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Vegetabe and Medicinal Plant Production

Feedback Copy

Technical and Vocational Stream

Learning Resource Material

Vegetabe and Medicinal Plant Production

(Grade 10)

Secondary Level

PLANT SCIENCE

Government of Nepal
Ministry of Education, Science and Technology
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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, Arjun Prakash Poudel, Santosh Koirala, Balachandra Chaulagain, Sujan Karki, Dinesh Timalsina, Suresh singh Dhami is highly acknowledged. The book is written by Bidur Paneru 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.

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Ministry of Education, Science and Technology

Curriculum Development Centre

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UNIT - 1

Introduction (VSQ= 2, SQ=1, LQ=1, TQ= 4)

Objectives:

- To know about the meaning and understanding of horticulture.
- Able to know about different branches of horticulture.
- To know the importance of vegetable and spices crops in our daily life.
- Students should be able to classify vegetables on the basis of cultural requirement, parts utilized and growth habit.

Content elaboration:

1.1 Meaning and Branches of horticulture:

Horticulture: The term horticulture is derived from a Latin word 'Hortus'' meaning ''garden' and 'cultura' meaning cultivation *i.e.* it deals with the study of garden cultivated plants.

Broadly it is defined as "It deals with the study of cultivation, processing and utilization of a variety of crops such as fruit, vegetable, ornamentals, plantation crop, spices, medicinal & aromatic plants".

1.2 It has broader field of study and has various branches that are briefly explained below:

1. **Pomology:** It deals with the cultivation and management of fruit crops.
2. **Olericulture:** It deals with cultivation and management of vegetable crops.
3. **Floriculture:** It is an art and science of growing flowers on a large scale for supply to domestic market as well as for export.
4. **Landscape Gardening:** It deals with the planting of ornamental plants of different type in such a way that it creates picturesque effect by imitating nature in the garden.
5. **Post-harvest Technology:** It deals with principles and practices adopted to prolong storage life of harvested fruits, vegetables and flowers in fresh, dried and processed form.

6. **Plantation and spices crop:** It deals with the high value crops in horticulture. Tea, coffee, cardamom, ginger etc. comes under this group.

1.3 Importance vegetable and spices:

The importance of vegetables in human diet is well known since the immemorial as they supply all main components in human diet. Vegetables contain carbohydrate, protein, minerals and also posses medicinal properties. Thus, vegetables play a vital role in the balance diet of human being. According to human dietitians about 300g vegetables (125g leafy vegetables, 100g root and tuber vegetables and 75g other vegetables) per capita per day are required. They are very often referred as "Protective food" because they supply major nutrients to the body.Economic returns to vegetable growers are better and yield per unit area is high. Vegetables and spices have short growing period, growth habit and plant height make them fit for inter cropping in perennial crops and suitable for intensive farming. They have wide utility e.g. in fresh vegetables, in salads, desserts, pickles, dehydrated, sauce, soup and sweet. They provide an early opportunity to farmers to recover losses due to failure of one crop. Vegetable crop generates supplementary incomes and expands employment through intensive cultivation. Vegetables especially onion, chilies, okra, tomato, brinjal, cabbage, cauliflower, beans and garlic are suitable for export hence foreign exchange.

Nepal has experienced a vast range of climates which differ from east to west and north to south and also differs in the aspect of the slopes. Nepal has a very longer border with India. Most of the big border cities are lying in the northern plains of India. Due to climatic unsuitability, vegetables could not be grown in these areas during summer and rainy season. Nepal can catch these big markets with proper planning of vegetable and to dispose its off-season production to these big markets. The production of remote areas is already in organic nature due to unavailability of inorganic inputs as well as farmers poor buying capacity. At present there is a huge market for organic produces in India alone.

Nepali ginger and spices are very popular in India, Pakistan and Bangladesh too. If these products are properly marketed, there is certainly economic boon in rural areas of the country. Nepal produced vegetable seeds have very well demands in India and Bangladesh. At present, a little amount of radish seed is being exported to these

countries. So these potentialities must be harvested in real sense by the technology and intervention in the needy area.

1.4 Classification of vegetables: The term olericulture is derived from a Latin term used to designate science, culture and management of vegetables crops. There are various methods to classify the vegetables, which are given as below-

1.4.1 Classification based on cultural requirement- In this method all vegetables crops having more or less similar cultural requirements are grouped together. There are 14 groups-

Group 1: Potato
Group 2: Solanaceous fruits (tomato, chilli, brinjal, capsicum)
Group 3: Cole crops (cabbage, cauliflower, knolkhol, sprouting broccoli, Brussels sprout)
Group 4: Cucurbits (Pumpkin, squashes, melon and gourds)
Group 5: Root crops (radish, carrot, turnip)
Group 6: Bulb crops (onion, garlic, leek)
Group 7: Sweet potato
Group 8: Okra
Group 9: Peas and beans
Group 10: Salad crops (lettuce, celery, parsely)
Group 11: Greens (spinach, palungo, amaranthus, coriander, fenugreek)
Group 12: Tuber crops (other than potato e.g. cassava, yam, elephant foot yam, colocasia)
Group 13: Temperate perennials (asparagus)
Group 14: Tropical perennials (drumstick, curyleaf)

1.4.2 Classification based on parts utilized- In this method vegetables are classified according to their plant parts utilized-

a) Leaves- Cabbage, lettuce, spinach, palungo, fenugreek, amaranthus
b) Flowers- Sprouting broccoli
c) Fruits- Tomato, brinjal, chilli, pea, beans, okra, all cucurbits

d) Modified stem- Asparagus, knolkhol

e) Underground plant parts- Sweet potato, potato, onion, garlic, radish, carrot, turnip, beet, cassava, ginger, turmeric, yam, elephant foot-yam, colocasia.

1.4.3 Classification based on growth habit of vegetables- In this classification the vegetable crops are classified as below-

a) Herbs- Ginger, turmeric

b) Shrubs- Okra, Beans

c) Climbers- All cucurbits

e) Trees- Tree tomato

Learning Process and support materials:

1. by practicing kitchen garden nearby school field.

2. Visit to vegetable garden developed by progressive farmers in local area.

3. by showing power point slide of different classes of vegetables to the students.

4. By searching the importance of vegetables in the internet.

5. Krishi Diary

Assessment:

Very short questions:

Q.N.1. Define horticulture.

Q.N.2. What do you mean by olericulture?

Q.N. 3 What do you mean by pomology?

Q.N.4 give any four examples of flowers.

Q.N.5 Define kitchen garden.

Q.N.6 give two examples of cole crops.

Q.N.7 give two example of root crops.

Short Questions:

Q.N.1 Classify vegetable crops based on parts utilized with examples.

Q.N.2 Classify vegetable crops on the basis of cultural requirement.

Q.N.3 how can you differentiate vegetable crops based on growth habit ?

Q.N.4 Explain about the scope of vegetable crop production in case of Nepal.

Long Questions:

Q.N.1 Explain in detail why a vegetable farmer should know its principles as well

as practices.

Q.N.2 Why vegetable and spices are important in our daily life? Illustrate with examples.

Q.N.3 Classify vegetable crops based on cultural requirement and parts utilized with examples.

Glossary:

- Ornamental= beautifying, embellishing, Characterized by ornament.
- Aromatic = fragrant or spicy
- Landscape= scenario, a portion of land or territory which the eye can comprehend in a single view.

Reference:

- Singh, K.P. and R.R. Bhandari. 2015 Vegetable crops production Technology, Samiksha Publication, Kathmandu, Nepal.
- An Agriculture Information Book, Martyr Mitramani Acharya Library and Museum, IAAS, Rampur Chitwan.
- www.agrifarming.in
- www.agriinfo.in

UNIT- 2

Vegetable Farming (VSQ= 1, SQ=1, LQ=1, TQ=3)

Objective:

- To know the concept and idea of vegetable farming.
- To know about different types of vegetable farming i.e. kitchen garden, truck garden, vegetable seed farming, off- season vegetable farming, peri- urban vegetable farming and organic vegetable farming.
- To be able to practice vegetable farming in their house as well as nearby area thus supporting national economy.

Contentelaboration:

Vegetable Farming

Vegetable farming is comparatively better source of income as it yields 5-10 times more than cereals in per unit area. Vegetables play an important role in human nutrition and are a good source for capturing foreign markets. In addition to provide food, vegetables cultivation help in solving the problem of unemployment, improve economic status and purify the surrounding environment. Depending upon the area and purpose of vegetable cultivation, different types of farming systems are developed as follows-

2.1 Kitchen garden-

The home or kitchen garden is the most ancient type of garden. When human beings learnt the art of tilling land, they used to live in tribes or colonies and were of a migratory nature. Each tribe used grows its own food and these gardens were **Kitchen Garden.** It is a growing of vegetable crop behind the residential house to meet the requirement of the family all the year round.

Various vegetable crops are grown intensively on a small piece of land year round on the basis of interest and taste of the family. It should be established at the backyard of the house, land must be fully exposed to light and should be located close to well or tap water or the other source of irrigation. The design of a kitchen garden depends upon the character of land, its extent and situation. Thus, to establish a kitchen garden

various points are to be kept in mind that are stated below:-

- Land must be at the backyard of the house and should of rectangular in shape.
- The lay-out should be attractive consisting of small plots with narrow path/borders accessing all parts & producing through-out the year.
- The land should be divided into small plots with narrow paths.
- One or two compost pit should be established at the corner of the last plot.
- Several sowing are practiced at short interval to get steady supply for longer period.
- The ridges separating individual plot should be utilized by planting root crops or cucurbits which can be trailed on the fences.
- The early maturing crop should be planted in continuous row so that area may be available for sowing late crop.
- Intercropping is preferred in each plot.

Crops for the kitchen garden:

The crop selection mainly depends upon size of the garden and choice of a family. Only those vegetables which give satisfactory yield, best suited to the region, choice and interest of a family are selected for kitchen garden.

Plot No.	Name of vegetables	s
Plot 1	Cabbage, inter-cropped with lettuce, cluster bean and French bean	November-March March-October
Plot 2	Cauliflower (late), inter cropped with knolkhol, Cowpea (summer) Cowpea (rainy season)	September-February March-August
Plot 3	Cauliflower (mid) Radish Onion	July-November November-December December-June
Plot 4	Potato Cowpea Cauliflower (early)	November-March March-June July-October
Plot 5	Brinjal (long) with spinach as intercrop Bhindi with amaranthus as intercrop	July-March March-June
Plot 6	Brinjal (round) with spinach as intercrop Bhindi with amaranthus as intercrop	August-April May-July

Plot 7	Chillies Bhindi	September-March June-August
Ridge 1-3	Turnip followed by radish	
Ridge 4	Beet followed by colocasia	
Ridge 5-6	Carrot followed by colocasia	
Ridge 7	Radish varieties followed by colocasia	
Perennial plot	Drumstick- One in a row Banana- five in a row Papaya- Five in a row Tapioca- Two in a row Curry leaf- One in a row Asparagus- Two small rows	

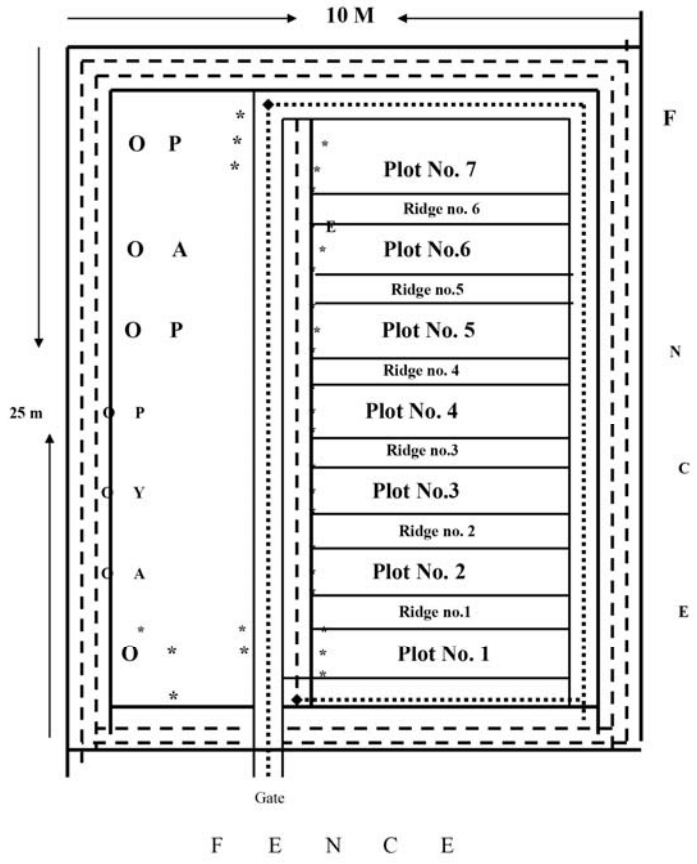

Fig: Plot design and crop selection for kitchen garden

2.2 Truck garden

Production of special crops in relatively large quantities for distant market is called Truck grading. It follows more extensive and less intensive method of vegetables production than market. The farmers concerned to grow one or two crops at commercial scale. The word "**Truck**" has no relationship with a motor truck but is derived from a French word "***Troquer"*** meaning ***to barter***. In this type of gardening production site is far from the market or cities where the cost of land & labour are usually cheap. On large holding, mostly mechanized farming is practiced which leads to reduction of cost of cultivation. Here middle men are also involved in marketing. Only few vegetables which have longer storage life and can thrive long distance transportation without any damages are suitable for truck garden e.g. potato, garlic, onion, chilli, pumpkin etc.

2.3. Vegetable seed farming

Vegetable seed production is a highly specialized job and requires technical skill. Such type of farming is adopted in large areas to produce the seed of high quality. Soil, climate and disease free condition are the main consideration in the selection of seed production areas. The producer should have thorough knowledge of the crop including growth habit, mode of pollination, isolation distance, rouging, harvesting, curing, threshing, cleaning, field seed standards, grading, packaging and storage condition. Special care should be provided for seed farming. Where there appears excessive hot dry wind, the crop should be protected by wind break. Isolation distance should be maintained in case of self pollinated crops to avoid natural crossing. The isolation distance should be maintained for cross pollinated crop at about 300-1600 m and 10-200 m for self pollinated crop depending upon the type of seed to be grown. The site of the seed should be free from major soil borne diseases and insect pests with adequate moisture in the soil. Periodical rouging of crop is practiced at vegetative growth, at flowering and at fruiting stage. Also most of the crop is cross pollinated by insect so provision of honey bee hives around the farm ensure proper pollination and increased seed yield.

In Nepal vegetable seed production is practiced in remote part hills at an altitude ranging from 1000-2700 masl where roads are lacking. e.g. Cabbage, cauliflower, radish, tomato, chili, brinjal, okra etc are grown for seed.

2.4. Off-season farming

Growing of vegetables out of its normal growing season is termed as off season vegetable farming or vegetable forcing.

The garden for off-season vegetable farming is located at any place but is generally preferred in cities and towns where the grower is more progressive to handle this complex and highly specialized type of farming involving special growing structures to regulate micro-climate like temperature and humidity. Various specialized structure required for regulating micro-climate for vegetable forcing are:-

- ***Trenches:*** Trenches are prepared for raising seedling in off-season. It helps to modify micro-climate for certain period and favour seed to germinate. A trench of 15" depth, 15" width with desirable length is prepared where polybag containing seeds are kept and then whole trench is covered air tightly with transparent white plastic sheet. Due to this temperature inside the trench increases and favour seed germination and protect small seedling from cold. It is mostly prepared in cool season for raising seedling of summer crop.
- ***Plastic tunnel:*** Plastic tunnel is frequently used to raise seedling in off-season during winter for off-season summer crop cultivation. It is also used to protect standing crop from cold waves in winter in hilly regions. Generally, 1m height tunnel covered air tightly with transparent white plastic sheet is recommended to prepare.
- ***Plastic house/glass house:*** A plastic house or glass house is also prepared to raise seedling and cultivate entire crop in off-season. It is costlier than trench or plastic tunnel but ultimate result/output is higher. It is prepared in such a way that entire cultural operation can be performed inside the house when necessary. It is also preferred in cool season which can modify/regulate micro-climate for certain period.
- ***Green house:*** It is similar to glass house but well equipped with high-tech instrument which can regulate climate any time inside the house. Here, the favorable climatic condition can be provided to the crop any time of the year and can cultivate particular crop throughout the year. It consists of atomizer and humidifier that regulate temperature & humidity required for the particular crop.

- Only a number of vegetables like tomato, cucumber, lettuce, radish, cauliflower, chilli, capsicum, spinach etc. are selected for off-season vegetable farming.

2.5 Peri-urban farming

Cultivation of vegetable crop around the periphery of the city or town to fulfill the demand of vegetable is termed as peri-urban farming.

It is one of the most intensive types of farming where most skillful method for production of vegetables for commercial purpose is employed. As the land is mostly situated near the city, land and labour is very costly. Thus it is practiced in small area where each and every part of land is fully utilized by adopting intercropping and planting crop in succession to get extra income from the same piece of land. Here the farmers are very skilled and have knowledge of cultivating of various vegetable crops. The vegetables selected for cultivation are on the basis of demand of the market. The farmers have to supply variety of vegetables continuously over a long season which is highly demanded by the urban market. Therefore, some of the points like adaptation to local condition, cost of labour, maturity time in relation to market demand etc. are required to be considered while selecting crops for peri-urban farming. Thus, following points should be considered while selecting site for peri-urban farming:

- The topography of land should be even in plain and terraced in slopes.
- The soil should be fertile and productive.
- There should be adequate irrigation facility.
- Labour should be available any time at cheaper rate.
- There should favorable climatic condition for selected crop.
- The site should be near to the market with adequate transportation facility.

Learning Process and support materials:

- Project work method by dividing students into different group and practicing different types of vegetable farming.
- We can also follow observation method to know the principles of vegetable farming.
- By making trenches and plastic house for raising seedling in winter season for transplanting in summer season.

- krishi Diary

Assessment:

Very Short questions

Q.N.1 what do you mean by vegetable farming?

Q.N.2 Define off-season vegetable farming.

Q.N.3 how do you define kitchen garden.

Q.N.4 Define peri- urban vegetable farming.

Q.N.5 list down what the specialized structures for off- season vegetable farming.

Q.N.6 What are the specialized structures for raising seedling?

Short Questions:

Q.N.1 what are the points to be considered while establishing kitchen garden? List down.

Q.N.2 what types of vegetables are suitable for growing in kitchen garden explain with reason.

Q.N.3 why specialist are needed for raising vegetable seed farming?

Q.N.4 how trenches and plastic tunnel differs with plastic house and green house?

Long Questions:

Q.N.1 Explain in detail about the specialized structures for growing off- season vegetable farming.

Q.N.2 why vegetaable farming is being famous among poor and marginal farmers of Nepal?

Q.N.3 Explain in detail how vegetable farming can support national economy.

