sorted and graded and then filled in sterilized gunny bags and stored in damp-free aerated stores.

Storage

Dried cumin seeds must be stored in moisture-proof containers away from direct sunlight. The stored seeds should be inspected regularly for signs of spoilage or moisture. If they have absorbed moisture, they should be re-dried to a moisture content of 10%. The storage room should be clean, dry, cool and free from pests. Mosquito netting should be fitted on the windows to prevent pests and insects from entering the room. Strong smelling foods, detergents and paints should not be stored in the same room as they will spoil the delicate aroma and flavour of the cumin.

Insect pest and disease

No any serious pest and disease has been observed in cumin. Common pest and disease are aphid, cutworm, bettles, powdery mildew, blight and damping off which can be control through any of others crop management methods.

Cardamom

Botanical name: *Amomum subulatum*

Common name: Alainchi

Family: Zingiberaceae

Origin: Indo-China

Chromosome number:2n=50

Uses

Large cardamom has a pleasant aromatic odour, due to which it is extensively used for flavouring vegetables and many food preparations. It is also used as an essential ingredient in mixed spices preparation. Apart from aroma, large cardamom also has high medicinal value. The decoction of seeds is used as a gargle in infection of teeth and gums. Large cardamom seeds are considered as an

antidote to either snake venom or scorpion venom.

Nutritive value

Cumin seeds are extensively used in various ayurvedic medicines also especially for the conditions like obesity, stomach pain and dyspesia. Nutritional value of cumin seeds is as follows: 17.7% protein, 23.8% fat, 35.5% carbohydrate and 7.7% minerals.

Variety

Ram shai, Goal shai, Damber shai, Chibe shai, Shauna, Varlanga are common variety cultivated in Nepal.

Climate

The crop grows well under the shade of forest trees at altitudes ranging from 1000-2000 metres with a rainfall of 3000-3500 mm per annum.

Soil

Deep and well drained soils with a loamy texture are best suited for cardamom. The soils have a pH range from 4.5 to 6.0. Even though the crop can be grown in undulating and steep terrains, land with a more moderate slope is preferred.

Propagation

Propagation of large cardamom is done through seeds and suckers. Propagation through seeds enables the production of a large number of seedlings. Virus diseases are not transmitted through seeds and therefore the seedlings are free from viral diseases, if adequate care is taken to isolate and protect the nursery from fresh infection. Plants raised from seeds need not necessarily be high yielders even if they are collected from very productive plants due to cross-pollination. The major pollination is done by wild bees and the rest by honey bees. Planting suckers on the other hand ensures true to type and high productivity if they are collected from high yielding plants.

Primary nursery

Cardamom seeds are generally sown in September-October. Seed beds are

prepared in well-drained soil dug to a depth of 30 cm and left for weathering. Raised beds with 15 to 25 cm height, 1 metre width and convenient length, preferably 6 metres, are prepared. Well decomposed cattle manure is mixed with the soil and the surface of the bed is made to a fine tilth. 80-100 gm of seeds are sown per bed in lines spaced 10 cm apart. The seeds are then covered with fine soil and mulched with paddy straw/dry grass (10-15 cm thick). Watering is done at regular intervals to keep the surface of the bed moist. Germination of acid treated seeds commences after 25-30 days of sowing. When average germination is noticed the mulch materials are removed. The inter space between rows is then remulched with chopped paddy straw. Shade pandals are immediately erected by using bamboo mats/reed mats or agro-shade nets. The beds are watered regularly and weeding is done as and when required. When the seedlings attain 3-4 leaf stage, they are transplanted to secondary beds.

Polybag nurseries Polythene bags of 15 cm x 15 cm with perforations at the base are used for planting the seedlings. The bags are filled with a potting mixture of soil, sand and cow dung in the ratio of 4:1:1. The bags filled with the mixture are arranged in rows of one metre width and of convenient length under shade pandals. Seedlings with 3-4 leaves are planted in the bags in April–May and watered regularly. They become ready for field planting in 10 to12 months.

Secondary nursery

Beds of size 15 cm in height and 100 cm in width with convenient length are prepared and well-decomposed cattle manure is mixed with the soil and an even surface is formed. Seedlings with 3-4 leaves are transplanted to the beds in May-June at spacing of 15 cm between them. An overhead pandal is erected for providing shade and the soil is kept moist with irrigation. When the seedlings attain a growth of 45-60 cm in height with 2-3 tillers, they are planted in the main field during June-July of the subsequent year.