Glossary:

- requirement= need
- supplementry= additional, added to supply what is wanted
- expose= bring to light, to reveal, introduce to

- trail= to follow behind, to drag behind the ground
- barter= equal exchange (eg. we had no money so we had to live by barter)
- Isolation= the state of being isolated, detached or separated
- Excessive= more than requirement, extravagant
- atomizer= an instrument for cooling, vapor for disinfecting
- adequate= sufficient, enough

Reference:

- Singh, K.P. and R.R. Bhandari. 2015 Vegetable crops production Technology, Samiksha Publication, Kathmandu, Nepal.
- An Agriculture Information Book, Martyr Mitramani Acharya Library and Museum, IAAS, Rampur Chitwan.
- www.agrifarming.in
- www.agriinfo.in

UNIT - 3

Climatic factors affecting vegetable production

(VSQ= 2, SQ=2, Lq=0 TQ= 4)

Objective:

- To know about the elements of climate
- To understand the concept and meaning of weather and climate
- To know the effect of climatic factors in vegetable production

Content elaboration:

Climate:

The climate of a region is the total of long time performance of various component like temperature, light, humidity, rainfall, wind direction, wind velocity and such phenomena like fall frost, fog, thunder etc. All crops have certain natural thresh hold limits of climatic component beyond which they don't grow normally. The main factors which affect the production of vegetable are describe below-

Temperature- Temperature is one of the most important components of climate. It plays vital role on production of vegetable crops. The requirement of temperature for seed germination is varies according to crop. In some vegetables like onion germinate at low temperature while beans require high temperature. Many vegetables are induce to flower to low temperature particularly brinjal and perennial plant. The induction of flowering due to low temperature is called **vernalization**. Excessively high temperature or low temperature may reduce pollen viability and receptivity of stigma, poor fertilization usually is characterized by abortion of flower. The quality of vegetable are reduces not only through respiration but also because of tissue damage or alternate morphology following exposure to excessive heat or chilling and because of change, the quantity of starch and sugar are reduces. High or low temperature reduces or increases the rate of respiration and photosynthesis. Respiration is also major factor affecting ripening and post harvest quality of vegetables.

Protection from low temperature- Growing low temperature tolerant varieties, establish wind break, maintain soil moisture, mulch the nursery bed, rising of

temperature by using heaters.

Protection from high temperature- Shading should be provide wind breaks are by planting hedges, raise crop with high density and irrigate the field regularly.

Light- Light is an electromagnetic radiation which is a form of kinetic energy. Light is also one of the most important factors affecting plant life very effectively. Light is an integral part of photosynthesis reaction in that it provides the energy for the combination of CO_2 and H_2O in the green cells having chlorophyll for the formation of carbohydrates with the release of O_2. Low light intensity are decrease in rate of photosynthesis, leaf tip become discolour, leaves and bud drops, flowers are light in colour while high light intensity are the plant wilt and light colour may becomes grey in colour. According to light duration vegetables are categorized in three types. Those plants which require short night of 8-10 hours of continue dark period for induction of flowering eg. Beans, cowpea, lettuce, radish, spinach beet etc. are called long day plant. Those plants which require long light 10-14 hours of continue dark for induction flowering eg. Onion, bean, sweet potato etc. are called short day plant. Those plants in which flowering are induced irrespective of duration of light such plants are known day neutral plant. Eg- French bean, tomato etc. Light also affect the germination of seed. For example lettuce seeds are compulsory to expose in light before sowing to break dormancy. Light also affect the growth of vegetable plant, for flowering and tuber and bulb formation.

Relative humidity- The relative humidity with in the plant canopy does influences the transpiration rate and turgor of leaves and the intensity of physiological disorders such as tip burn. Humidity also affects plant growth indirectly by supporting development of diseases and insect infestations. In some species of beans low humidity seems to increase flower abortion and pollen viability is decreased in many plants.

Rainfall- This is very important factor in vegetable production and if market garden is established in a new area it is essential that the pattern of rainfall in the region studied before any decision in the taken concerning the type of crop to be cultivated. Hills and ridge of high land favour uneven distribution of rainfall. High rainfall seems

to fall the flowers of vegetable which lead to decrease in production. High rainfall cause water logging condition while low rainfall cause deficiency of water in the field. It also affects the fertilization of flower by diluting pollen at the time of fertilization.

Learning Process and support materials:

- Collecting data of rainfall and temperature to know the pattern of rainfall and temperature.
- Visiting weather station located in the DADO (District Agriculture Development Office)
- By making presentation about the effect of climatic factors in vegetable production.
- krishi Diary

Assessement:

Very Short Questions

Q.N.1 Define climate.

Q.N.2 What do you mean by weather?

Q.N.3 Define the term 'vernalization'.

Q.N.4 How can you protect your vegetables from low temperature and high temperature?

Short Questions:

Q.N.1 Explain the effect of temperature in vegetable production.

Q.N.2 What are the climatic factors affecting vegetable production? Explain the effect of rainfall and wind.

Q.N.3 What is light? Explain the effect of light in vegetable production.

Long Questions:

Q.N.1 enlists the different factors affecting on vegetable production and explain positive and negative effect of each factors.

Glossory:

- Climate= climate refers to the sum total of weather condition over a longer period of time in large area. such as temperate climate, tropical climate, sub-tropical climate, temperate climate etc.
- weather= weather refers to the atmospheric condition in terms of light, rainfall, temperature, humidity in relatively smaller area.
- Vernalization= induction of flowering in vegetables due to low temperature is called vernalization.

Reference:

- Singh, K.P. and R.R. Bhandari. 2015 Vegetable crops production Technology, Samiksha Publication, Kathmandu, Nepal.
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UNIT - 4

Cultivation practices of vegetables and spices (VSQ=2, SQ=1, LQ=1 TQ=4)

Objective:

- To know the basic principles of vegetable cultivation.
- Became able to cultivate different vegetables in the field.
- To know about the different physiological disorder that appears in vegetables.
- To know how to manage attack of insect, pest in the vegetable field.
- To know symptoms, causes and control measures of different diseases that attacks on different vegetables.

Content elaboration:

- To know the processing techniques of vegetables locally as well as internationally.

Solanaceous vegetables

Potato

B.N.- *Solanum* tuberosum **Famliy-** *Solanaceae*

Nutritive value- The potato is rich source of carbohydrates (22.6g) while other nutrients like protein (1.6g) and vitamin C (17 mg) are also present in the edible part of the potato.

Uses- Potato is the king of the vegetables. It is mainly used as curry. Preserve potatoes are very popular in market as allu chips, allu bhujiya. It is highly consumed as allu chop, katlet, aalu dam etc.

Varities- Kufri jyoti, Kufri siduri, Dijire, Janak dev, Khumal rato-2, Khumal seto-1, Cardinal, NPI 106, Kufri badshah etc.

Climatic and soil requirement- Potato is a cool season crop and requires low temperature, low humidity and bright sunny days. The temperature for germination of tubers and satisfactory tuber growth is 25ºC and 17-19ºC respectively. A temperature above 30ºC completely stops the tuber formation.

Potato can be grown on a variety of soil but well drained sandy loam to clay loam soils rich in organic matter having pH 5.5-7.5 are found best.

Manuring-Potato is heavy feeder and thus, needs a high doses of nutrients. Well rotten FYM @ 200-250 q/ha in the soil 3-4 weeks before planting is incorporated. Besides 100 kg N, 100 kg P, 60 kg K depending upon type of soil and fertility status should be supplied. 2/3 quantity of N and whole quantities of P and K should be applied at the time of planting. Apply the remaining dose of N at 30-35 days after planting *i.e.* at the time of first earthing up.

Time of planting- The planting time of potato varies considerably from region to region. The main time of planting in high hills is falgun to chaitra, poush to magh for mid hills and asoj to mangsir for terai.

Method of planting- The commonly used methods of potato planting are as follows:

- **Flat bed method-** It is commonly adopted in areas having light sandy soils. The tubers are planted in flat beds in very shallow furrows. The method requires two earthing up. First at 30-35 DAS and second 25-30 days after first earthing up.
- **Furrow planting-** In this method tubers are planted in furrows (5-7 cm deep) and adopted in irrigated areas having light sandy soils. It needs ridging to 10-15 cm height soon after planting and then at 30-35 DAP.
- **Planting on ridges-** The ridges of 30 cm height are made at 70 cm spacing and tubers are planted opposite in these ridges.

Seed size, spacing and seed rate- Tuber having 25g weight and 2.5-3.0 cm diameter are considered ideal for main crop planting. Seed rate depends upon the size of seed tubers and spacing. A medium size of tuber can be planted at a distance of 75 cm from row to row and 25 cm from plant to plant. Generally 15-20 q seed tubers are required for one hectare area.

Cutting of seed- Cut the large sized tubers in small pieces with the help of disinfected knife. The main objective of cutting the seeds are to lower down the cost of seed. During cutting keep 2-3 healthy eyes on the cut pieces. The average weight of the cut seed piece should be 30-40g.

Irrigation- Being a shallow rooted crop, potato requires light irrigation frequently. In general light soils should be irrigated at an interval of 8-10 days whereas heavy soils at 12-15 days. Light irrigation should be given when frost is expected. The critical stages for irrigation are germination, tuber formation followed by earthing up and tuber bulking appears at 10-12, 30-35 and 55-60 DAP respectively.

Weeding- Two manual weeding first at 15-20 DAP and second weeding-cum-hoeing at 30-35 DAP. The first weeding may be replaced by use of herbicide but second weeding and hoeing at earthing is a must. The most common herbicide used to control weeds in potato are Fluchloralin (1.0 kg/ha) and Pendimethalin (0.5 kg/ha) used as pre-planting while Simazine (0.5 Kg/ha), Alchlor (1.0-1.5 kg/ha) applied as early pre-emergence and Paraquat (0.5 kg/ha) applied at early post emergence *i.e.* when more than 5% potato plants have just emerged from the soil.

Earthing- If potato tubers are exposed to sunlight, they will start to synthesize anthocyanin and chlorophyll. The chlorophyll formation in tubers check the accumulation of starch which resulted in small sized tubers with bitter in taste due to presence of *Solanin.* Generally two earthing is sufficient in flat bed planting. First at 30-35 DAP and second at 25-30 days after first earthing up. Irrigate the field lightly just after earthing.

Harvesting- The time of harvesting of potato depends on number of factors *viz.* variety, market price, weather condition, purpose for which crop is grown etc. Early varieties mature in 80 days, medium in 90-100 days and late in 100-120 days. Sometimes, the crop is harvested early to fetch high market price and to facilitate the sowing of succeeding crop. Potatoes harvested at full maturity stage will have better shelf life. Withholding of irrigation about 15 days before the harvesting will harden the skin of tubers. The harvested tubers are allowed to dry in open under shade.

Insect pests-

Aphids (*Aphis gossypii* and *Myzus persicae***)-** The nymph and adults suck the sap from tender parts of the plant. They also act as vector for several viral diseases like potato mosaic, leaf roll virus etc.

Management-

- Incorporate Phorate 10 g @15 kg/ha in the soil at planting in the furrows.
- Spray the crop with Dimethoate (Rogor) 0.05%.

Potato tuber moth (*Gnorimoschema operculella*)- It is a serious pest of potato both in the field and storage. After hatching, the caterpillar bores and makes tunnels into the tubers.

Management-

- Select healthy and insect free tubers for planting.
- Proper earthing should be done so that tubers are not exposed to ovipositing female moth.
- Spray the crop with carbaryl (0.2%).
- Treat the gunny bags used for storage with Neem karnel extract at 10%.

Cutworms (Agrotis ipsilon)- Among the different spices of cutworm the Agrotis ipsilon is the most common and devasting one. The caterpillars cut the young seedlings at the base near the soil.

Management

- Apply phorate 10 g @ 15 kg/ha in the soil before sowing.
- Drench the soil around the plants with cholofevninphos @ 0.05%.

White grub (*Holotrichia insularis*)- The grub feed on the roots and developing tubers and make large holes. The adults feed on the foliage of trees and lay eggs in the soil.

Management-

- Follow clean cultivation.
- Apply phorate 10 g @ 15 kg/ha in the soil before sowing.
- Spray the neighbouring trees with endosulphan @ 0.03%.

Diseases- (Fungal diseases)

Early Blight (c.o.- *Alternaria solani*)- The disease is characterized by the appearance of dead spots with concentric rings on the leaves. The fungus is soil borne and warm moist weather is favourable for the development and spread of disease.

Control-

- Grow resistant varieties like kufri sinduri, kufri jeevan etc

- Follow crop rotation
- Adopt phytosanitary measures
- Spray dithane M-45(Mancozeb), Dimethomorph etc. @ 0.25% at 10 days interval.

Late blight (c.o.- *Phytophthora infestans*)- Circular or irregular water soaked spots appear on the leaves which soon turn to brownish black lesions. The lesions enlarge and coalesce killing the entire leaves. Decayed leaves emit offensive odour. Cool moist environment is favourable.

Control-

- Use healthy, disese free and certified seed tubers for planting.
- Locate resistant varieties like- Kufri jeevan, kufri alankar etc.
- Make four prophylactic sprays of Blitox-50 or dithane M-45 at 7 days interval.
- Spray the crop with dithane M-45 @ 0.25% at 15 days interval starting from the appearance of disease.

Wart (*Synchytrium endobioticum*)- It is a serious soil disease but restricted to only Darjelling hills and surrounding areas. The disease attacks all under ground part except roots. Affected parts exhibit warty outgrowth. The wart is a distorted, proliferated branched structure grown together into a mass.

Control

- Follow quarantine measures
- Avoid potato cultivation on wart affected soil.
- Grow wart resistant varieties like Kufri jyoti, kufri jeevan.
- Soil sterilization should be done by copper sulphate or formaline before planting.

Bacterial diseases

Bacterial wilt (*Pseodomonas solanacearum*)- It is characterized by the appearance of wilting, stunting and yellowing of foliage followed by collapse of the plant. Browning of the xylem in the vascular bundles occurs. The infected tubers are discoloured. The pathogen is soil borne.

Control-

- Use healthy, disese free and certified seed tubers for planting.
- Follow at least 3 years crop rotation with maize, cowpea, French bean etc.
- Treat the seed tubers with streptocycline solution @ 0.02% for 30 minutes before planting.

Soft rot (*Erwinia carotovora* spp. *atroseptica*)- The infected plants remain dwarf and stunted. Leaves turned yellow and curled. Brown black rotten areas develop on the base of the stem called **black leg.** The affected tubers become dark both inside and outside. The internal tissues become soft resulting in disintegration of whole tuber. The pathogen is also prevalent in storage.

Control-

- Select disease free seed tubers for planting.
- Follow long term crop rotation.
- Uproot affected plants and destroy them.
- Treat the seed tubers in streptocyclin solution @ 0.01% before planting.

Viral diseases

Leaf roll- It is affected by leaf roll virus. The leaves of affected plant roll upward turn light green in colour and become leathery in texture. It is transmited through several species of aphids (*Myzus persicae*).

Mosaic- The causal organism is potato mosaic virus. mild mottling or light green colours of the infected plants occur. It is transmitted mechanically by the contact of disease plants and other farm implements.

Control-

- Select disease free seed tubers for planting.
- Uproot affected plants and destroy them.
- Before the use of tools implements wash them with 3% solution of trisodium phosphate.

Post-harvest, handling and storage- Nearly one fifth of the total potato production in the country is used as planting material in the following season. Therefore, post-harvest handling particularly seed stocks become very important. After harvesting potatoes are kept in heaps in cool places for another 10-15 days for drying and curing of skin. Heaps 3-4 meter long, wide at the base and 1 meter in the central height are the best. In hills the harvested potatoes are spread in well ventilated rooms for drying. Before grading all the cut, damaged and rotted tubers are removed. The tubers are then graded and packed in gunny bags according to sizes preferably in 4 sizes, e.g. small (below 25g), medium (25-50g), large (50-75g) and extra large (above 75g). After grading potatoes meant for use as seed next year are treated with 3% boric acid solution for 30 minutes for protecting against soil-pathogens, e.g. black scurf, common scab etc. before storing in the bags.

In plains the seed potatoes after drying, curing and grading are stored in cold stores where temperature is maintained at 2-4^{o}C with high relative humidity. The low temperature checks sprouting and rottage and high relative humidity reduces weight loss in tubers.

Value added products of potato- Potatoes can be easily processed into dehydrated and canned products like- chips, french fries, finger chips, granules, disc, cubes, flour etc.

Marketing- Potatoes are semi-perishable and bulky therefore their transport to long distance is problem. Often potatoes rot during transit because of high temperatures at the time of transportation. The problem is compounded further due to shortage of transporting wagons. The total cold storage capacity in the country is very low. The markets in potato producing belts in plains are also not properly integrated. Because of these factors marketing of potato is a complicated process and potato price are

prone to high fluctuations and often glut situations.

Tomato

B.N.- *Lycopersicon esculentum* **Family-** *Solanaceae*

Nutritive value-

Nutrient	**Green**	**Red**
Protein (g)	1.9	0.9
Fat (g)	3.6	3.6
Calcium (mg)	20	48
Iron (mg)	1.8	0.4
Vitamin A (IU)	320	585
Vitamin C	31	26

Uses- Tomato supplies vitamin C and adds variety of colours and flavours to the food. The fruits are eaten raw or cooked. Large quantities of tomatoes are used to prepare soup, juice, ketchup, puree, pickle, paste and powder.

Variety- Pusa ruby, Manpracs, Roma, C.L. 1131, N-162, Bisesh, Bhim, Surekhchha, Manisha, N.S.-815, Grasco, HRD 1, Lapsi gade, Bari-4, CL cross etc.

Climatic requirement- Tomato requires warm season for successful cultivation. The optimum temperature for tomato cultivation is 15-25ºC. Below 10ºC fruits are unable to develop red colour. Above 30ºC red colour start to disappear and fruits become yellowish red. When temperature goes to above 40ºC lycopene is completely destroyed.

Soil and field preparation- Tomato can be grown on a wide range of soil from sandy to heavy clay. However, for higher yield well drained, rich in organic mater loamy soils having a pH of 6.0 to 7.0 are ideal. The soil should be ploughed thoroughly to bring fine tilth. Generally, 4-5 ploughings are needed to make the soil friable followed by planking.

Nursery raising- The sandy loam and loam soils rich in organic matter are suitable for the nursery. In soil with good tilth 15 cm raised nursery beds of 3m length and 1

m width are prepared. 15 kg FYM and 300g of N:P:K (15:15:15) complex fertilizer along with 7.5g carbofuran per bed is incorporated. The beds are drenched with captan or any systemic fungicide @ 2-3 g/liter of water. Seeds are sown thinly in rows 6 cm apart and 0.5 cm deep. The beds are covered thinly with straw or grass layer and irrigate with rose-cane. On germination (5-7 days) the beds are again drenched. After the appearance of first true leaf seedlings are thinned out. On the 20th day Monocrotophos or any systemic insecticide (1.5-2 ml) and on 25th day mancozeb are sprayed. During the last week of nursery, the seedlings may be hardened by slightly withholding water for better establishment of seedlings. The seedlings with 5-6 true leaves are transplanted after 30 days. Normally 400-500g seed/ha is sufficient for the spring crop and 1.0-1.2 kg for summer crop, since mortality of seedling is high. Incase of hybrids 100-150g seed is sufficient for one hectare area.

Sowing time- Tomato can be grown throughout the year. However, the number of crops grown varies from region to region. Mainly tomato is sown in high hills from Baisakh to Jestha, in mid hills from Falgun to bhadau and in terai from bhadra to magh.

Transplanting- When seedlings attain the height of 8-12cm having 5-6 true leaves, these are ready to transplanting in the already prepared field. Normally transplanting is done in the evening hours. The field should be irrigating immediately after transplanting and then frequent irrigations are made until the establishment of seedlings. Spacing depends upon the type of variety, growth habit and season. Generally 75 X 45cm in determinate type while 120 X 30cm are adopted in indeterminate type of variety. The spacing should be increased and decreased as per the fertility status of the soil, favourability of the environment.

Manure and Fertilizer- The entire quantity of FYM or compost (200-250q/ha) is incorporated at the time of first ploughings. 25 kg Carbofuran per hectare is also applied. Generally 150-200 kg N, 60-100 kg P and 100-120 kg K are required for one hectare area. Half dose of N and full dose of P and K is applied as basal and the remaining half dose of N is applied as top dressing in two equal splits *i.e.* 30 and 45 days after transplanting. For the indeterminate varieties the top dress should be made in 3 split doses *i.e.* 30, 50 and 75 days. In case of furrow and ridge method, the mixture

of fertilizers is applied in the bands and earthing up.

Irrigation- Tomato requires frequent irrigation. However, excess irrigation may lead to more vegetative growth and less fruiting while water deficiency leads to reduction in fruit setting. The first irrigation is applied soon after transplanting. The subsequent irrigations are made at 8-10 days interval or as per requirement of the crop.

Inter-culture operation and weed control- For raising a successful crop, gap filling, hoeing, earthing up, stalking pruning and mulching is required. Generally during summer and rainy season 6-8 DAP there is mortality of seedlings. In order to maintain adequate plant population, gap filling is essential. Gap filling is done in the evening and soon after the field is irrigated.

Pre-transplant surface application of Alachlor (1-1.5 kg) or Oxadiazon (1.0 kg) and post-transplant spraying of Metribuzine (0.5 kg) controls the weed very effectively.

Harvesting- The time of harvesting depends upon the purpose and distance from the market. Tomato fruits can be harvested on the following stages:

- **Green stage-** Fully mature green fruits are harvested to get more price of the produce at early stage.
- **Breaker or turning stage-** The fruits are harvested when ¼ blossom end of the fruit show pink colour. This is suitable to send the fruits to distance market.
- **Pink stage-** When ¾ of the surface towards blossom end shows pink colour. These fruits can be used to sale in the local market as well as to send distant market.
- **Ripe stage-** When entire fruit develop pink or red colour but fruits are still firm. This stage is suitable for table or salad purpose and to sell at farmer's field.
- **Over ripe stage-** When fruits attain maximum colour and become soft. Such fruits are suitable for processing purposes.

Yield- The yield of tomato depends on many factors like soil, variety, season and management practices followed. However, the average production of tomato is 200-300q/ha.

Physiological disorder-

a) **Blossom end rot-** It is the most common and destructive type of disorder of tomato. Brown coloured lesions appear at the blossom end while the fruits are green. At the point of attachment of senescent petals water soaked spots develop which enlarge in size. This disorder results in the sunken, lathery and dark colour development on the affected part of the fruit.

Causes-

- High soil moisture and high temperature.
- Moisture stress conditions.
- Application of nitrogen in abundant quantity.
- Deficiency of calcium.

Control-

- Give light and frequent irrigation to maintain optimum soil moisture.
- Apply recommended quantity of nitrogen.
- Spray crop with calcium chloride.

b) **Fruit cracking-** The surface of mature green and ripe fruit cracks at the stem end. It is common disorder during rainy season.

Causes-

- Long dry spell during rainy season.
- Moisture stress condition.
- Exposure to fruit to sunlight.
- Boron deficiency in the soil.

Control-

- Maintain soil moisture through light irrigation.
- Avoid pruning and stalking of plants during summer.
- Grow resistant varieties like- Sioux, Punjab chhuhara, Pusa ruby, Roma etc.
- Harvest the fruit before ripe fully.

Puffiness- When the fruit attain about 2/3 of normal size, the growth of internal tissues retards whereas the outer wall develops normally. The affected fruits are light in weight, lack of firmness and partially filled. The disorder is more common in winter

season.

Causes-

- Lack of fertilization.
- Abortion of embryo after fertilization.
- High temperature and high soil moisture.
- Application of high dose of nitrogen.

Control-

- Avoid over watering to the crop.
- Apply recommended dose of nitrogen.

Cat face- The affected fruits are characterized by the distortion of the blossom end rot and development of ridges, furrow indentation and blotches.

Causes- Unfavourable climatic conditions during flowering cause distortion of growth of the pistil cells.

Control

- Grow varieties free from disorder.
- Cultivate the tomato in normal growing season.

Insect-pests

Aphids (*Aphis gossypii, Myzus persicae***)-** They suck the cell sap from leaves and tender points.

Control

- Spray Dimethoate (0.03%) at 10 days interval starting from flowering stage.

Fruit borer (*Helicoverpa ormigera***)-** The larvae feed on flowers, flower buds and young tender fruits. They feed on the newly formed fruits and make them unfit for consumption causing rotting.

Control

- Spray endosulphan (0.05%) at 10 days interval starting from flowering stage.
- Grow tall varieties of marigold as intercrop in a row after every 14 rows of tomato to attract the insects.

- Grow leaf affected varieties like Pusa red plum.

White fly (*Bemisia tabaci*)- The minute insects suck the sap of tender parts. Severe damage results in yellowing and curling of leaves. It also acts as a vector to transmit leaf curl virus.

Control-

- Uproot alternate host.
- Spray Dimethoate (0.05%).

Root Knot Nematode (*Meloidogyne incognita*)- Affected plants remain stunted and weak, foliage turn yellow and wilt. Knot like swelling can be seen on the roots.

Control-

- Follow long term crop rotation with rice, maize or marigold.
- Deep ploughing of the field during summer.
- Grow resistant varieties like Sel-120, PNR 7, Hissar lalit etc.
- Apply organic amendments like neem cake or mahua cake @ 25 q/ha in the soil.
- Incarporate Carbofuran or Phorate or Aldicarb @ 25 kg/ha in the soil before planting.

Diseases-

Fungal diseases-

Damping off (*Pythium sp., Rhizoctonia sp., Fusarium sp., Phuotophthora parasitica*)- It cause damage both at pre and post emergence death of seedling. It is characterized by rapid shirinking and rotting at colar region resulting in toppling down of infected seedlings.

Control

- Provide proper drainage facility to avoid stagnant of water.
- Deep ploughings during summer.
- Thin sowing of seeds to avoid overcrowding.
- Seed treatment with Bavistin @ 2g/kg of seed.

Early Blight (c.o.- *Alternaria solani*)- The disease is characterized by the appearance of dead spots with concentric rings on the leaves. The fungus is soil borne and warm moist weather is favourable for the development and spread of disease.

Control

- Follow crop rotation
- Adopt phytosanitary measures
- Spray dithane M-45(Mancozeb), Dimethomorph etc. @ 0.25% at 10 days interval.

Late blight (c.o.- *Phytophthora infestans*)- Circular or irregular water soaked spots appear on the leaves which soon turn to brownish black lesions. The lesions enlarge and coalesce killing the entire leaves. Decayed leaves emit offensive odour. Cool moist environment is favourable.

Control-

- Use healthy, disese free and certified seeds for sowing.
- Make four prophylactic sprays of Blitox-50 or dithane M-45 at 7 days interval.
- Spray the crop with dithane M-45 @ 0.25% at 15 days interval starting from the appearance of disease.

Buckeye rot or fruit rot (*Phytophthora nicotianae* var. *parasitica***)-** Brown spots appear at the point of the contact between fruit and soil. The spot enlarge to produce concentric rings of narrow, dark brown and wide light brown bands.

Control

- Ensure proper drainage during rainy season.
- Destroy weed hosts.
- Treat the seed with Bavistin 2g/kg of seed.

- Pick rotten fruits regularly and destroy them.
- In case of indeterminate type of tomato keep the plants erect by stalking.
- Alternately spray the crop with Bavistin (0.25%) at 10 days interval.

Bacterial diseases

Bacterial wilt (*Pseudomonas solonacearum*)- Wilting of lower leaves followed by sudden and permanent wilting of entire plants are the typical symptom. The vascular tissues of lower stems and roots exude slimy bacterial ooze.

Control

- Adopt 3 year crop rotation with non solanaceous crops.
- Raise nursery in disease free area.
- Uproot infected plants and burn them.
- Use resistant varieties like BT-1, BT-10 etc.
- Dip seeds in Streptocyclin suspension @ 150 ppm for 90 minutes.
- Spray Streptocyclin (0.25%) at 10 days interval.

Leaf curl- The characteristic symptoms are curling of leaves and crowding together. Stunted growth of plants, infected leaves turn pale. Infected plants produce more stunted lateral branches resulting in a bushy growth. Incidence is favoured high temperature and low humidity. This disease is transmitted by white fly.

Control

- Rouge out infected plants.
- Uproot the weeds.
- Raise nursery in disease free areas.
- Treat the nursery beds before sowing with furadan @ 10 g/bed.
- Spray Dimathoate (0.05%) at 10 days interval.
- Planting of border crops like maize about 2 months before transplanting.

Mosaic- It is characterized by TMV. Mottling of leaves and formation of dark green patches on the leaves are the characteristic symptom. The growth of infected plants is stunted and bears very few fruits. The virus is sap transmitted and also seed borne.

Control

- Follow clean cultivation.
- Select virus free seeds.
- Follow crop rotation excluding potato, brinjal, chilli etc.
- Give hot water treatment at 50° C at 30 minutes to the seed.

Maturity standards and post-harvest management- Optimum maturity of the tomato depends upon the marketing and other processing purposes. The maturity stages of tomato fruits are classified by USDA as: mature green, breaker, turning red, pink, light-red and red. Red ripe tomatoes are preferred for local market and processing use and fruits at the fully matured green, turning red and pink are preferred for long distance market and storage. Tomatoes are graded for specialized city markets; however, grading is also in vogue in local market.

Storage and marketing- Tomatoes can be stored in low temperature and evaporative cool storage. Pre-cooling of tomato after harvest and prior to storage and transportation are reported to prolong their storage-life. Tomato fruits at mature green stage could be stored successfully at 12-13°C in polythene bags of 100 gauge thickness for 3-5 weeks. Storage-life of tomatoes could be increased by keeping in evaporative cool storage (Zero energy cool chamber). It is found that tomato at breaker stage stored in zero energy cool chamber during summer extended shelf-life by 4-5 days. The cool chamber has been found effective in maintaining fruit acceptability for longer period and minimizing weight loss considerably distances markets. Use of polythene for pre-packaging of tomatoes could reduce the physiological losses in weight and increases the shelf-life.

Chillies and Sweet pepper

Nutritive value-

Contents	Green	Dry
Protein (g)	2.9	15.9
Fat (g)	0.6	6.2
Carbohydrates (g)	3	31.6
Calcium (mg)	30	160
Iron (mg)	1.2	1.3
Vitamin A (IU)	292	575
Vitamin C (mg)	111	50

Uses- Chilli is cultivated for vegetables, spices and pickles. Green fruits are good

source of vitamin A and C.

Capsicum or sweet pepper or simla mirch or bell pepper bears bell shaped, non pungent, mild and thick fleshed fruits. Green fruits are used as vegetables because they are less pungent.

The pungency in chilli is due to crystalline volatile alkaloid **capsaicin**, which has good export potentiality. The red colours of chillies are due to presence of pigment **capsanthin**.

Varieties of chillies- Jwala, N.S. 1701, Local nepali

Varieties of capsicum- California, Wonder well

Climate and soil requirement- Chilli is very sensitive to frost. The optimum temperature for fruit set is 24ºC. When night temperature goes below 10ºC, the fruit set is restricted. Comparatively milder climatic conditions are preferred for sweet pepper cultivation as compared to hot pepper. Temperature above 23.5ºC affects the development of fruit adversely. Fruit weight, length, girth, pericarp thickness and number of seeds per fruits were high at 25ºC/18ºC day and night temperature. Rainy season is the main season for chilli cultivation while it might be cultivate in summer and winter season also. Rainy crop is planted in the month Ashar to Shrawan, Winter crop in the month of Ashwin to Kartik and summer crop in the month of Magh to Falgun.

Chilli can be grown on all types of soils from light sandy to heavy clay. The optimum soil pH is 5.8-6.5. Chilli crop is very sensitive to waterlogging.

Thoroughly plough the land 3-4 times to obtain a fine tilth. The last ploughing should be followed by planking to level the field.

Nursery Raising- The sandy loam and loam soils rich in organic matter are suitable for the nursery. In soil with good tilth 10-12 beds of 15 cm raised nursery beds of 3m length and 1 m width are prepared. 15 kg FYM and 500g of N:P:K (15:15:15) complex fertilizer along with 7.5g carbofuran per bed is incorporated. The beds are drenched with captan or any systemic fungicide @ 2-3 g/liter of water. Seeds are sown thinly in rows 6 cm apart and 2.5 mm deep. The beds are covered thinly with straw or grass

layer and irrigate with rose-cane. On germination (10-12 days) the beds are again drenched. After the appearance of first true life seedlings are thinned out. On the 20th day Monocrotophos or any systemic insecticide (1.5-2 ml) and on 25th day mancozeb are sprayed. During the last week of nursery, the seedlings may be hardened by slightly withholding water for better establishment of seedlings. The seedlings with 5-6 true leaves are transplanted after 30 days. About 1.0-1.5 kg seed is sufficient for one hectare area.

Transplanting- When seedlings attain the height of 8-12cm having 5-6 true leaves, these are ready to transplanting in the already prepared field. Normally transplanting is done in the evening hours. The field should be irrigating immediately after transplanting and then frequent irrigations are made until the establishment of seedlings. Spacing depends upon the type of variety and season. The optimum spacing is 60 X 45cm. The spacing should be increased and decreased as per the fertility status of the soil, favourability of the environment.

Manure and Fertilizer- The entire quantity of FYM or compost (200-250q/ha) is incorporated at the time of first ploughings. 25 kg Carbofuran per hectare is also applied. Generally 80-100 kg N, 40-50 kg P and 40-50 kg K are required for one hectare area. Half dose of N and full dose of P and K is applied as basal and the remaining half dose of N is applied as top dressing at 30 days after transplanting.

Irrigation- Chilli requires frequent irrigation. However, excess irrigation may lead to more vegetative growth and less fruiting while water deficiency leads to reduction in fruit setting. The first irrigation is applied soon after transplanting. The subsequent irrigations are made at 8-10 days interval or as per requirement of the crop.

Inter-culture operation and weed control- For raising a successful crop, gap filling, hoeing and mulching is required. Generally during summer and rainy season 6-8 DAT there is mortality of seedlings. In order to maintain adequate plant population, gap filling is essential. Gap filling is done in the evening and soon after the field is irrigated. Pre-transplant surface application of Alachlor (1-1.5 kg) or Oxadiazon (1.0 kg) and post-transplant spraying of Metribuzine (0.5 kg) controls the weed very effectively.

Harvesting- Chilli is mainly grown for ripe fruits whereas bell pepper is grown for green fruits. Green fruits are harvested when they are still green in colour at 60 DAT and dry fruits 90 DAT. Generally 5-6 pickings are made for green chillies while 2-3 picking for red ripe fruits.

Yield- Green – 50-60q/ha (rainfed), 200-300 q/ha (irrigated) and Dry chillies 5-6 q/ha (rainfed), 20-30 q/ha (irrigated).

Insect-pests

Aphids (*Aphis gossypii, Myzus persicae***)-** The suck the cell sap from leaves and tender points.

Control-

Spray Dimethoate (0.03%) at 10 days interval starting from flowering stage.

Fruit borer (*Helicoverpa ormigera***)-** The larvae feed on flowers, flower buds and young tender fruits. They feed on the newly formed fruits and make them unfit for consumption causing rotting.

Control-

- Spray endosulphan (0.05%) at 10 days interval starting from flowering stage.
- Grow tall varieties of marigold as intercrop in a row after every 14 rows of tomato to attract the insects.
- Grow leaf affected varieties like Pusa red plum.

White fly (*Bemisia tabaci***)-** The minute insects suck the sap of tender parts. Severe damage results in yellowing and curling of leaves. It also acts as a vector to transmit leaf curl virus.

Control-

- Uproot alternate host.
- Spray Dimethoate (0.05%).

Diseases-

Fungal diseases-

Damping off (*Pythium sp., Rhizoctonia sp., Fusarium sp., Phuotophthora parasitica***)-** It cause damage both at pre and post emergence death of seedling. It is characterized by rapid shirinking and rotting at colar region resulting in toppling down of infected seedlings.

Control-

- Provide proper drainage facility to avoid stagnant of water.
- Deep ploughings during summer.
- Thin sowing of seeds to avoid overcrowding.
- Seed treatment with Bavistin @ 2g/kg of seed.

Early Blight (c.o.- *Alternaria solani*)- The disease is characterized by the appearance of dead spots with concentric rings on the leaves. The fungus is soil borne and warm moist weather is favourable for the development and spread of disease.

Control-

- Follow crop rotation
- Adopt phytosanitary measures
- Spray dithane M-45(Mancozeb), Dimethomorph etc. @ 0.25% at 10 days interval.

Late blight (c.o.- *Phytophthora infestans*)- Circular or irregular water soaked spots appear on the leaves which soon turn to brownish black lesions. The lesions enlarge and coalesce killing the entire leaves. Decayed leaves emit offensive odour. Cool moist environment is favourable.

Control-

- Use healthy, disese free and certified seeds for sowing.
- Make four prophylactic sprays of Blitox-50 or dithane M-45 at 7 days interval.
- Spray the crop with dithane M-45 @ 0.25% at 15 days interval starting from the appearance of disease.

Ripe fruit rot, dieback and anthracnose (*Colletotrichum capsici***)-** Black water soaked spots appear on the leaves which gradually turn brown to black in colour. Dieback is usually observed after the rains have stopped and prolonged deposition of

dew of the plants.

Control-

- Use disease free seeds.
- Treat the seed with Bavistin 2g/kg of seed.
- Spray the crop with dithane M-45 @ 0.25% at 15 days interval starting from the appearance of disease.

Bacterial diseases

Bacterial leaf spot (*Xanthomonas vesicatoria***)-** The important characteristics of the disease is the development of small dark and greasy spots on the leaves, petioles and stems and water soaked spots on the green fruits. Spot remain light brown and slightly sunken towards the centre.

Control-

- Use disease free seeds
- Seed treatment with hot water at 50ºC for 25 minutes.
- Remove the affected plants.
- Spray Streptocyclin 200 ppm + copper oxychloride (0.03%) thrice during Ashwin-Kartik.