Sucker multiplication nursery

As mentioned earlier, suckers should be generated only in sucker multiplication nursery where adequate precautions are taken to ensure that viral diseases are not transmitted through the suckers produced. The site for such a nursery should be

located at least 500 metres away from large cardamom plantations. They are established either under the shade of forest trees or under shade pandals with 50% shade using black agro shade nets. Trenches of 30x30 cm are prepared at convenient lengths with an inter space of 30 cm. Well decomposed cattle manure or compost is mixed with the soil and the trenches are filled to the brim. Then the suckers from high yielding disease free plantations, with one grown up shoot with an emerging bud are planted at 30 cm apart in the trenches. The time for planting is May–June. After planting, the plant base is mulched with dried forest leaves. The multiplication rate in this method is about 1:8 in one years time. The grown up tillers are split into units of one tiller with an emerging bud and planted in the main field during June-July.

Micro propagation

For rapid multiplication of high yielding clones, vegetative buds from disease free high yielding mother plants are collected and plantlets are produced through the tissue culture technique. These plantlets are hardened in poly bags or in secondary nurseries and once sufficient growth is attained, they can be planted in the main field during June–July.

Planting

Large cardamom grows well in forest loamy soils with gentle to medium slopes. Water logged conditions are detrimental to the growth of the plants. It performs well under shade. Utis (*Alnus nepalensis*) is the most common and preferred shade tree for large cardamom. The other species of shade trees are panisai (*Terminalia myriocarpa*), pipli (*Bucklandia* spp.), malito (*Macaranga denticulate*), argeli (*Edgeworthes gardneri*), asare (*Viburnus eruberens*), bilaune (*Maesa cheria*), kharane (*Symplocos* spp.), siris (*Albizzia lebbeck*), dhurpis and Khasi cherry, katuse, faledo (*Erythrina indica*), jhingani (*Euria tapanica*) and chillowne (*Schima wallichi*).

Land preparation

Planting is done during June–July when there is enough moisture in the soil. The land selected for planting is cleared of all undergrowth, weeds, etc., for new planting, or if it is replanting, old plants may be removed. Pits of size 30x30x30

cm are prepared on the contour of the hill at a spacing of 1.5 x 1.5 m after the onset of monsoon showers. A wider spacing of 1.8x1.8 m is recommended for robust cultivars like Sawney, Varlangey, Ramsey, etc. The pits are left for weathering for a fortnight and then filled with topsoil mixed with cow dung or compost at the rate of 1-3 kg. per pit. Seedlings/suckers are planted in the middle of the pit. Care should be taken not to plant the seedlings/rhizomes very deep in the pit. After planting the seedling/suckers may be staked and the base of the plant is mulched with dry leaves.

Manuring

For a sustained production the soil fertility should be maintained at its optimum. Well decomposed cattle manure or compost and oil cakes may be applied at the rate of 2 kg per plant at least once in two years in April–May. If all the crop residues are recycled in the plantation, application of inorganic fertilizers may not be necessary.

Weeding

Weed control in the plantations is important for the maximum utilization of the available soil moisture and nutrients by the plant. Three rounds of weeding are required for effective control of the weed growth in the initial two to three years. Weeding can either be hand weeding or sickle weeding depending upon the intensity of weed growth. From around the plant base the weeds can be pulled out by hand and the weeds in the inter space need only be slashed with a sickle. While weeding, dried shoots and other trashed materials can be used as mulch around the plant base to conserve moisture in the ensuing dry months, and to prevent weed growth around the plant base.

Soil and moisture conservation

Cardamom is mainly grown in hilly terrain. The topography and the wet climate of mid hills permits soil erosion to a considerable extent. Intensive operations which loosen and expose the soil will increase soil erosion and therefore only minimum tillage operations should be followed. As far as possible, contour terraces may be made well before taking up planting operations. This helps in reducing soil erosion and soil moisture conservation. Though contour terracing is

expensive and requires high initial investment, the long term benefit will compensate the initial extra expenditure.

Irrigation

In some of the large cardamom plantations, water sources are available which can be exploited to irrigate the crop by gravity flow, either through pipes, sprinklers or flood irrigation through open channels. It is observed that productivity is higher in plantations where irrigation is provided. For sustainable and better yield the plants may be watered during the dry months. Depending on the availability of water sources, hose, or sprinkler or flood irrigation through channels can be adopted. Hose irrigation can be done at the rate of 40-50 litres per plant at fortnightly intervals. In case of sprinkler, irrigation equivalent to 35-45 mm of rain at fortnightly intervals is recommended.