Leaf curl- The characteristic symptoms are curling of leaves and crowding together. Stunted growth of plants, infected leaves turn pale. Infected plants produce more stunted lateral branches resulting in a bushy growth. Incidence is favoured high temperature and low humidity. This disease is transmitted by white fly.

Control-

- Rouge out infected plants.
- Uproot the weeds.
- Raise nursery in disease free areas.
- Treat the nursery beds before sowing with furadan @ 1 kg/ha.
- Spray Dimathoate (0.05%) at 10 days interval.
- Spray border crops like maize about 2 months before transplanting.

Mosaic- It is characterized by TMV. Mottling of leaves and formation of dark green

patches on the leaves are the characteristic symptom. The growth of infected plants is stunted and bears very few fruits. The virus is sap transmitted and also seed borne.

Control-

- Follow clean cultivation.
- Select virus free seeds.
- Follow crop rotation excluding potato, brinjal, chilli etc.
- Give hot water treatment at 50º C at 30 minutes to the seed.

Storage and marketing-

Pre and post-harvest handling- Green chilli and capsicum should be harvested at full maturity stage. Green chilli and capsicum are usually tight filled in gunny bags and send to the local wholesale markets and also transported to long distance markets.

When chilli is used as dry red chilli, harvesting the crop when the pods are well ripened and partially withered in the plant itself gives superior produce with better pungency and colour retention properties. Ideal thing to do would be to keep the harvested pods in heaps either indoors or in shade ways from direct sunlight for 2-3 days so as develop uniform red colour.

To get uniform and quick drying pods have to be spread out in the drying yard in layer of 8-10 cm. Frequent string should be practiced to avoid mold growth and discolouration. Unless the pods are dried properly, they may lose their colour, glossiness and pungency. To avoid microbial activity and aflatoxins, the moisture in the dried pods should be less than 10%. Sun drying takes about 5-15 days depending the day temperature and humidity. Improved drying system includes drying using air blow drier at 44-46ºC and to dry very solar drier. However, it is extremely difficult to dry very large quantities of chillies through these methods.

Marketing- Though chilli is grown mostly in rainy season, harvesting of red ripe chilli commence in November- December. The present system of marketing chilli is through regulated market committees.

Storage- Green chillies and capsicum should be cooled immediately after harvesting, stored and transported at temperature ranging between 7ºC and 10ºC with relative

humidity for 90-95%. If properly cooled and stored, the shelf life can be extended by 14-21 days.

In case of dry chillies, pods should be dried properly after removing plant parts and foreign matter. Later, they can be packed in clean, dry gunny bags and stored in cool dry places ensuring protection from dampness. Dunnage has to be providing to stack the packed bags to prevent moisture ingress from the floor. Care should be taken to stack the bags 50-60 cm away from the wall. Stored product should preferable be exposed to sun periodically. Dry chilli could be stored better in kraft pack at 27ºC and 65% relative humidity where as for powder, polythene bag is effective then clear glass containers.

It is of great importance that the colour and pungency in case of chillies and colour in the case of paprika are maximally preserved during storage. In trade there is preference for mechanically dried capsicums with around 10% moisture as those that are over dried suffer from loss of colour darkening and those with higher moisture level are susceptible to infection and bleaching of colours during storage.

Value added products- The demand of value added chilli powder, colour oleoresin and pungent oleoresin has been steadily increasing. In food beverage industries, chillies has acquired a great importance in the form of oleoresin which permits better distribution of colour and flavour in food as compared to chilli powder. The food industry prefers to use highly coloured and less pungent chillies for preparation of oleoresin. Oleoresin offers many advantages over straight spices, *viz.* cleanliness and uniform flavour. Oleoresin is used in preparation of processed products and also in a number of pharmaceutical formulations.

Brinjal

Brinjal or eggplant (*Solanum melongena* L.) is one of the most popular and principal vegetable crops. It is a perennial plant but grown as an annual. Brinjal has three main botanical varieties under the species melongena; the round or egg shaped cultivars grouped under var. esculentum; the long slender types are under vari. surpentinum; and the dwarf brinjal plants put under depressum. The flowers of brinjal are hermaphrodite and of 4 types depending upon the length of style.

- Long-styled with big sized overy.
- Medium-styled with medium sized ovary
- Pseudo-short styled with rudimentary overy and
- True-short styled with very rudimentary ovary.

Fruit set does not take place in pseudo-short and true-short styled flowers. Brinjal is originated from a wild species *Solanum sysimbrifolium.* Brinjal has Ayurvedic properties. The fruits of brinjal are excellent remedies for those suffering from lever troubles. White brinjal is good for diabetic patient. The green leaves of brinjal are excellent source of vitamin C. The bitter taste of brinjal is due to ***glycoalkaloids***.

Varieties- Nurki, Arka Nidhi, Arka kesav, Sarlahi green, Purple long, Lukee, Benighat Seto

Climate- The brinjal is warm season crop, therefore, susceptible to severe frost. Low temperature during the cool season crop causes deformation of fruits. A daily mean temperature of 13-21ºC is most favourable for optimum growth. The brinjal seed germinate well at 25ºC.

Soil and field preparation- Light soils are good for an early yield, while clay loam and silt loam are well suited for higher yield. Loam and sandy loam soils of normal and high fertility status are best suited for brinjal cultivation.

The soil should be thoroughly prepared by ploughing 4-5 times before transplanting the seedlings. Bulky organic manures like well rotten cowdung or compost should be incorporated evenly in the soil.

Nursery raising- The sandy loam and loam soils rich in organic matter are suitable

for the nursery. In soil with good tilth 10-12 beds of 15 cm raised nursery beds of 3m length and 1 m width are prepared. 15 kg FYM and 300g of N:P:K (15:15:15) complex fertilizer along with 7.5g carbofuran per bed is incorporated. The beds are drenched with captan or any systemic fungicide @ 2-3 g/liter of water. Seeds are sown thinly in rows 6 cm apart and 1.0 cm deep. The beds are covered thinly with straw or grass layer and irrigate with rose-cane. On germination (6-8 days) the beds are again drenched. After the appearance of first true life seedlings are thinned out. On the 20th day Monocrotophos or any systemic insecticide (1.5-2 ml) and on 25th day mancozeb are sprayed. During the last week of nursery, the seedlings may be hardened by slightly withholding water for better establishment of seedlings. The seedlings with 5-6 true leaves are transplanted after 30 days. About 500-700 g seed for pureline varieties and 250 g for hybrids are sufficient for one hectare area.

Sowing time- The time of sowing of seed and transplanting of seedlings varies according to the agro-climatic regions. In high hills it can be sown from Baisakh to Shrawan, in mid hills Falgun to Asar and In plains it can be successfully sown from Ashwin to Kartik.

Manure and Fertilizer- Brinjal is a heavy feeder crop. Therefore, a balance application of manure and fertilizer are very important for successful crop production. Well rotten FYM or compost @ 200-250q/ha are incorporated at the time of field preparation. About 100 kg N, 60 kg P and 60 kg K are required for one hectare area. Full dose P and K and half dose of N is applied at the time of final field preparation before transplanting and the remaining quantity of N as urea is applied in 2-3 splits after 30, 45 and 60 days after transplanting.

Transplanting- The seedlings are ready in 4-5 weeks for transplanting, when they have attained a height of 12-15 cm with 3-4 leaves. Harden the seedlings by withholding irrigation for 4-6 days prior to transplanting. Irrigate the nursery lightly before lifting of seedlings. Uproot the seedlings carefully without injury the roots. Spacing of brinjal plants depend upon the fertility status of soil, type of variety and suitability of season. In general, 60 X 45 cm spacing is kept for brinjal plants.

Irrigation- Chilli requires frequent irrigation. However, excess irrigation may lead

to more vegetative growth and less fruiting while water deficiency leads to reduction in fruit setting. The first irrigation is applied soon after transplanting. The subsequent irrigations are made at 8-10 days interval or as per requirement of the crop.

Inter-culture operation and weed control- For raising a successful crop, gap filling, hoeing and mulching is required. Generally during summer and rainy season 6-8 DAP there is mortality of seedlings. In order to maintain adequate plant population, gap filling is essential. Gap filling is done in the evening and soon after the field is irrigated.Pre-transplant surface application of Alachlor (1-1.5 kg) or Oxadiazon (1.0 kg) and post-transplant spraying of Metribuzine (0.5 kg) controls the weed very effectively.

Harvesting- The brinjal fruits are harvested when they attain full size and colour before start for ripening. Tenderness, bright colour and glossy appearance of fruits are the optimum stage for harvesting the fruits. When the fruits look dull, it is an indication of maturity.

The fruit should be severed from the plant by cutting with a sharp knife. The fleshy calyx and a short piece of the stem are left attached to the fruits.

Yield- The yield varies from season to season, variety to variety and location to location. However, in general 300-400 q/ha of healthy fruits of brinjal can be obtained.

Insect-pests

Aphids (*Aphis gossypii, Myzus persicae***)-** The suck the cell sap from leaves and tender points.

Control-

- Spray Dimethoate (0.03%) at 10 days interval starting from flowering stage.

Shoot and Fruit borer (*Leucinodes orbonalis***)-** The tiny larvae immediately after hatching enters into plant tissue. At initial stage, it attacks on the terminal shoots and later on young fruits as soon as they start setting. The entire hole is so small that it heals up as fruit grow. Young shoots and leaf petioles show sign of wilting and dropping due to insect attack.

- Spray endosulphan (0.05%) at 10 days interval starting from flowering stage.

- Grow tall varieties of marigold as intercrop in a row after every 14 rows of brinjal to attract the insects.

Root Knot Nematode (*Meloidogyne incognita*)- Affected plants remain stunted and weak, foliage turn yellow and wilt. Knot like swelling can be seen on the roots.

Control-

- Follow long term crop rotation with rice, maize or marigold.
- Deep ploughing of the field during summer.
- Grow resistant varieties like Sel-120, PNR 7, Hissar lalit etc.
- Apply organic amendments like neem cake or mahua cake @ 25 q/ha in the soil.
- Incarporate Carbofuran or Phorate or Aldicarb @ 25 kg/ha in the soil before planting.

Diseases-

Fungal diseases-

Damping off (*Pythium sp., Rhizoctonia sp., Fusarium sp., Phuotophthora parasitica*)- It cause damage both at pre and post emergence death of seedling. It is characterized by rapid shirinking and rotting at colar region resulting in toppling down of infected seedlings.

Control-

- Provide proper drainage facility to avoid stagnant of water.
- Deep ploughings during summer.
- Thin sowing of seeds to avoid over crowding.
- Seed treatment wit Bavistin @ 2g/kg of seed.

Phomopsis blight (*Phomopsis vexans*)- It is a serious disease of brinjal. The small circular spots develop on the leaves which turn grey to brown with light colour centres. The disease also attack the stem. The affected leaves become yellowish and die.

Control-

- Collect the seed from healthy fruits.
- Grow resistant varieties like Pusa Bhairav, Florida market etc.
- Give hot water treatment to seed at 50ºC for 30 minutes.

Wilt (*Verticillium dahliae, Fusarium solani***)-** The infected plants retard growth, leaves turn yellow, lack of flowers and fruit set and finally the plant wilt and dies. Vascular tissues of stem turn dark coloured. The fungus also attack on the roots.

Control-

- Follow long term crop rotation with non solanaceous crops.
- Provide proper drainage.
- Drench the soil with a mixture of Bavistin + Dithane M-45 (0.25%).
- Spray Bavistin (0.1%).

Bacterial diseases

Bacterial wilt (*Pseudomonas solonacearum***)-** Wilting of lower leaves followed by sudden and permanent wilting of entire plants are the typical symptom. The vascular tissues of lower stems and roots exude slimy bacterial ooze.

Control-

- Adopt 3 year crop rotation with non solanaceous crops.
- Raise nursery in disease free area.
- Uproot infected plants and burn them.
- Use resistant varieties like BT-1, BT-10 etc.
- Dip seeds in Streptocyclin suspension @ 150 ppm for 90 minutes.
- Spray Streptocyclin (0.25%) at 10 days interval.

Viral diseases-

Mosaic- It is characterized by TMV. Mottling of leaves and formation of dark green patches on the leaves are the characteristic symptom. The growth of infected plants is stunted and bears very few fruits. The virus is sap transmitted and also seed borne.

Control-

- Follow clean cultivation.
- Select virus free seeds.
- Follow crop rotation excluding potato, brinjal, chilli etc.
- Give hot water treatment at 50º C at 30 minutes to the seed.

Mycoplasmal Disease-

Little leaf- It is caused by mycoplasma like organism (MLO). The characteristics symptom are reduction in size of leaves, excessive growth of auxillary branches and stunting of plant growth. Affected plants give rosette like appearance. The floral parts convert into leafy structure. This disease is transmitted by leaf hopper.

Control-

- Rogue out the affected plants.
- Grow resistant varieties like Arka Sheel, Banaras gaint, Manjari gota etc.
- Treat the seed beds with carbofuran 15-20 kg /ha followed by Tetracyaclin hydrochloride solution (500 ppm).
- Spray the crop with Rogor (0.05%) at 10 days interval to control the vector.

Post-harvest handlings and storage- There are several diseases observed in brinjal after harvesting of the crop till marketing. Maximum incidence of fruit rot occurred during the monsoon months of Asoj-Mangsir when temperature and relative humidity usually remain high. Fruit rot also occurs during storage which prevented by post harvested treatments of brinjal in a solution containing 200 ppm NAA in combination with 900 ppm Prochloraz that retards fruit senescence and decaying.

Brinjal green fruits had longer shelf-life of 4 weeks based on the physiological loss in weight, discolouration, spoilage and CO_2 injury during storage at 8-10ºC under controlled atmosphere with initial concentration of 5% CO_2. Room temperature of 20-22ºC was not, however, suitable for storage under modified atmosphere. Brinjal fruits should not keep in the same store with other ethylene producing fruits. Brinjal fruits are better stored at 20ºC than at 6ºC and in perforated polythene bags than in open boxes. The fruits can also be stored for 7-10 days in fairly good condition at 7.2-10ºC with 85-90% relative humidity.

Packing, packaging materials- The freshly harvested fruits are cleaned properly by washing them under sprinkler. They are then graded. Uniform, superior quality fruits, free from disease and insect's blemishes are individually wrapped in the tissue paper and arranged in suitable cartons for exporting them to foreign markets. In Isreal, sometimes they use PVC stretch film for packing of individual fruits. Currently, they pack several fruits (10-25) pre treated with a solution of Prochloraza and NAA inside an imperforated polyethylene lining bags, together with 10 layers of tissue paper to prevent water condensation. The method prevents weight loss and maintains fruit quality during 14 days of storage at 12ºC for 17 days at 20ºC and helps in exporting of brinjal to other countries.

Cole crops- This group includes cauliflower, cabbage, knolkhol, broccoli, Brussels sprout, Chinese cabbage, red cabbage, kale etc. This is very important group of winter season vegetables. All cole crops are hardy and thrive best in cool weather except early variety.

CAULIFLOWER

B.N.- *Brassica oleracea* .L. var. *botrytis* **Family:** Cruciferrae

Nutritive Value- The Cole crops are rich source of vitamin C and A.

Particular	**Cauliflower**	**Cabbage**	**Broccoli**
Carbohydrates (g)	4.0	4.6	5.5
Protein (g)	2.6	1.8	3.3
Fat (g)	0.4	0.1	0.2
Vitamin A (IU)	51	2000	9000
Vitamin C (mg)	56	124	137
Calcium(mg)	33	39	1.29

Variety-

Early- Silver cup 60, White glass, Rami, Milkway, white flash, Sweta

Late- Kathmandu local, Dolpa snowball, Kiojaint, Sarlahi Deepali, Jyapu, N.S. 90, Snowdome, N.S. 84 etc.

Climatic requirement and soil- Indian varieties of cauliflower can tolerate to high

temperature while snowball group is very sensitive to high temperature. Curd formation in cauliflower is sensitive to high as well as low temperature. Different varieties of cauliflower require very specific temperature for their curd formation and its quality. Indian varieties of cauliflower can tolerate the temperature as high as 40°C. The optimum temperature for most of the cole crops for seed germination and growth is 12-18°C except early cauliflower. High temperature in cauliflower caused riceyness, fuzziness, buttoning, yellowing and loosening of curds. The low temperature injury in cauliflower causes blindness.

Fertile, medium to heavy well drained loam soils are best suited to grow cole crops. Cole crops can be grown in slightly acidic to saline soils. However, the optimum pH range is 6.0-7.0 because there is incidence of club rot disease. Molybdenum deficiency occurs more frequently in acidic soil below pH 5.5 which causes whiptail disorder in cauliflower. Therefore, liming of soil should be done to raise the soil pH above 5.5. One deep ploughing and 2-3 light ploughing followed by planking is essential to obtain the fine tilth.

Nursery raising- The sandy loam and loam soils rich in organic matter are suitable for the nursery. In soil with good tilth 15 cm raised nursery beds of 3m length and 1 m width are prepared. About 20-30 beds are sufficient for on hectare area. 15 kg FYM and 50g of N:P:K (19:19:19) complex fertilizer, 200g powered neem cake along with 10g carbofuran per bed is incorporated. The beds are drenched with captan or any systemic fungicide @ 2-3 g/liter of water. Seeds are sown thinly in rows 6 cm apart and 1 cm deep. The beds are covered thinly with straw or grass layer and irrigate with rose-cane. On germination (8-10 days) the beds are again drenched. After the appearance of first true leaf seedlings are thinned out. On the 20th day Monocrotophos or any systemic insecticide (1.5-2 ml) and on 25th day mancozeb are sprayed. During the last week of nursery, the seedlings may be hardened by slightly withholding water for better establishment of seedlings. The seedlings with 5-6 true leaves are transplanted after 30 days.

Seed Rate- For Early crops 600 to 750g of seed are required and for late crops 375 to 400 g seed are required per hectare.

Sowing time- The seed is sown in raised nursery beds which should be sterilized by formaldehyde or some fungicidal treatment. The seed for early sowing should be treated with some mercurial fungicide to save the young seedlings for damping off. According to season early sowing is done from the middle of Jestha to the end of Asar. The late crop is sown from the middle of Bhadra to the end of Ashwin. According to altitude the Magh to Baisakh is suitable time for high hills while shrawan to falgun for mid hills and asar to shrawan in terai depending upon varieties.

Transplanting- The seedlings are transplanted when four to six weeks old, depending upon the season in a well prepared field. The planting distance depends upon the fertility of soil, season, variety and market demand. In some markets small to medium sized curds are preferred to large- sized ones. Closer spacing is given for supplying cauliflowers to such markets. Generally, a spacing of 45cm away is kept for the early varieties and 45 cm from plant to plant and 60 cm from roe to row for late varieties.

Manures and fertilizers-The cauliflower requires very heavy manuring as it removes large quantities of major nutrients from the soil. The fertilizer practices differ in different regions. For best results, 20 to 30 tons of farm yard manure or compost should be applied per hectare three to four weeks before transplanting. 200 kg of nitrogen, about 120 kg of phosphate and 200 kg of potash per hectare should be applied before transplanting. A placement of 5 to 7 cm deep on both sides of rows are advisable. A cauliflower crop often shows boron and molybdenum deficiency symptoms when grown either on an alkaline or highly acidic soil. In such cases 10 to 15 kg of borax per hectare may be applied to the soil or two sprays with 0.3 percent borax on the seedlings may correct the boron deficiency symptoms. Molybdenum deficiency symptoms occur in highly acidic soils and can be corrected by liming or application of about 1 to 1.5 kg per hectare of sodium molybdate.

Interculture and Irrigation- Frequent shallow cultivation should be given to the soil to kill weeds and provide soil mulch. Cauliflower being a shallow-rooted crop, most of its roots is within 45 to 60 cm of the top soil.

Deep cultivation should, therefore, be avoided. The plants should be earthed up about 4 to 5 weeks after transplanting. Water must be supplied to ensure continuous growth.

An early crop after transplanting may need irrigation twice a week and late crop once a week.

Blanching-A perfect head of cauliflower pure white, it is necessary to execute sunlight to obtain this. White head is protected by the inner leaves but later the curds are exposed. The common practice is to bring the outer leaves up over the head and tie them with a twine or rubber band,it is easy at the time of harvest to select those tied earliest.

Harvesting, Grading, Packing and Storing-Cauliflower is harvested when the curds attain a proper size and before they begin to discolour. It is separated into three grades, depending upon the size colour, quality and variety. The usual method of packing and transport of cauliflower is in big nets and trucks. Tight packing is essential to prevent shifting and bruising. In some countries cauliflower is packed in crates and wire-bound boxes. Cellophane and transparent films are also used to pack cauliflowers which are hydro-cooled to remove field heat. Cauliflower with leaves attached can be stored for 30 days at 0^0C with 85 to 90 percent relative humidity.

Yield- The yield of cauliflower may vary from 15 to 20 tons per hectare. The early crops give low yields and the mid-season crops give high yields.

Physiological Disorders

Browning (Brown rot or red rot): This is caused by boron deficiency. The trouble first appears as water-soaked areas in the stems and on the surface of the curd. Later, these areas change into a rusty-brown colour. Browning is associated with hollow stems. Other symptoms are changes in colour of foliage, thickening, brittleness and downward curling of order leaves. Application of borax @ of 10 to 15 kg per hectare on acid soils controls browning, though the amount depends upon the character of soil, soil reaction and the extent of deficiency. On neutral and alkaline soils, a larger quantity should be used.

Whiptail: The results from the deficiency of molybdenum becomes unavailable in very acid soils. Liming may correct the deficiency symptoms in such cases. There is varietal sensitiveness to molybdenum. The leaf-blades do not develop properly. In the severe cases only the midrib develops, and whiptail can be prevented by bringing

the soil pH to 6.5 by liming or by applying 1 kg of sodium or ammonium molybdate per hectare.

Buttoning: The term 'buttoning' is applied to the development of small heads or buttons. The plants do not develop normally and the leaves remain small and do not cover the developing heads. Deficiency of nitrogen is the main cause of buttoning. Planting early varieties as late season may also cause buttoning. Apply recommended dose of N.

Blindness*:* Blind cauliflower plants are those without terminal buds. The leaves which develop, large, thick, leathery and dark green. Blindness is supposed to be due to low temperature when the plants are small or due to damage to the terminal bud during handling of the plant or injury by insects pests. Protect crop from the low temperature and control the insect-pest.

Riceyness- Pedicles bearing the individual flower elongated. The curd become granual and loose. Warm weather and poor quality seed is responsible for this disorder. To mange this disorder, sow the seed when temperature is favourable.

Fuzziness- Peduncle elongated to give a rise a full velvety appearance of curds formed. This is mainly caused due to unfavourable climatic condition. To control this disorder avoid sowing when temperature is high.

Hallow stem-This disorder affects all cole crops. Hollowness caused by boron deficiency is characterized by the appearance of water soaked areas and discolouration of tissues. When it is caused due to excess of N, The affected stem remain clear white with no sign of disintegration. To control this, spray borax @ 0.3-0.4%, reduce the dose of N and transplant the crop at closer spacing.

Diseases-

Soft rot*:* It occurs in the field usually after an attack of black rot, or after mechanical injury of nearly mature curds. The casual organism os another bacterium known as *Erwinia carotovora.*

Clubroot: The roots show large swellings presenting a clubbed appearance. It is caused by a fungus *Plasmodiophora brassicae.* The foliage wilts on sunny days and

recovers towards the evening. The disease is prevalent in acid soils. Avoiding cole crops in affected plots, long rotations without any cruciferous crops and keeping the soil alkaline are the control measures.

Black leg (*Phoma lingam*)*:* It affects all the parts of the plant. Infection often occurs on the stem of the young plants in the seed- bed or in the field, causing dark sunken areas. The wilting of the plants is characteristic of the advanced stages of this disease. Hot water treatment @ 50 ºC for 25-30 minutes, is affective in destroying the fungus in the seed.

Downy Mildew*:* It is common in young plants and is characterized by the appearance of purplish- brown spots on the underside of the leaves. Downy growth usually appears on the under surface of the lesions. The upper surface of the leaf on the lesion is tan to yellow. The casual organism is *Peronospora parasitica,* an obligate parasite. The primary inoculums being present in the soil, sanitation, and crop rotation help in reducing the infection. The disease also affects cabbage.

Insect pests

Cabbage maggot*:* The maggots first attack the young rootlets and then burrow into the main root, causing the plant to wilt. Dusting or application as a water suspension of Calomel or application of Dieldrin also controls the insects.

Green cabbage worm and cabbage looper : These feed on the foliage of cauliflower and can be controlled by spraying DDT or malathion 2 to 3 weeks prior to harvest and application of Pyrethrum when the curds have formed.

Cabbage and Turnip Aphids: These insects are more injurious during the latter part for the growth or when the crop is left for seed production. The attack is controlled by spray of malathion or parathion but if the curd is ready for harvest, nicotine sulphate is used.

CABBAGE

B.N.- *Brassica oleracea* .L. var. *capitata* **Family:** Cruciferrae

Variety- Golden Acre, Pride of India, Copenhegon market, Green coronet, Green stone, Snow king, Snow queen etc.

Climatic requirement and soil- Different varieties of cabbage require very specific temperature for their curd formation and its quality. Most of the cabbage varieties arrested the growth at the temperature 25°C. The optimum temperature for most of the cole crops for seed germination and growth is 12-18°C.

Fertile, medium to heavy well drained soils are best suited to grow cole crops. Cole crops can be grown in slightly acidic to saline soils. However, the optimum pH range is 6.0-7.0. One deep ploughing and 2-3 light ploughing followed by planking is essential to obtain the fine tilth.

Nursery raising- The sandy loam and loam soils rich in organic matter are suitable for the nursery. In soil with good tilth 15 cm raised nursery beds of 3m length and 1 m width are prepared. About 20-30 beds are sufficient for on hectare area. 15 kg FYM and 50g of N:P:K (19:19:19) complex fertilizer, 200g powdered neem cake along with 10g carbofuran per bed is incorporated. The beds are drenched with captan or any systemic fungicide @ 2-3 g/liter of water. Seeds are sown thinly in rows 6 cm apart and 1 cm deep. The beds are covered thinly with straw or grass layer and irrigate with rose-cane. On germination (8-10 days) the beds are again drenched. After the appearance of first true leaf seedlings are thinned out. During the last week of nursery, the seedlings may be hardened by slightly withholding water for better establishment of seedlings. The seedlings with 5-6 true leaves are transplanted after 30 days.

Seed Rate- For Early crops 600 to 750 g of seed are required and for late crops 375 to 400 g seed are required per hectare.

Sowing time- The seed is sown in raised nursery beds which should be sterilized by formaldehyde or some fungicidal treatment. The seed for early sowing should be treated with some mercurial fungicide to save the young seedlings for damping off. According to season early sowing is done from the middle of Shrawan to the end of Bhadra. The late crop is sown from the middle of Ashwin to the end of Kartik. According to altitude the Falgun to Shrawan is suitable time for high hills and mid hills and Ashwin to Magh in terai depending upon varieties.

Transplanting- The seedlings are transplanted when four to six weeks old, depending upon the season in a well prepared field. The planting distance depends upon the

fertility of soil, season, variety and market demand. In some markets small to medium sized cabbage are preferred to large- sized ones. Closer spacing is given for supplying cauliflowers to such markets. Generally, a spacing of 45cm away is kept for the early varieties and 45 cm from plant to plant and 60 cm from roe to row for late varieties.

Manures and fertilizers- The fertilizer practices differ in different regions. For best results, 15 to 20 tons of farm yard manure or compost should be applied per hectare three to four weeks before transplanting. 100 kg of nitrogen, about 60 kg of phosphate and 50 kg of potash per hectare should be applied before transplanting. 10-15 kg Borex is applied to avoid hollow stem disorder and also 1-1.5 kg sodium molybdate is to avoid whiptail.A placement of 5 to 7 cm deep on both sides of rows are advisable.

Interculture and Irrigation- Deep cultivation should, therefore, be avoided. The plants should be earthed up about 4 to 5 weeks after transplanting. Water must be supplied to ensure continuous growth. An early crop after transplanting may need irrigation twice a week and late crop once a week.

Harvesting, Grading, Packing and Storing-Cabbage is harvested when the curds attain a proper size and before they begin to discolour. It is separated into three grades, depending upon the size colour, quality and variety. The usual method of packing and transport of cauliflower is in big nets and trucks. Tight packing is essential to prevent shifting and bruising. In some countries cabbage is packed in crates and wire-bound boxes. Cellophane and transparent films are also used to pack cabbage are hydro-cooled to remove field heat. Cabbage can be stored for 30 days at 0^0C with 85 to 90 percent relative humidity.

Yield- The yield of cabbage may vary from 15 to 20 tons per hectare. The early crops give low yields and the mid-season crops give high yields.

Physiological Disorders

Browning (Brown rot or red rot): This is caused by boron deficiency. The trouble first appears as water-soaked areas in the stems and on the surface of the curd. Later, these areas change into a rusty-brown colour. Browning is associated with hollow stems. Other symptoms are changes in colour of foliage, thickening, brittleness and downward curling of order leaves. Application of borax @ of 10 to 15 kg per hectare

on acid soils controls browning, though the amount depends upon the character of soil, soil reaction and the extent of deficiency. On neutral and alkaline soils, a larger quantity should be used.

Whiptail: The results from the deficiency of molybdenum become unavailable in very acid soils. Liming may correct the deficiency symptoms in such cases. There is varietals sensitiveness to molybdenum. The leaf-blades do not develop properly. In the severe cases only the midrib develops, and whiptail can be prevented by bringing the soil pH to 6.5 by liming or by applying 1 kg of sodium or ammonium molybdate per hectare.

Buttoning: The term 'buttoning' is applied to the development of small heads or buttons. The plants do not develop normally and the leaves remain small and do not cover the developing heads. Deficiency of nitrogen is the main cause of buttoning. Planting early varieties late may also cause buttoning. Apply recommended dose of N.

Blindness*:* Blind cauliflower plants are those without terminal buds. The leaves which develop are large, thick, lathery and dark green. Blindness is supposed to be due to low temperature when the plants are small, or due to damage to the terminal bud during handling of the plant or injury by insects or pests. Protect crop from the low temperature and control the insect-pest.

Riceyness- Pedicles bearing the individual flower elongated. The curd become granual and loose. Warm weather and poor quality seed is responsible for this disorder. To mange this disorder, sow the seed when temperature is favourable.

Fuzziness- Peduncle elongated to give a rise a full velvety appearance of curds formed. This is mainly caused due to unfavourable climatic condition. To control this disorder avoid sowing when temperature is high.

Hallow stem-This disorder affects all cole crops. Hollowness caused by boron deficiency is characterized by the appearance of water soaked areas and discolouration of tissues. When it is caused due to excess of N, The affected stem remains clear white with no sign of disintegration. To control this, spray borax @ 0.3-0.4%, reduce the dose of N and transplant the crop at closer spacing.

Diseases-

Soft rot*:* It occurs in the field usually after an attack of black rot, or after mechanical injury of nearly mature curds. The casual organism os another bacterium known as *Erwinia carotovora.*

Clubroot: The roots show large swellings presenting a clubbed appearance. It is caused by a fungus *Plasmodiophora brassicae.* The foliage wilts on sunny days and recovers towards the evening. The disease is prevalent in acid soils. Avoiding cole crops in affected plots, long rotations without any cruciferous crops and keeping the soil alkaline are the control measures.

Black leg (*Phoma lingam*)*:* It affects all the parts of the plant. Infection aften occurs on the stem of the young plants in the seed- bed or in the field, causing dark sunken areas. The wilting of the plants is characteristic of the advanced stages of this disease. Hot water treatment, @ 50 ºC for 25-30 minutes, is affective in destroying the fungus in the seed.

Downy Mildew*:* It is common in young plants and is characterized by the appearance of purplish- brown spots on the underside of the leaves. Downy growth usually appears on the under surface of the lesions. The upper surface of the leaf on the lesion is tan to yellow. The casual organism is *Peronospora parasitica,* an obligate parasite. The primary inoculums being present in the soil, sanitation, and crop rotation help in reducing the infection. The disease also affects cabbage.

Insect pests

Cabbage maggot*:* The maggots first attack the young rootlets and then burrow into the main root, causing the plant to wilt. Dusting or application as a water suspension of Calomel or application of Dieldrin also controls the insects.

Green cabbage worm and cabbage looper : These feed on the foliage of cauliflower and can be controlled by spraying DDT or malathion 2 to 3 weeks prior to harvest and application of Pyrethrum when the curds have formed.

Cabbage and Turnip Aphids: These insects are more injurious during the latter part for the growth or when the crop is left for seed production. The attack is controlled by

spray of malathion or parathion but if the curd is ready for harvest, nicotine sulphate is used.

Broccoli

B.N.: Brassica oleracea var italic **Family:** Cruciferae

Nutritive value:

The nutritive value of cauliflower per 100gm of edible portion is given below:

Moisture	84.8gm
Protein	4.7 gm
Fat	0.5 gm
Carbohydrates	8.7 gm
Copper	-
Sulphur	78.00 mg
Calories	-
Thiamine	-
Phosphrous	78.0
Chlorine	78.0
Vit c	60.00 mg
Vitamin K	400.0 mg
Iron	1.3 mg
Vitamin A	400 I.U

Climate and soil:

Best thrives in cool climate. Sandy and silt loam soils are most suited for sprouting broccoli. It grows well in drained upland soils. Heavy soils are not fit for its cultivation. It does well at pH of 5.8 to 7.2.

Varieties:

Green sprouting
De Cicco
Calabrasse
Green Comet,
Green Duock
Green Globe
Crusender

Raising of seedling in nursery (same as cauliflower)

Time of planting

Varieties	Terai	Midhills	High hills
	Asoj-kartik/mangsir	Bhadra-asoj/kartik	Baisakh-Jeth

Seed rate: 30 gm/ropani

Spacing: 45x45cm

Manure and fertilizers:

FYM/compost: 1 ton/ropani

NPK: 5:3:2.5 Kg/ropani

Where nitrogen is further splitted in to three parts (first half as a basal dose .1/4 30DAT, AND ¼ 60 DAT. Broccoli are susceptible to micronutrient deficiency thus should be applied through Agromin or tracel @1kg/ha or Multiplex @2ml/litre. Boron and zinc 750gm/ropani.

Irrigation and weeding (same as cauliflower)

Harvesting: The sprouting Broccoli should be harvested shortly before the buds began to open and heads remain compact

Yield: 400-500kg/ropani

Plant protection (same as cauliflower)

Root Vegetables

This is an important group of vegetable crops. Root vegetables are short duration crop and are used as salad and pickles.

Radish

Radish (*Raphanus sativus* L.) is a winter season crop and belongs to family Cruciferae. It is popular in both tropical and temperate regions. It is easily grown as a companion crop or intercrop between the rows of other vegetables. It may also be planted on ridges of the beds; this vacant area can be utilized profitably. The radish

leaves are rich in minerals vitamins (A and C). Radish has cooling effect and prevents constipation. The edible part of radish is modified root (fusiform). The pungency in radish is due to the presence of volatile *isothiocynates* and red colour is due to *anthocyanin* pigment.

Nutritive Value-

The nutritive value analysis (per 100g of edible portion) of radish is fat 0.1g, protein 0.7g, carbohydrates 3.4g, calcium 50mg, vitamin A 5 IU, and vitamin C 15mg.

Varieties-

White neck, Mino early, Puthane rato, Tokinashi, Chalis Diney and Pusa Chetki

Climate-

Radish is essentially a cool season crop. Long days coupled with high temperature results in bolting before attaining marketable roots. The optimum temperature for best flavour, texture, root growth and development is 10- 15^{o} C.

Soil and Field Preparation-

Radish can be grown on all type of soils but it thrives best under well drained, sandy loam soil. Heavy soils produce misshapen roots. The optimum soil pH ranges 5.5-7.0. Add well rotten FYM or compost as undecomposed FYM results in forked or branched roots. Bring the soil to a fine tilth by ploughing the land 3-4 times followed by planking.

Manure and Fertilizers-

Incorporate 200 q of well rotten FYM per hectare after the first ploughing. Make ridges and furrows of convenient length. Keep 20 cm spacing between two ridges and 15 cm between plants. Add fertilizer mixture @ 100 kg N, 60 kg P_2O_5 and 80 Kg K_2O/ha at the bottom of the ridges and cover it with soil. Furrow should be irrigated one or two days before of sowing the seeds.

Seed Rate and Sowing-

About 10-15 kg seed is sufficient to grow in one hectare. Seeds are usually on ridges to facilitate good root production. Shallow furrow of 2 cm depth are prepared on the

ridges using a stick. The seeds are thinly sown in the shallow furrows and covered with soil or pulverized manure.

Radish can be grown throughout the year, but the main season is from June to July in high hill, September to October in mid hills and September to November in terai area.

Irrigation-

Irrigate the crop in 6-7 days depending upon weather condition. Before sowing soil must be moist, a light irrigation is given immediately after sowing.

Inter-Culture and Weed Control-

One weeding should be done 15-20 days after sowing. Thinning of plants must be carried out 15-20 days after sowing keeping a distance of 15 cm between plants in a row.

Top dress the crop with the N at 25-30 days after sowing and do earthing up which prevents discoloration of roots exposed to the atmosphere and resulted in better quality roots.

The pre-emergence application of Fluchloralin (0.5 kg/ha) effectively control the weeds in the radish field.

Harvesting-

Generally radish varieties are ready to harvest at 50-60 days after sowing but the cultivar Tokinashi is ready to harvest at 30-35 days after sowing. They will become fluffy or pithy (which are unfit for consumption) if kept in the field for longer period. The crop should be irrigated before the pulling out of roots.

Yield-

The yield of radish is varies from the 300-400 q/ha.

Carrot

Carrot (*Daucus carota* L.) is an important vegetable crop of both tropical and temperate region and belongs to family Umbeliferae. Carrot is used as salad, cooked as vegetable preferable with potatoes and peas. It is also used in making pickles and sweets. The edible part of carrot is modified root (conical form). A special type of

beverage known as *Kanji* is prepared from black carrot and used as appetizer.