Harvesting and curing

The indication of the time of harvest is when the seeds of the top most capsules turn brown. To enhance maturity, bearing tillers are cut to a height of 30-45 cm and left for another 10-15 days for full maturity. The spikes are harvested using special knives. The harvested spikes are heaped and capsules are separated and dried. The cured capsules are rubbed on a wire mesh for clearing and removal of the calyx (tail).

Traditionally large cardamom is cured in a bhatti where the capsules are dried by direct heating. Under this system the cardamom comes in direct contact with smoke which turns the capsules to a darker browner black colour with a smoky smell. Improved curing techniques are available by which cardamom is processed to give better quality and appearance.

Packaging

The properly dried capsules should be allowed to cool and then packed in polythene lined jute bags. The bags may be stored on a wooden platform to avoid absorption of moisture, which may result in fungus growth damaging the stored produce.

Insect Pests

Large cardamom is by and large free from the attack of any major pests except for the sporadic incidence of leaf eating caterpillars. Aphids are found in most of the areas which transmit the viral diseases chirke and foorkey.

Leaf eating caterpillar

Initially the caterpillar of the moth *Artona chorista* feeds on the leaf lamina from under the surface of the leaf and finally defoliates the leaf completely leaving only the midribs. Their incidence is noticed in May-July and October-March. At present these insects are kept under control by their natural enemies. If insecticides are used to control them, then their natural enemies will also disappear which may lead to an outbreak of these pests in epidemic form. The best method of control is to inspect the plantations during May-July and October-March, to handpick the infected leaves along with the caterpillars and destroy them by burning.

Diseases

Fungal or bacterial diseases are seldom reported in large cardamom. Only minor diseases like leaf streak or rot diseases are found in isolated areas. The major threat to large cardamom is the widespread occurrence of viral diseases, viz., chirke and foorkey. These diseases are seen throughout the large cardamom growing tracts of Sikkim and Darjeeling and cause considerable crop loss. These diseases have spread due to drastic change in the ecosystem, inadequate rain in dry months and absence of good agricultural practices by the farmers. Many cardamom farmers failed to plant varieties suitable to their altitude.

Chirke

The symptoms are characterized by mosaic appearance on the tender leaves with pale streaks, which slowly turns into brown, resulting in withering and drying of the plants. Growth and yield of the affected plants gradually declines and ultimately they perish. The disease is transmitted by aphids. It also spreads by planting infected suckers. Transporting of infected suckers from one area to another leads to the spread of this disease. The disease is also transmitted mechanically through the knife used for harvesting.

Foorkey

Numerous small tillers appear at the base of the affected plants which become stunted and fail to give any yield. Even the inflorescence is noticed to produce unproductive spikes.

Management of viral diseases

Plants affected by the viral diseases cannot be cured but the losses can be minimized by adopting appropriate management practices.

- Keep a constant vigil to detect disease affected parts.
- Uproot and destroy affected plants as soon as symptoms appear. Repeat detection and uprooting at regular intervals.
- Use seedlings produced in certified nurseries.
- Propagation through suckers is recommended only through certified multiplication nurseries.

Turmeric

Turmeric is widely used as a food colorant and is one of the principal ingredients in curry powder. It has long been used in both ayurvedic and Chinese medicine as an anti-inflammatory, to treat digestive disorders and liver problems and for the treatment of skin diseases and wound healing. The active ingredient in turmeric is curcumin.

Botanical name: *Curcuma longa*

Common name: Besar

Family: Zingerbraceae

Origin: Indo-Berma region

Chromosome number: 2n=32

Uses

Turmeric is used widely as spice crops which increase the taste and appearance of cooking vegetables. Besides this it is used as colouring agent for cooking rice.

Nutritive value

Table: Nutritive value of turmeric per 100 gm

Principle	Nutrient Value
Energy	354 Kcal
Carbohydrates	64.9 g
Protein	7.83 g
Total Fat	9.88 g
Cholesterol	0 mg
Dietary Fiber	21 g

(Source: USDA National Nutrient data base)

Trade

The area under turmeric cultivation is 6777ha with production of 65999 Mt (MOAD 2073/74).

Variety

Koopurkot halado is the only on recommended variety of turmeric within the country.

Climate

The crop can be successfully grown from sea level to an altitude of 1200 m. above mean sea level. It can tolerate an annual rainfall of 640 to 4290 mm. Moderate rainfalls of 1500mm. at sowing, fairly heavy and well distributed rain during growing period and dry weather about one month before harvest are much suitable. The temperature range of 18.2-27.4°C is optimum. The crop is raised as rain fed where rainfall is high and distributed for 5-7 months and as irrigated crop where rainfall is low.

Soil

Turmeric can be grown on various soils but thrives best in well drained, friable, rich sandy or clay soils having a pH range of 4.3-7.5. The crop cannot withstand water logging and alkalinity. Loamy soils are best suited for the development of rhizomes. The soils should be free from stones or gravels.

Planting

The optimum time of planting is April-May depending upon the availability of irrigation facility. However it can be delayed till fall of first monsoon showers under the rainfed conditions, but yield is reduced under late planting.

Seed rate

Seed rate varies between 20-25q/ha. The seed rhizomes bits of 30g. with 2 to 3eyes are planted. Rhizomes are treated with 0.25% Dithane M-45+ 0.10% Bavistin for 30 minutes before planting. Hot water treatment at 50°C for 30 minutes without affecting germination eradicates all associated with turmeric seed rhizome. These seed rhizomes are planted in three ways namely raised bed method where each bed is of 1m width, 15 cm. in height and of any convenient length. Ridge and Furrow method is especially useful to protect crop from water logging in rainy season. Flat system can be followed in sandy loam or well pulverized soils.

Spacing

The spacing varies depending on the planting method followed:

Raised Bed: 30x20 cm

Ridge/Furrow method: 45x22.5 cm

Flat system: 50x15cm

The seed rhizomes are placed 10-12 cm deep in the soil. Germination starts in 10-20 days and will be over by 60 days.

Nutrient management

Farmyard manure @30-40 t/ha is applied by broadcasting and ploughed at the time of preparation of land or as basal dressing by spreading over the beds. ZnSO4 @ 20 kg/ha may be applied at the time of planting and organic manures like oil cakes can also be applied@ 2t/ha and such case, the dosage of FYM can be reduced. Integrated application of compost@ 2.5t/ha combined with FYM, biofertilizer (Azospirillum) and half of recommended dose of NPK is also recommended. Fertilizers @ 60 kg N (120 kg Urea), 30 kg P2O5 (66 kg DAP)

and 90 kg K2O (153 kg MOP) per hectare are to be applied in split doses. Whole of phosphorus & potash should be applied as basal dressing. The nitrogen should be given 45 and 90 days after planting.

Mulching

It is an essential operation in turmeric to enhance sprouting, conserves soil moisture, maintains optimum temperature and prevents weeds, evaporation, and runoff of soil due to heavy rains. Preferably locally available material like green or dry grass/leaves, paddy straw, cane trash, sarkanda etc. can be used. Generally 20-25 t/ha is recommended. The first mulching is done at the time of planting and is repeated again after 3 months.

Intercropping

Turmeric is a long duration crop and takes 8-9 months. The field remains occupied for longer duration. Other crops are planted to get maximum returns per unit area. It can be grown as inter crop with chillies, colocasia, onion and brinjal. In this way, more income is obtained and risk of loss in case of natural hazards is reduced. It can be rotated with onion, garlic, chillies and other vegetables in irrigated condition.

Water management

A good soaking irrigation is given immediately after planting. Thereafter, irrigate at weekly interval. The number of irrigations may be varied with the soil types. 15-20 irrigations are given for clayey soil and about 40 for the sandy loam soils. During the period of rhizome development and maturity, frequent irrigations are necessary.

Earthing- up

The main aim of earthing -up is to make the plant base strong/stable to avoid lodging of the plants in strong winds. Earthing -up is practiced during 40 -50 days after planting (DAP), 90-105 DAP, and if required 120-135 DAP. This helps to form and enlarge rhizomes and also protect rhizome from insects.

Weed management

The initial growth of turmeric is slow and weed management during this period is must. The pre emergence application of Simazine @ 1.5l/ha or Basalin @ 2.0 l/ha applied immediately after planting can effectively control the weeds.