Nutritive Value-

Roots of carrot are rich in protein 0.2 g, Vitamin A 3150 IU and iron 2.2 mg.

Varieties-

New Kurauda, Nantes, Chantaney, Imperator, Early Nantes, Zeno, Pusa Kesar, Pusa Meghali (high carotene 11.5 mg/100g), Selection 233 (free from splitting) and Pusa Yamdagni.

Climate-

Carrot is predominantly a cool season crop. A temperature range of 7.2-23.9ºC is suitable for seed germination and 18.3-23.9ºC for better growth of roots. The optimum temperature for better colour development of roots is 15.6-21.1ºC.

Soil and Field Preparation-

The long, smooth, slender roots desired for fresh market can successfully be produced deep, well drained light soils. The optimum soil pH is 6.0-7.0. About 3-4 ploughing are required to bring the soil to a fine tilth.

Manure and Fertilizer-

Add well rotten FYM or compost @ 150-200 q/ha after the first ploughing. Fertilizers could be applied on the basis of fertility status of the soil. In normal soils, 220 kg N, 140 kg P_2O_5 and 140 kg K_2O/ha is sufficient. The mixture of half of N and full dose of P_2O_5 and K_2O is applied at the bottom of the ridges and covered with the soil. Generally furrows are irrigated one or two days prior to sowing. The remaining half dose of N is applied 30 days after sowing.

Seed Rate and Time of Sowing-

About 8-10 kg healthy seeds are required to grow in one hectares area. The carrot is grown in flat beds as well as on the ridges. Ridges and furrow method facilitates better root development. The ridges are made at the spacing 25-30 cm. Shallow furrows of 2 cm depth are made on the ridges and seed is sown thinly in these furrows and covered with mixture of soils and well rotten manure. June to July for high hills,

October to December for mid hills and October to November for terai is the optimum time for sowing in Nepal. The optimum spacing is 30 cm between the rows and 10 cm between the plants.

Irrigation-

Irrigate the crop in 6-7 days depending upon weather condition. Before sowing soil must be moist, a light irrigation is given immediately after sowing. Carrots grown in low moisture conditions have very strong and pungent flavor.

Inter-Culture and Weed Control-

Two weeding should be done firstly 15-20 days after sowing and secondly 30-35 days after sowing and earthing up is done after each weeding. The pre-emergence application of Fluchloralin (0.5 kg/ha) and post emergence like Nitrofen (1.0 kg/ha) is applied at leaf stage effectively control the weeds in the carrot field.

Harvesting-

Generally radish varieties are ready to harvest at 70-90 days after sowing. Delay in harvesting of roots leads to splitting resulted in poor quality. Sometimes delay in harvesting even make it unfit for consumption.

Yield-

The yield of radish is varies from the 200-250 q/ha.

Physiological Disorders

Carrot Splitting-

It is a major physiological disorder of carrot where roots crack and seems to be controlled by genetic factors but a number of other factors like heavy side dressing, sowing at wide spacing, large size of roots and fluctuation in soil moisture are also found to be responsible for splitting.

Control-

- Grow resistant varieties like Selection-233.
- Sow the seeds at close spacing.
- Maintain optimum moisture in the field.
- Harvest the crop at right maturity stage.

Cavity Spot-

It is characterized by the appearance of cavity in the cortex and in most cases the subtending epidermis collapse to form a pitted lesion. The disorder caused due to Ca deficiency, increased level of K_2O and delay in harvesting.

Control-

- Incorporate Calcium containing fertilizers in thed soil.
- Harvest the roots at optimum time.

Insect-Pests

Aphid (*Myzus persicae, Liphaphis erysimi*)-

Insects suck the sap from the tender parts of plant. In case of heavy infestation leaves become curled, yellowed and finally die. The cloudy and humid conditions are favorable for their rapid multiplication.

Control-

Spray crop with Malathion (0.1%) or Endosulfan (0.05%) and repeat the spray after 10 days.

Carrot rust fly (*Psila rosae*)-

The larvae burrows into the roots leading to misshapen and decay of roots to make them unfit for consumption. Wilting and redness of foliage are the main symptoms above the ground.

Control-

- Grow resistant Varieties like Nantes
- Sowing should be done at proper spacing to avoid thinning.
- Destroy the thinned plants immediately.
- Fill the holes made due to thinning to avoid the laying of eggs by flies.
- Incorporate Dimethoate (0.1%) in the soil.

Diseases

Alternaria blight (*Alternaria raphani*)-

Small, yellowish and slightly raised lesions appear first on the leaves. It also infects the stem, pods and seeds.

Control-

- Adopt crop rotation.
- Use disease free seed.
- Seed treatment with hot water at 50ºC for 30 minutes.
- Spray Bavistin (0.2%) or Dithene M 45 (0.2%) at 7-10 days interval.

Black rot (Alternaria radicina)-

It affects the foliage as well as roots of carrot in both field and storage. The affected roots develop irregular or circular sunken black areas and finally decay.

Control-

- Follow phytosanitary measures.
- Follow crop rotation.
- Selected affected roots and destroy them.
- Store the roots at 0-2ºC temperature.

Bacterial soft rot (*Erwinia carotovora*)

It is a destructive disease of carrot in storage and transport. The infected roots become soft, watery and as the rooting progresses, exude watery substances which give foul odour.

Control-

- Uproot the infected roots and destroy.
- Clean the roots and keep dry.
- Avoid bruising during harvesting, grading, transport, storage and handling.
- Store the roots at 0ºC temperature and 90% RH.

Radish Mosaic Virus (RMV)-

Small, circular to irregular chlorotic lesions develop on the leaves. The virus is transmitted by aphid.

Control-

- Uproot weed hosts.
- Collect seeds from healthy plants.

- Remove affected plants and burn them.
- Spray Dimethoate (0.03%).

Bulb Crops

All bulb crops belong to class monocotyledoneae, family Alliaceae and the genus *Allium*. They are grown in winter season. They also have medicinal properties.

Onion

Nutritive value-

Onions are high in food energy, Intermediate in protein (0.9 g), rich in Vitamin A (992 IU) and rich in calcium (50 mg).

Varieties-

Arka Pragati, N-53, Arka Niketan, N-2-4-1 (tolerant to *Alternaria* blight), Agrifound Light Red, Agrifound Drak Red, Agrifound Rose, Early Grano (Free from bolting), Nasik Red and Red Criol

Climate-

The onion crop does best under mild climate without extremes of heat and cold. It does not perform well in excessive rainfall regions. Before bulbing, temperature between 12.8 ^{0} C to 21^{o} C for at least 10 hours/day is required for proper bulb development. About 70% relative humidity is good for crop. Very low temperature in the beginning favors bolting. Sudden rise in temperature favors early maturity of the crop in *winter* and results in smaller size of the bulbs. Mostly varieties are short day plant only Spanish Brown and Early Lockyar Brown are long day varieties.

Soil and field preparation-

In general sandy-loam to clay-loam soils are recommended for this crop. Sandy soils need more and frequent irrigation and favor early maturity whereas; heavy soils give rise to misshapen bulbs. For good yield of quality bulbs deep, friable, well drained alluvial and loamy soils which are slightly acidic (pH 5.8 to 6.5) are considered best. The onion crop can be grown successfully within a pH range of 5.8 to 8.0. In alkaline and sodic soils bulb development is adversely affected. Hisar-2 and Punjab selection

varieties are slightly tolerant to alkalinity and salinity.

About 4-5 shallow ploughings are sufficient to make the soil loose, friable and porous. The last ploughing should be followed by planking to level the field.

Sowing-

Onion crop is raised through seed or sets (small bulbs).

i) Raising through seed-

In this method sowing is done in the nursery beds. About 50 raised beds of 3X1X0.15 m size are sufficient to raise seedlings for one hectare. Treat the nursery beds with Thiram or Captan @ 4-5gm/square meter area and also treat the seed by same fungicides. Apply 15-20 kg well rotten FYM to each bed and mix them in well in the soil. The seed is sown in lines made at 5cm apart and covered with mixture of well rotten FYM and soil. The nursery beds should be irrigated immediately with the help of water-can. Light and frequent irrigations are made till the germination and stand of seedlings. After germination apply 0.3% Captan or Thiram with irrigation (Drenching) to control root rot disease and repeat, if necessary. Seedlings should be saved from abiotic stresses. The seedlings will be ready for transplanting within 6-7 weeks.

Transplanting-

6-7 weeks old seedlings are ready for transplanting. The nursery beds should be irrigated 4-5 hours prior to the uprooting of the seedlings. Before transplanting, deep the roots in the solution of Bavistin @ 2g/liters to save the crop from pink rot disease. The appropriate plots are made in the already prepared field and transplanting is done in the evening at 15X10 cm spacing. Irrigation immediately after transplanting is essential. Gap filling should be done one week after transplanting as some seedlings may die because transplanting shock.

ii) Raising through sets (small bulbs)-

This is generally done in case of *rainy* season crop. In this method ridges and furrows are made at 40 cm spacing. The sets are planted on the ridges at 15cm apart. Water just after planting is applied through furrows. Earthing up is very essential at time to

time to facilitate large sized bulbs.

Weed Control-

It is very difficult and costly to uproot the weeds manually as onion is shallow rooted crop and planted closely. Hence, different herbicides may be used to control the weeds with two shallow hoeing at 20-25 days and 40-45 days after transplanting. Application of Fluchloralin @ 1.0-.15 kg/ha as pre-transplant soil incorporation and Alachlor @ 1.5-2.0 kg/ha as post-transplant successfully control the weeds.

Irrigation-

In general, onion crop is irrigated at 10-15 days interval in winter and 6-7 days interval in summer. Withhold irrigation 15-20 days prior to maturity.

Harvesting and Yield-

Onion crop sown by seed requires 140-150 days to mature, whereas crop raised through sets takes 90-110 days. The crop is ready to harvest when the leaves turn yellow. For winter crop neck fall is another symptom of maturity. The mature bulbs are uprooted and left in the field as such for 7 days for curing. About 200-300 q/ha bulb yield may be obtained from one hectare area.

Physiological Disorder

Sprouting of bulbs-

It is one of the most important disorders in the storage and causes a huge lose to the cultivators. It is found both in onion and garlic. Sprouting is also associated with the soil moisture at maturity and supply of nitrogen.

Control-

- Adjust sowing time in such a way that harvesting can be done in dry period.
- Withhold irrigation as soon as bulbs reach to maturity.
- Apply comparatively less quantity of nitrogenous fertilizers.
- Grow purple or pink coloured variety
- Spray growth inhibitor like MH (2500-3000 ppm), 15 days before harvesting.

Bolting-

It is a serious disorder of onion. It refers to the emergence of seed stalk prior to time of their formation and adversely affects the formation and development of bulbs. Winter onions start to bolt at 20-25^0 C temperature. Early transplanting and late induce bolting. Low temperatures (10-12^0 C) refers to bolting, Late transplanting of seedlings, aged seedlings of above 10 weeks old seedlings and poor supply of nitrogen induce bolting.

Control-

- Adjust the time of transplanting and sowing
- Grow non bolting cultivars like- Early Grano, Texas Early Grano etc.
- Transplant healthy and about 6-7 week old seedlings.
- Supply recommended dose of Nitrogen.
- Cut the seed stalk at early stage.

Production Constaints

Poor seed germination-

The onion seed loss their viability within a year under ordinary storage condition. Therefore, poor germination is a main problem in onion cultivation.

Control-

Store the seed in cold storage.
Soak the seeds in water for 2-6 hours prior to sowing
Use healthy and fresh seed.

Garlic

Garlic (*Allium sativum* L.) is the second important bulb crop after onion. It belongs to the family Alliaceae. Garlic is used as spice or condiment. It has a higher nutritive value than other bulbous crop. It is used in different preparation to cure against sore throat and lingering stomach diseases, sore eyes and earaches. It reduces the cholesterol in the blood. The garlic extracts also has nematicidal, fungicidal and bactericidal properties. The foliage of garlic is flattened rather than hollow like that of the onion.

Garlic contains amino acid *'Allin'* which is colourless and odourless. However when

cloves are crushed *allicin* is formed due to enzymatic reaction of *allinase*. The principal ingredient in *allicin* is *diallyl di-sulphide* which gives the garlic odour.

Nutritive value-

Garlics are high in food energy, Intermediate in protein (6.3 g) and rich in calcium (30 mg).

Varieties-

Local, Agrifound White (G-41), Yamuna White (G-1), G-282, Agrifound Parvati (G-313).

Climate-

Garlic is a winter season crop requiring cool and humid atmosphere during growth and relatively dry period during bulb maturity. High temperature and long days are not congenial for proper bulb formation.

Soil and Field Preparation-

Garlic can be grown on all type of soils, However soils rich in organic matter and well drained are preferred. Loamy soils were found better while heavy soils caused deformation of bulbs. Land should be thoroughly prepared by repeated ploughing and planking.

Manure and Fertilizer-

Apply well rotten 150-200 q/ha FYM or compost at the time of land preparation. Apply 80 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha. Complete dose of P_2O_5, K_2O and full dose of N are applied at the time of sowing. Remaining half dose of N may be applied after one month of sowing as top dressing.

Time of Sowing-

The crop may be sown April to May in high hills, July to February in mid hills and October to November in terai region of Nepal.

Seed Rate and Method of Sowing-

Cloves are used as planting material in garlic. About 500-600 kg cloves of 8-10 mm in diameter are sufficient to plant one hectare area. The field is divided into small plots

as in onion. While sowing care should be taken that the pointed position is kept upward. The cloves are dibbled at a spacing of 15 cm from row to row and 7-8 cm from plant to plant.

Irrigation-

Generally irrigation is done at 10 days interval. Garlic is a shallow rooted crop, hence, light and frequent irrigations are recommended.

Weed Control-

To keep the field free from weeds, two shallow hoeing are required at 20-25 and 40-45 days after sowing. Garlic is planted closely therefore, hoeing may cause injury to the plant so application of Fluchloralin @ 1.0-1.5 kg/ha as pre plant application and Alachlor @ 1-2 kg/ha after 30 days after planting successfully control the weeds of garlic.

Harvesting and Curing-

Garlic is usually ready for harvesting within 130-150 days after sowing when the tops become partly dry and bend to the ground. The bulbs are lifted and windrowed gathering several rows into each windrow. Tops are placed over the bulbs to protect the bulbs from sun. If temperature is very high the bulbs are taken to shade for curing for about a week otherwise curing is done in field. Tops and roots are removed by hand leaving about 2 cm of root and 2.25 cm of top.

Yield-

The yield varies from 50-80 q/ha with 85-95% recovery of clove in the bulbs.

Insect- Pests

Onion thrips (*Thrips tabaci*)-

Minute pale insect feed on foliage during February-May and produce whitish spots followed by curling- a condition known as 'silver top'. This pest is very injurious at the flowering and impairs seed production.

Control-

- Follow crop rotation.

- Grow resistant varieties like Nashik Red and Spanish White.
- Apply Carbofuran 3G @ 20-25 kg/ha at 2, 6 and 10 weeks after transplanting.
- Spray Endosulphan (0.05%) 3-4 times at 15 days interval starting from transplanting.

Onion maggots (*Hylemia antiqua*)-

In infested plants, the leaves turn brown from the tip downward and crop wilts. The bulb and the base of leaves become flaccid and watery and contain about 0.5 cm long maggots which taper towards the end.

Control-

- Adopt crop rotation.
- Apply Carbofuran 3G @ 20-25 kg/ha at 2, 6 and 10 weeks after transplanting.
- Spray Endosulphan (0.05%) 3-4 times at 15 days interval starting from transplanting.

Cut worm (Agrotis ipsilon**)-**

It is a polyphagous insect and active at the onset of cool weather. The caterpillars cut the seedlings at the ground level during night hours.

Control-

- Follow clean cultivation and break the big clods of soil.
- Dust the soil with 4% Endosulphan @ 25 kg/ha.

Diseases

Downy mildew (Peronospora destructor**)-**

The affected plants remain dwarf, distorted and pale green colour. The affected leaves drop at the point of lesion and dry at the tip.

Control-

- Spray the crop with Dithane Z-78 or Dithane M-45 @ 0.3% at weekly interval.

Purple blotch (*Alternaria porri*)-

A small water soaked area develops on the leaf or the seed stalk which immediately turns brown and later on changes to purplish zonated spot. The seed stalks usually

break at the point of attack.

Control-

- Dip the bulbs before sowing in 0.25% solution of Dithane M-45 for an hour.
- Spray the crop with 0.25% Dithane M-45 or 2% Captan at fortnightly interval starting from the first appearance of diseases.

Black mould (Aspergillus niger**)-**

Black moulds develop on the bulbs followed by rotting of scales. It occurs when bulbs stored at a high temperature and high humidity.

Control-

- Store the bulbs in well ventilated, cool and dry place.
- Spray 0.2% Difolatan during storage.

Basal rot (Fusarium oxysporum f. sp. cepae**)-**

The fungus attacks the onion crop in field as well as storage. Leaves turn yellow, wilt and die rapidly whereas, roots become pinkish as the plants approaches maturity. Finally the rotting of roots takes of place. The bulbs become soft and a semi watery decay develop from the base of the scale leaves.

Control-

Follow long term crop rotation excluding bulb crops.

Treat the seeds with Thiram @ 2.5 g / kg seed before sowing.

Spray 0.2% Bavistin.

Stalk rot (Pseudomonas gladialli pv. allicala**)-**

Basal portion of the lower stalk starts to rot before the formation of seed resulting in the partial to complete wilting of inflorescence. The bacteria also infect the bulb scales initially and latter enters the bulbs through wound. The affected bulbs become slimy and give a foul sulphurous smell.

Control-

Allow soaking the bulbs in the solution of Streptocycline @ 0.1 g/lit of water for 2 hours before planting of the bulbs for seed crop.

Soft rot (*Erwinia carotovora* pv. *carotovora***)-** The bacteria attack the green necked bulbs which are not cured. The rotting starts from the neck of the bulb and reaches to the inner scales which become water soaked and soft. When neck is squeezed it gives foul odour.

Control-

- Avoid any mechanical injury to the bulbs during harvesting.
- Store the properly cured bulbs when the neck becomes tight and scale leaves dry up.
- Avoid the storage of green necked bulbs.
- Spray the bulbs before storage with Bavistin + Plantomycin each at 0.5%.

Yellow dwarf-

The disease is caused by onion yellow dwarf virus which is transmitted by insect vector. The characteristics symptoms of the diseases are severe stunting of plants dwarfing and twisting of flower stalk. The leaves turn yellow, tend to flatten and crinkle.

Control-

- Use disease free seed for sowing.
- Rogue out infected plants.
- Spray the crop with 0.05% Monocrotophos or 0.03% Endosulfan.

Pea

Pea (*Pisum sativum* L.) is a common nutritious leguminous vegetables crop grown in cool season. It is used as vegetables, pulses and processed (pickles, canning, frozen or dehydrated) to increases the availability during off season. Pea belongs to family Leguminosae.

Nutritive Value-

Pea is rich source of protein (7.2g in green and 19.7 g in dry), carbohydrates (15.9 g in green and 56.5 g in dry). A anti nutrient factor in pea is *cyanide* containing compounds.

Varieties-

Aazad, Aarkel, Sikkim local, Bonnevile, Jawahar matar – 4, Early Badger, Kanwari etc.

Climate-

Pea is a winter season crop and required frost free cool and dry weather, the optimum temperature for better growth and yield is 13-19ºC. At high temperature sugars changes to hemicelluloses and starch which reduce the quality of pea.

Soil and Field Preparation-

Pea can be grown on all kinds of soils but best crop is harvested from well drained and fertile loam soil. Peas do best in a soil having pH 6.0-7.5. One deep ploughing followed by 2-3 light ploughing and planking are made to get the soil to fine tilth.

Manure and Fertilizer-

Apply 200-250 q/ha well decomposed FYM or compost at the time of field preparation. Also apply 20-30 kg N, 60-80 kg P_2O_5 and 50-60 kg K_2O/ha. Supply the half dose of N and complete dose of P_2O_5 and K_2O at the time of sowing. The remaining half quantity of N is top dressed at the time of flowering.

Pea is N fixing crop therefore, treatment of seeds with bacterium culture *i.e. Rhizobium leguminosarum* is advisable to reduce the quantity of nitrogenous fertilizer. The seed treatment with *Rhizobium* culture is necessary when the crop is grown in new field. Dissolve the culture in the solution of *Gur* (10%) and thoroughly mix the seed to make a coating of culture followed by shade drying. If seeds are also treated with fungicide and insecticide, then the treatment should be given in the following sequence fungicide-insecticide-*Rhizobium* (FIR).

Sowing and Seed rate-

Peas are sown in the month of April-May in high hills, January- February in mid hills and September-October in terai. 60-80 kg seed/ha is sufficient for one hectare of area. Treat the seed with Thiram or Captan @ 3 g/kg of seed. Sow the seeds in rows spaced at 60 cm apart and within rows 60 cm spacing. Generally seeds are sown about 2.5 cm deep.

Irrigation-

Irrigate the field immediately after sowing when the crop is sown on light soils whereas; in heavy soils irrigate the field prior to sowing for better germination. Flowering, pod filling and chance of frost are the critical stages for irrigation in pea.

Stalking-

It is important cultural operation in pea because plants bear tendril and have climbing habit. Tall indeterminate varieties require stalking to produce better quality pods. To provide staking, erect a wire trellis supported by poles.

Weed control-

Keep the field free from weeds up to 35-40 days after sowing by giving two hands weeding at 20 and 45 days after sowing. The weed can also be controlled by herbicide like Fluchloralin at 0.75 kg/has pre plant soil incorporation or Pendimethalin at 2.0 kg/ha.

Harvesting-

The green and tender pods are harvested before the webbing starts. It is ready to harvest at 50-60 days. The maturity can also be judged with tenderometer. The picking should start as soon as the green ovules are fully developed and pods are still not over mature. Picking should always be done at an interval of 10-12 days. Pea gives 3-4 picking during the duration of 15-20 days. Over mature pods should not be harvested to use as greens because grains contain low sugar and more of starach.

Yield-

Generally 20-30 q yields are obtained from one hectare area. The yield depends upon variety, climatic condition and management practices. 30-35 % shelling is obtained depending upon the type of variety.

Micro Nutrient disorder-

Marsh spot-

The deficiency of Mn in soil causes marsh spot of pea. The leaves of affected plants sow slight interveinal chlorosis. The flat surfaces of seeds have a brown spot or cavity in the centre. It represents the necrotic areas which disintegrate and become hollow at later stage.

Control-

It may be corrected by soil application of $MnSO_4$ @ 5-10 kg/ha or foliar application of $MnSO_4$ @ 0.25% twice or thrice. Foliar spray is better suited for its immediate correction.

Insect- Pest

Thrips (Thrips indicus**)-**

It causes severe damage to the young plants by sucking the cell sap.

Control-

- Grow tolerant/resistant varieties
- Spray Phosphamidon (0.03%) or Dimethoate (0.03%) at 15 days interval.

Aphids (Macrosiphum pisi**)-**

They suck the cell sap of younger parts. The leaves of attacked plants turn pale and dry.

Control-

- Grow tolerant/resistant varieties
- Spray Phosphamidon (0.03%) or Dimethoate (0.03%) at 15 days interval.

Pod borer (*Heliothis sp.*)-

The young caterpillars start to feed on the surface of the pods, bore into them and feed on the seeds. They make the pods unfit for the consumption.

Control-

- Spray the Malathion (0/1%) or Carbaryl (0.2%) at regular interval.

Diseases

Powdery mildew (*Erisiphe polygoni*)-

White floury patches covering the large areas appear on the stems, branches, leaves, tendrils and pods.

Control-

- Grow resistant varieties like JP-83, PM-2, JP-4, JRS-14.

- Spray the crop with Karathene (0.2%) at weekly.

Rust (*Uromyces pisi and U. fabae* **)-**

Red to black, spherical and raised pustules appears only on the lower side of leaves. Finally the leaves turn yellow and drop. It is serious on the late sown crop.

Control-

- Follow crop rotation avoiding beans.
- Destroy weed host
- Give three subsequent spray of Dithene M-45 (0.2%) at 10 days interval.

Bacterial blight (*Pseodomonas pisi*)-

Watery and olive-green blisters appear on the stems and leaf base. Water soaked oily spots develop on the pods and leaves. The incidence is more severe on the plants injured by frost.

Control-

- Follow two years or long crop rotation.
- Treat the seeds with Streptocycline @ 250 ppm for 4 hours.
- Spray the crop with Streptocycline @ 0.01% at 8-10 days interval.

Mosaic-

The leaves and pods mottled and appear pale green or yellowish patches. Mosaic virus infected plants produce small outgrowth on the lower surface of same leaves. Terminal growth is retarded, curling and rossetting occur. The viruses are transmitted by aphids.

Control-

- Grow resistant varieties like Little Marvel.
- Rogue out infected plants.
- Spray Malathion (0.1%) or Monocrotophos (0.03%) to ontrol the insect vector.

French bean

French bean (*Phaseolus vulgaris*) is also knaown as common bean, Kidney been, dwarf bean, haricot bean, snap bean string bean and garden bean. Seeds are kidney

shaped as the name implies. In Nepali it is called as Rajma. It belongs to the family Leguminacae.

Nutritive value-

The green pods are rich in Ca (50 mg) and Iron (1.7 mg). The seeds are are highly proteinaceous.

Uses-

Fresh posds are consumed as vegetable and dried seeds from mature pods are also consumed as vegetable and fetch high price in the market. Its flour is also used in preparing various nutritional products and baby food.

Varieties-

Contender, Bountiful, Kentucky wonder, Premier, Lakshmi, Pusa Parvati etc.

Climate-

It is a warm season crop and cannot tolerate frost. A mean temperature of 10.3-23.9ºC is optimum for its growth and high pod yield. At higher temperature they do not grow well and drooping of blossom at flowering stage. Freezing temperature or below 15ºC is also not congenial for its better growth and development.

Soil and Field Preparation-

It can be cultivated in a wide range of soil but well drained, fertile sandy loam soils are ideal. The soil should not interfere with the seed germination and seedling emergence. The optimum range of soil pH is 5.5-6.5. Plough the soil thoroughly giving one deep ploughing during summer followed by 2-3 light ploughing. Finally, planking should be done to level the field.

Manure and Fertilizer-

25-30 tones of FYM or compost /ha and N: P: K @ 40 kg: 60kg: 50kg/ha. Full dose of P, K and ½ dose of N is applied in bands as a basal dose and remaining N is top-dressed 30-35 DAS (Day after sowing) or at the time of flowering.

Sowing Time-

It can be sown twice in a year *i.e.* July to September and January to February in plains

and March to April in hills.

Seed Treatment-

If the beans are sown in the field for the first time, it is advisable to inoculate the seed with N-fixing bacteria before sowing. This helps in quick nodulation mainly through *Rhizobium phaseoli,* which fix atmospheric nitrogen. Seeds are treated with *Rhizobium* @ 30g sugar solution/kg of seed and dry in shade.

Seed Rate and Spacing-

Generally seed rate of 50-75 kg seed/ha is recommended for bush bean and 25-30 kg seed/ha for pole type bean. The seed should be soaked in water overnight then sown in line at spacing 30X5 cm for bush bean and 90cm X 8-10 cm for pole type.

Irrigation-

Irrigate the crop as and when required. Frequent irrigations after sowing till crop emergence may hinder the germination due to chocking of respiration. Light but frequent irrigation is needed. Irrigation is provided in summer at 6-7 days interval and 10-15 days interval in winter.

Inter-Culture and Weed control-

Hoeing and earthing up is done mainly in the standing crop. Hoeing is done to remove the weeds and pulverize the soil for proper aeration. Generally two hoeing are sufficient to keep the field from weeds. The weed can also be controlled by herbicide like Fluchloralin at 0.75 kg/has pre plant soil incorporation or Pendimethalin at 2.0 kg/ha.

Stalking-

Pole type varieties need staking for proper plant stand and to avoid deterioration of pods by touching the ground. A single bamboo stick of 1.8-2.0 m length is fixed near each plant to give support.

Harvesting and Yield-

French beans are harvested when beans/pods are tender and fresh. Bush bean become ready for harvesting at 50 DAS where as pole bean become ready for harvesting at

60-75 DAS. Generally 2-5 picking is practiced depending upon the type of crop. For seed, it is harvested when the pods is fully mature and ripen. The yield is 50-60 q/ha for bush type beans and 110-140 q/ha for pole type bean. For seed, it yields 12-18 q/ha.

Physiological Disorders

Transverse cotyledone cracking (TVC)-

It is a major disorder of French bean. It is enhanced by planting dry seeds in wet soil. While seeded cultivars are more prone to this disorder. Hard seed coat is essential for resistance to TVC and seed coat shattering. Therefore, seed containing 12% moisture has better germination.

Hypocotyle necrosis-

This disorder occurs due to low Ca in the seeds.

Insect-Pests

Aphids (Aphis craccivora**)-**

They suck the cell sap of younger parts. The leaves of attacked plants turn pale and dry.

Control-

- Grow tolerant/resistant varieties
- Spray Phosphamidon (0.03%) or Dimethoate (0.03%) at 15 days interval.

Pod borer (*Heliothis sp.*)-

The young caterpillars start to feed on the surface of the pods, bore into them and feed on the seeds. They make the pods unfit for the consumption.

Control-

- Spray the Malathion (0/1%) or Carbaryl (0.2%) at regular interval.

Diseases

Powdery mildew (*Erisiphe polygoni*)-

White floury patches covering the large areas appear on the stems, branches, leaves,

tendrils and pods.

Control-

1. Grow resistant varieties like JP-83, PM-2, JP-4, JRS-14.
2. Spray the crop with Karathene (0.2%) at weekly.

Rust (*Uromyces appendiculatus* **)-**

Red to black, spherical and raised pustules appears only on the lower side of leaves. Finally the leaves turn yellow and drop. It is serious on the late sown crop.

Control-

- Follow crop rotation avoiding beans.
- Destroy weed host
- Give three subsequent spray of Dithene M-45 (0.2%) at 10 days interval.

Anthracnose (*Colletotrichum lindmuthianum***)**

The symptoms appear on all plantparts like leaf, stem and pods. But the most characteristics symptoms appear on the pods. On immature pods black sunken cankers with light coloured or grey centres appear with the raised border.

Control-

- Collect and destroy affected plants.
- Treat the seeds with Bavistin @ 2 g/kg seed.
- Spray the crop with Bavistin (0.05%), Dithane M-45 (0.25%) at 8-10 days interval.

Leaf spot (*Cercospora cruenta***)-**

Irreegular water soaked lesions develop on the older leaves. The spots turn reddish-brown to brown. Ashy-grey with purplish borders appear at later stages.

Control-

- Use disease free seeds
- Adopt crop rotation.
- Spray the crop with Bavistin (0.05%), Dithane M-45 (0.25%) at 8-10 days interval.

Bacterial blight (*Xanthomaonas phaseoli*)-

Watery and olive-green blisters appear on the stems and leaf base. Water soaked oily spots develop on the pods and leaves. The incidence is more severe on the plants injured by frost.

Control-

- Follow two years or long crop rotation.
- Treat the seeds with Streptocycline @ 250 ppm for 4 hours.
- Spray the crop with Streptocycline @ 0.01% at 8-10 days interval.

French bean common mosaic-

The leaves and pods mottled and appear pale green or yellowish patches. Mosaic virus infected plants produce small outgrowth on the lower surface of same leaves. Terminal growth is retarded, curling and rossetting occur. The viruses are transmitted by aphids.

Control-

- Grow resistant varieties like Little Marvel.
- Rogue out infected plants.
- Spray Malathion (0.1%) or Monocrotophos (0.03%) to control the insect vector.

Dolichos bean

The Indian bean or hyacinth bean or dolichos bean or lablab bean or field bean (*Dolichos lablab* L.) is one of the ancient among the cultivated plants. It belongs to the family Leguminacae. The crop is multipurpose and can be used as pulse, vegetables and for forage. It is a herbaceous perennial plant but cultivated as an annual or biennial. The term *Dolichos* is derived from Greek word means '*Long pods'* and *lablab* is an Arabic term, means '*production of sound by dried seeds in the pods'*. The mature and dark coloured seeds of dolichos bean have *trypsin* inhibitor. On heating it is broken down into toxic *cyanogenic* glucoside which is soluble in boiling water. Therefore, it is necessary to boil the mature seeds in water before consumption.

Nutritive value-

The green pods are rich in Ca (210 mg) and Iron (1.7 mg). The seeds are are highly

proteinaceous (3.8 g).

Uses-

Fresh pods are consumed as vegetable and dried seeds from mature pods are also consumed as vegetable and fetch high price in the market. Its flour is also used in preparing various nutritional products and baby food.

Varieties-

Khumal Tane, Sarlahi Tane, Adila, Jawahar Sem-53, Arka Vijay, Arka jay, Pusa sem-2, Pusa Sem-3 and Pusa Early Prolific.

Climate-

It is a cool season crop and best adapted to tropical and subtropical areas. . A mean temperature of 18-30ºC is optimum for its growth and high pod yield. Severe frost damages the crop. drought resistant varieties are also available.

Soil and Field Preparation-

It can be cultivated in a wide range of soil but well drained, fertile sandy loam soils are ideal. The soil should not interfere with the seed germination and seedling emergence. The optimum range of soil pH is 5.5-7.8. Plough the soil thoroughly giving one deep ploughing during summer followed by 2-3 light ploughing. Finally, planking should be done to level the field.

Manure and Fertilizer-

25-30 tones of FYM or compost /ha and N: P: K @ 40 kg: 60kg: 50kg/ha. Full dose of P, K and ½ dose of N is applied in bands as a basal dose and remaining N is top-dressed 30-35 DAS (Day after sowing) or at the time of flowering.

Sowing Time-

It can be sown twice in a year *i.e.* June to July.

Seed Treatment-

If the beans are sown in the field for the first time, it is advisable to inoculate the seed with N-fixing bacteria before sowing. This helps in quick nodulation mainly through *Rhizobium phaseoli,* which fix atmospheric nitrogen. Seeds are treated with

Rhizobium @ 30g sugar solution/kg of seed and dry in shade.

Seed Rate and Spacing-

Generally seed rate of 30-40 kg seed/ha is recommended for bean. It can be sown at a spacing of 120X30 cm. Three to four seeds are sown at 2-2.5 cm deep on each hill. After germination only one or two plants are allowed on each hill.

Irrigation-

Irrigate the crop as and when required. Frequent irrigations after sowing till crop emergence may hinder the germination due to chocking of respiration. Light but frequent irrigation is needed. Irrigation is provided in summer at 6-7 days interval and 10-15 days interval in winter.

Inter-Culture and Weed control-

Hoeing and earthing up is done mainly in the standing crop. Hoeing is done to remove the weeds and pulverize the soil for proper aeration. Generally two hoeing are sufficient to keep the field from weeds. The weed can also be controlled by herbicide like Fluchloralin at 0.75 kg/has pre plant soil incorporation or Pendimethalin at 2.0 kg/ha.

Flower drop-

Flower drop is a major limiting factor of productivity. Only 10-20% flowers produce mature pods. Soil application of nitrogen @ 20 kg/ha at flowering increased the yield. Application of $CaCl_2$ (0.5%) + NAA (100 ppm) when the first inflorescence comes to flowering also increases fruit set and productivity.

Harvesting and Yield-

The pods are picked when green and succulent prior to fiber development. The green pods are available throughout the winter and spring. It produce an average yield of 50-80 q/ha of green pods. When the crop is grown for dry seeds. It yields 10-15 q/ha.

Insect-Pests

Aphids (Aphis craccivora**)-**

They suck the cell sap of younger parts. The leaves of attacked plants turn pale and

dry.

Control-

- Grow tolerant/resistant varieties
- Spray Phosphamidon (0.03%) or Dimethoate (0.03%) at 15 days interval.

Pod borer (*Heliothis sp.*)-

The young caterpillars start to feed on the surface of the pods, bore into them and feed on the seeds. They make the pods unfit for the consumption.

Control-

- Spray the Malathion (0/1%) or Carbaryl (0.2%) at regular interval.

Diseases

Powdery mildew (*Erisiphe polygoni*)-

White floury patches covering the large areas appear on the stems, branches, leaves, tendrils and pods.

Control-

- Grow resistant varieties like JP-83, PM-2, JP-4, JRS-14.
- Spray the crop with Karathene (0.2%) at weekly.

Rust (*Uromyces appendiculatus* **)-**

Red to black, spherical and raised pustules appears only on the lower side of leaves. Finally the leaves turn yellow and drop. It is serious on the late sown crop.

Control-

- Follow crop rotation avoiding beans.
- Destroy weed host
- Give three subsequent spray of Dithane M-45 (0.2%) at 10 days interval.

Anthracnose (Colletotrichum lindmuthianum)

The symptoms appear on all plant parts like leaf, stem and pods. But the most characteristics symptoms appear on the pods. On immature pods black sunken cankers with light coloured or grey centres appear with the raised border.

Control-

- Collect and destroy affected plants.
- Treat the seeds with Bavistin @ 2 g/kg seed.
- Spray the crop with Bavistin (0.05%), Dithane M-45 (0.25%) at 8-10 days interval.

Leaf spot (Cercospora cruenta)-

Irregular water soaked lesions develop on the older leaves. The spots turn reddish-brown to brown. Ashy-grey with purplish borders appear at later stages.

Control-

- Use disease free seeds
- Adopt crop rotation.
- Spray the crop with Bavistin (0.05%), Dithane M-45 (0.25%) at 8-10 days interval.

Bacterial blight (Xanthomaonas phaseoli)-

Watery and olive-green blisters appear on the stems and leaf base. Water soaked oily spots develop on the pods and leaves. The incidence is more severe on the plants injured by frost.