Harvesting

Depending upon the varieties, the crop matures in 8-9 months. Main season of harvesting falls in January to April. Maturity indication is complete yellowing and drying up of plants. Above ground parts are cut close to the ground level. Field is irrigated 3-4 days in advance of harvesting the crop. The crop is harvested by ploughing or digging. Rhizomes are gathered by hand picking and cleaned.

Yield

Mother rhizomes are separated from the fingers before they are cured. Average rhizome yield is 200-225 q/ha.

Storage of seed rhizomes

Turmeric may be stored in cool and dry environment, to keep the material for the next season sowing. Poor storage causes rotting, dehydration and sprouting. Fully mature and disease free rhizomes are stored. Conventionally the storage is done above or below ground. In above ground, mature and healthy rhizomes are heaped over a layer of 5-10 cm. sand under shade of the tree or shed. These are covered with turmeric leaves. Then the heaps are plastered with earth mixed with cow dung. The rhizomes are treated with Diathane M-45@ 0.25%+ Bavistin@ 0.10% solution for 30 min. and shade dried before heaping. Remove rotten rhizomes at the end of storage period.

Rhizomes for seed purpose are generally stored by heaping in well ventilated rooms and covered with turmeric leaves. In below ground storage, pits if size 1x1x1 m or as per requirement are made under shade/shed. The walls of the pit are plastered with cow dung with a layer of sand at the base. Healthy and disease free rhizomes treated in solution of Diathane M-45+ Bavistin are placed loosely. Filling is done up to 10-15 cm. below from the top. This top is covered with dry

grass. The pit is closed with help of wooden plank. Plaster the space between the planks with soil or cow dung. Keep a perforated PVC pipe of 2 inches diameter in the centre of the pit for removal of gases. The material can be stored for 3-4 months in this way. The rhizomes can be removed 20-25 days before planting. The seed rhizomes can also be stored in saw dust and sand.

Insect pest of ginger and turmeric

Shoot boring caterpillar, thrips and leaf roller causes damage to the crops.

Control Measure:

- Spraying a malathion 0.1%

Disease of ginger and turmeric

1. Rhizome rot

Caused by Pythium myriotylum, P. graminicolum & P. aphanidermatum.

The pathogen is soil and seed borne in nature. The disease is characterized by the appearance of water soaked lesions at the base of pseudo stem and yellowing of lower leaves. The root infection is visible as browning and rotting of roots which advances to rhizomes changing its colour from bright orange to different shades of brown. The rhizomes finally becomes soft & rotten. The infected plants show gradual drying up of leaves along the margins and later entire leaf dries.

Control measure:

Rhizome treatment with a combination of mancozeb (0.25%) and quinalphos (0.075%) for 15 minutes is recommended. Soil drenching with metalaxyl + mancozeb (0.2%) or mancozeb (0.25%) at 15-20 day interval twice with the first appearance of symptoms is effective in managing the disease.

2. Storage rot

Caused by Macrophomina phaseolina and Cladosporium cladosporioides Other species viz. Aspergillus, Fusarium, Rhizoctonia and Sclerotium are also reported to be associated with rot.

It is a serious problem in turmeric. Improper storage as well as heaping harvested

rhizomes under sun results in rotting of rhizomes. The rot is caused by a complex of fungus species. Favorable incubation temperature and relative humidity at 60% leads to maximum spoilage. But no rotting occurs at 15°C even when the RH varied from 30-90%. The rot is maximum in September and minimum in May in north Indian conditions.

Control Measure

- Storage rot can be controlled by treating the rhizomes with mancozeb @ 0.25%.
- After seed treatment, the rhizomes should be well air dried before storage.

C. Learning process and support materials

Learning process includes the Visual methods, Demonstration method, Practical method, Observation method, Exhibition methods.

D. Assessment

Very Short (Answer question)

1. Write down the scientific name and family of ginger.
2. List out the important spice crops cultivated in Nepal.
3. Name any two important varieties of cardamom.
4. List any two major diseases of ginger.

Short (Answer question)

1. Define Spices crops with examples.
2. Write down the method of curing in cardamom crop.
3. Write any four varietie coriander and cumin.

Long (Answer question)

1. Write the cultivation practices of cardamom with respect to, botanical name, climate, method of propagation, manure & fertilizer and curing process.
2. Write the cultivation practices of ginger with respect to, botanical name, family, climate, manure & fertilizer, method of planting, harvesting.
3. Write the cultivation practices of cumin with respect to, botanical name,soil, method of propagation, harvesting and marketing.

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