Control-

- Follow two years or long crop rotation.
- Treat the seeds with Streptocycline @ 250 ppm for 4 hours.
- Spray the crop with Streptocycline @ 0.01% at 8-10 days interval.

French bean common mosaic-

The leaves and pods mottled and appear pale green or yellowish patches. Mosaic virus infected plants produce small outgrowth on the lower surface of same leaves. Terminal growth is retarded, curling and rossetting occur. The viruses are transmitted by aphids.

Control-

- Grow resistant varieties like Little Marvel.
- Rogue out infected plants.

- Spray Malathion (0.1%) or Monocrotophos (0.03%) to control the insect vector.

PALAK (SPINACH BEET/INDIAN SPINACH)

Spinach beet or Palungo or beet leaf (*Beta vulgaris* var. *bengalensis*) is an important leafy vegetable commonly grown in Nepal. It belongs to family Chenopodiaceae.

Nutritive value-

It is a rich source of protein (3.4 g), vitamin C (70 mg), Vitamin A (9770 IU), calcium (380 mg) and iron (16.2 mg).

Use-

Its succulent leaves and stem from a nutritious dish after cooking. The herbaceous parts of palak are mildly laxative besides other medicinal values.

Varieties-

Patane, Haripatte, All Green, Pusa Palak, Pusa Jyoti, Pusa Harit, Jobner Green, Punjab Selection, Arka Anupama, etc.

Climate-

It is a cool season crop and require mild climate for optimum growth and development. It tolerates frost and high temperature under good irrigation. Under high temperature condition early bolting occurs and leaves pass edible stage quickly with poor yield.

Soil and Field Preparation-

It can be cultivated in a wide range of soil but the idle soil is well fertile sandy loam soil with good drainage facility. It is tolerant to slight alkaline condition and is highly tolerant to salt and can be cultivated in sodic soil also. For raising palungo crop the soil is ploughed 3-5 times, pulverized and planked.

Manuring-

25-30 tones of FYM or compost /ha and N: P: K @ 80 kg: 60kg: 40kg/ha. Full dose of P, K and ½ dose of N is applied as a basal dose and remaining N is top dressed at 20-25 DAS and 40-45 DAS (Day after Sowing).

Sowing and Seed rate-

Normally spinach beet is grown during April-July in high hills, August-December in mid hills and September-October in terai. Normally seeds are broadcasted and 20-25 kg/ha seed is sufficient for one hectare area. The sowings of seeds in lines is an improvement over broadcasting method. For line sowing a distance of 20 cm from row to row and 5 cm from plant to plant is kept.

Irrigation-

Light but frequent irrigation is needed. Irrigation is provided in summer at 6-7 days interval and 10-15 days interval in winter.

Weed Control-

Hoeing and earthing up is done mainly in the standing crop. Hoeing is done to remove the weeds and pulverize the soil for proper aeration. Generally two hoeing are sufficient to keep the field from weeds. The weed can also be controlled by herbicide like Fluchloralin at 0.75 kg/has pre plant soil incorporation or Pendimethalin at 2.0 kg/ha.

Harvesting and Yield-

The first flush of leaves become ready for harvesting 3-4 weeks after sowing. Afterward its leaves are harvested at 15-20 days interval. Thus 6-8 pickings can be taken and it yield about 8-10 tones of leaves/ha.

Insect-Pests

Aphids (Aphis gossypii)-

They suck the cell sap of younger parts. The leaves of attacked plants turn pale and dry.

Control-

- Grow tolerant/resistant varieties
- Spray Phosphamidon (0.03%) or Dimethoate (0.03%) at 15 days interval.

Leaf eating caterpillar (*Laphygma exiqua*)-

The caterpillars make the hole in the leaves and deteriorate the quality.

Control-

Spray Malathion (0.1%) or Endosulphan (0.05%). Leaves should not be consumed before a week of spray.

Diseases

Damping off (Rhizoctonia solani and Pythium ultimum)-

It causes pre and post emergence death of plants. Pre-emergence attack results in inhibition of seed germination whereas, Post-emergence causes rotting of seedlings at collar region.

Control-

- Adopt long term crop rotation.
- Seed treatment with Ceresan @ 2 g/kg seed.
- Drench the nursery soil with Captan (0.2%).
- Avoid water logging condition.
- Spray Captan @ 0.2%.

Leaf spot (*Cercospora beticola*)-

The fungus attacks on beet where small circular to sub-circular spots with grey centres surrounded by red margins appear on the leaves.

Control-

- Spray Bavistin or Dithane M-45 @ 0.2% at 15 days interval starting from the appearance of symptoms.

Downy mildew (*Peronospora spinaciae*)-

Grey brown spots of mould appear on the under surface of the leaves. The disease is soil as well as seed borne.

Control-

- Follow crop rotation
- Remove the crop debris of previous crop.
- Treat the seeds with Captan or Thiram @ 2 g/kg seed before sowing.
- Spray Dithane M-45 or Dithane Z-78 @ 0.2%.

White rust (Albugo occidentalis)-

The appearance of white blisters on the lower surface of the leaves and on the upper

surface opposite to blister, the development of yellow patches are the characteristics symptoms of the diseases.

Control-

- Adopt proper crop rotation.
- Remove the weeds.
- Spray Bordeaux mixture (1%) or Dithane M-45 (0.2%).

LETTUCE

Lettuce (*Lactuca sativa L.)* is one of the most important salad crops occupying the maximum area among salad vegetables. It is temperate vegetables but also grown in tropical and subtropical areas of the world. The tender leaves and heads are consumed as salad after chopping. It is rich in vitamin A (990 IU), calcium (50 mg), Vitamin C (10 mg) and iron (2.4 mg). When it is cooked the entire amount of vitamin C is lost. For salad purpose it is grown as an annual crop but perennial for seed purpose.

There are four important botanical varieties of cultivated lettuce, *viz.*

1. **Head Type** *(L. sativa var. capitata L.)* It is divided into two groups.

   a) ***Butter head type:-*** They produce relatively small and loose heads. The outer leaves are green in colour Whereas, inner leaves are creamy or yellow which are oily, crumpled and soft textured. They donot withstand shipping and handling.

   b) ***Crisp head type:-*** These varieties are popular in North America and European countries. Produce brittle textured and tight folded large heads (Up to 1 kg) which have excellent shipping and handling abilities. Leaves are wrinkled, non-wrapper and round. The outer leaves are green and inner leaves are very thin, crisp and soft.

   c) **Leafy or bunching type.** *(L. sativa var. crispa L.)* The group includes non-heading cultivators. The colour of leaves varies from light green to red. They are cultivated in America, Australia, Europe and India.

   d) **Cos or Romaine type. (** *L. sativa var. longifolia L.)* Plants are straight growing and about 25cm in height which produce elongated leaves to form a loaf shaped head. The outer leaves are slimy and light green coloured but inner leaves are

finer and light in colour. It produces coarse leaves but have good eating quality. The cultivators of this group are non much popular.

e) **Asparagus or Stem type.** *L. sativa var. asparaginia L.)* It is known as "celery lettuce" and produces thick stems which are consumed either raw or cooked as vegetable after peeling. The leaves are also edible but inferior in quality than other types.

Varieties.

White Boston, Dark Green, Green Lakes, Imperial 859, Slobolt , Chinese Yellow, Celtuce, Iceberg etc.

Climate

Lettuce is essentially a cool season crop and requires a monthly average temperature of 12-15º C. The seeds become dormant and fail to germinate when the soil temperature is above 22- 30º C. Temperature above 22ºC promotes seed stalk (bolting), causing bitterness in leaves and accelerate the development of tip turn and rot. Hot and rainy or humid weather is also not favourable as it causes rotting of head lettuce.

Soil and Field preparation:-

Lettuce thrives best on well-drained sandy loam soil rich in organic matter. It is sensitive to high acidity and the optimum pH for cultivation is between 5.8 to 6.6.

About 2-3 ploughings followed by planking is essential to get the soil friable and leveled.

Manure and fertilizers:-

Being a shallow rooted plant it requires abundant quantity of nutrients. Incorporate 100-150 q well rotten FYM, 70 kg N and 60 kg each of P_2O_5 and K_2O/ha. Entire doses of P_2O_5 andK_2O and half dose of N are applied just before transplanting. The remaining half quantity of N should be top dressed one month after transplanting.

Sowing Time

The optimum sowing time of lettuce is September – October.

Seed Rate and Sowing:-

About 400-500 g seed is sufficient to raise the crop in one hectare area. Prior to sowing soak the seeds in water for 16 hrs to enhance germination. The seeds are sown either in nursery beds or *in situ.* Generally, the leafy type lettuce is sown directly in the field. About 5-6 week old seedlings become ready for transplanting.

Withhold irrigation water in nursery beds one week prior to transplanting to harden the seedlings. However, irrigation prior to uprooting of seedlings is very essential to avoid the root damage. Seedlings are transplanted in well prepared field at a spacing of 40 x 30-45 cm.

Irrigation:-

Irrigate the crop just after transplanting and then at short intervals to get the seedlings established. Subsequently, irrigate the crop at an interval of 8-12 days. The inadequate supply of irrigation leads to bolting. Avoid stagnation of water in heavy soils because it causes rotting and burning of leaf margins.

Inter-Culture and Weed Control

Shallow hoeing and weedings are essential to keep the field free from weeds and 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 weeds.

Harvesting

The leafy varieties become ready for harvesting within 50- 60 days of sowing and harvested when the leaves attain full size but remain tender. Head type varieties take 60-70 days to harvest. Heads are harvested when they attain a good size and become solid. Avoid the harvesting immediately after rain or in dew period as it causes crispness and breaks during handling.

Yeild

Head type lettuce yields about 100- 140 q/ha whereas, leaf type lettuce gives more yield.

Physiological Disorder

Tip burn The disorder may be caused due to the prevalence of high temperature, light intensity and long duration, excess of Nitrogen, Calcium and boron deficiency, ontogenic age of plant, high Mn content, soil moisture content and high endogenous level of IAA. This disorder is characterized by the appearance of tip burning of the lateral margins of the inner leaves of manure heads. The disorder is common in glasshouse grown crop than the field crop.

Control

- Increase the dark period and relative humidity.
- Spray the crop with $CaCl_2$ @ 0.5%

Insect-Pests

Aphids (Aphis gossypii)-

They suck the cell sap of younger parts. The leaves of attacked plants turn pale and dry.

Control-

- Grow tolerant/resistant varieties
- Spray Phosphamidon (0.03%) or Dimethoate (0.03%) at 15 days interval.

Diseases

Damping off (Rhizoctonia solani and Pythium ultimum)-

It causes pre and post emergence death of plants. Pre-emergence attack results in inhibition of seed germination whereas, Post-emergence causes rotting of seedlings at collar region.

Control-

- Adopt long term crop rotation.
- Seed treatment with Ceresan @ 2 g/kg seed.
- Drench the nursery soil with Captan (0.2%).
- Avoid water logging condition.
- Spray Captan @ 0.2%.

Downy mildew (*Bremia lactucae*)-

Grey brown spots of mould appear on the under surface of the leaves. The disease is soil as well as seed borne.

Control-

- Follow crop rotation
- Remove the crop debris of previous crop.
- Treat the seeds with Captan or Thiram @ 2 g/kg seed before sowing.
- Spray Dithane M-45 or Dithane Z-78 @ 0.2%.

Bacterial soft rot (Erwinia carotovora)

It is a destructive disease of carrot in storage and transport. The infected roots become soft, watery and as the rooting progresses, exude watery substances which give foul odour.

Control-

- Uproot the infected roots and destroy.
- Clean the roots and keep dry.
- Avoid bruising during harvesting, grading, transport, storage and handling.
- Store the roots at 0^{o}C temperature and 90% RH.

Lettuce mosaic-

It is a seed borne virus and characterized by the mottling, yellowing, internal tip necrosis and rusty brown discolouration of leaves. In severe condition plants fail to form heads. It is transmitted through aphids.

Control

- Adopt crop rotation.
- Use diseases free seeds.
- Rogue out affected plants and burn them.
- Spray Malathion (0.1%) or Endosulphan (0.05%) to control the aphid vector.

Big vein-

The disease is caused by a soil borne virus which is transmitted through fungus (Olpidium brassicae). Yellowing and thickening of leaves are characteristics

symptoms.

Control-

- Fumigate the soil with DD mixture, Vapam, Chloropicrin or Methyl Bromide before sowing.
- Avoid moist condition of soil to spread the infection of fungus.

Broad leaf Mustard

Broad leaf mustard commonly known as Bhaji or raeosag (*Brassica sp.*) is an important leafy vegetable commonly grown in Nepal. It belongs to family Brassicaceae.

Nutritive value-

It is a rich source of protein, vitamin C, Vitamin, calcium and iron.

Use- Its succulent leaves and stem from a nutritious dish after cooking. The herbaceous parts of palak are mildly laxative besides other medicinal values.

Varieties-

Khumal Chaudapaat, Tangkhua, Marph Chaudapaat, Khumal Ratopaat etc.

Climate- It is a cool season crop and require mild climate for optimum growth and development. It tolerates frost and high temperature under good irrigation. Under high temperature condition early bolting occurs and leaves pass edible stage quickly with poor yield.

Soil and Field Preparation-

It can be cultivated in a wide range of soil but the idle soil is well fertile sandy loam soil with good drainage facility. It is tolerant to slight alkaline condition and is highly tolerant to salt and can be cultivated in sodic soil also. For raising Raeosaag crop the soil is ploughed 3-5 times, pulverized and planked.

Manuring-

25-30 tones of FYM or compost /ha and N: P: K @ 80 kg: 60kg: 40kg/ha. Full dose of P, K and ½ dose of N is applied as a basal dose and remaining N is top dressed at 20-25 DAS and 40-45 DAS (Day After Sowing).

Sowing and Seed rate-

Normally spinach beet is grown during April-July in high hills, August-December in mid hills and September-October in terai. Normally seeds are broadcasted and 200-250 g/ha seed is sufficient for one hectare area. The sowings of seeds in lines is an improvement over broadcasting method. For line sowing a distance of 45 cm from row to row and 30 cm from plant to plant is kept.

Irrigation-

Light but frequent irrigation is needed. Irrigation is provided in summer at 6-7 days interval and 10-15 days interval in winter.

Weed Control-

Hoeing and earthing up is done mainly in the standing crop. Hoeing is done to remove the weeds and pulverize the soil for proper aeration. Generally two hoeing are sufficient to keep the field from weeds. The weed can also be controlled by herbicide like Fluchloralin at 0.75 kg/has pre plant soil incorporation or Pendimethalin at 2.0 kg/ha.

Harvesting and Yield-

The first flush of leaves become ready for harvesting 3-4 weeks after sowing. Afterward its leaves are harvested at 15-20 days interval. Thus 6-8 pickings can be taken and it yield about 8-10 tones of leaves/ha.

Insect-Pests

Aphids (Aphis gossypii**)-**

They suck the cell sap of younger parts. The leaves of attacked plants turn pale and dry.

Control-

- Grow tolerant/resistant varieties
- Spray Phosphamidon (0.03%) or Dimethoate (0.03%) at 15 days interval.

Leaf eating caterpillar (*Laphygma exiqua*)-

The caterpillars make the hole in the leaves and deteriorate the quality.

Control-

Spray Malathion (0.1%) or Endosulphan (0.05%). Leaves should not be consumed before a week of spray.

Diseases

Damping off (Rhizoctonia solani and Pythium ultimum)-

It causes pre and post emergence death of plants. Pre-emergence attack results in inhibition of seed germination whereas, Post-emergence causes rotting of seedlings at collar region.

Control-

- Adopt long term crop rotation.
- Seed treatment with Ceresan @ 2 g/kg seed.
- Drench the nursery soil with Captan (0.2%).
- Avoid water logging condition.
- Spray Captan @ 0.2%.

Leaf spot (*Cercospora beticola*)-

The fungus attacks on beet where small circular to sub-circular spots with grey centres surrounded by red margins appear on the leaves.

Control-

- Spray Bavistin or Dithane M-45 @ 0.2% at 15 days interval starting from the appearance of symptoms.

Downy mildew (Peronospora spinaciae)-

Grey brown spots of mould appear on the under surface of the leaves. The disease is soil as well as seed borne.

Control-

- Follow crop rotation
- Remove the crop debris of previous crop.
- Treat the seeds with Captan or Thiram @ 2 g/kg seed before sowing.
- Spray Dithane M-45 or Dithane Z-78 @ 0.2%.

White rust (Albugo occidentalis)-

The appearance of white blisters on the lower surface of the leaves and on the upper surface opposite to blister, the development of yellow patches are the characteristics symptoms of the diseases.

Control-

- Adopt proper crop rotation.
- Remove the weeds.
- Spray Bordeaux mixture (1%) or Dithane M-45 (0.2%).

Ginger (Zingiberaceae)

Ginger (*Zingiber officinale* L.) is an important spice of the world. Besides use as spice, the dry ginger is also used for the production of oil, oleoresin, essence, soft drinks and non alcoholic beverages. Ginger has manifold medicinal properties as carminative and stimulant of gastro-intestinal tract.

Nutritive value-

It is rich source of protein (2.3 g), Ca (20 mg) and Iron (3.5 mg).

Varieties-

Kaporkot-1, China Suruchi, Suprabha, Surabhi and Himgiri etc.

Climate-

Prevailing high humidity along with warm climate throughout the crop season is very essential for better growth and higher yield of ginger. It is the main crop of tropic. The areas having moderate to heavy rainfall during crop season is best suited for its cultivation. Low to moderate rainfall during rhizome sprout and moderate to heavy rainfall during crop growth and dry weather one month before harvesting coupled with 28-35^{o}C temperature is essential for higher yield and better quality of rhizome.

Soil and Field preparation-

Well drained fertile sandy loam to loam soils are well suited to grow ginger. One deep ploughing during summer and 3-4 light ploughing followed by planking is made to get the soil prepared. The beds of 3 m length, 1 m wide and 15 cm height are prepared

leaving 30-40 cm space between to beds.

Manure and fertilizer-

Incorporate 100-150 q/ha well rotten FYM or compost at the time of field preparation. Also apply 50-75 kg each of P_2O_5 and K_2O as basal dose at planting. About 75-100 kg N/ha is sufficient. Apply half quantity of N at planting and remaining half in two to three splits at 30, 45 and 80 days after planting as top dressing.

Sowing time-

February-March is the optimum time of sowing. However, it completely depends upon the receipt of pre-monsoon showers.

Seed rate and sowing-

The rate of rhizomes varies from region to region, however in general 13-15 q/ha seed rhizomes should be free from insect-pest and diseases. Seed rhizomes of 3-5 cm in length, 20-25 g in weight with 2-3 healthy bud eyes are considered best. Before sowing, the seed rhizome should be treated with 0.25% Dithane M-45 or 0.25% Agallol for 30 minutes. The seed rhizomes are sown 5.0 cm deep keeping a spacing of 25-30 cm between rows and 15-20 cm between plants. Seed rhizomes take 20 days to sprout.

Irrigation-

Irrigate the field just after planting and subsequently at an interval of 15-20 days to keep the soil moist.

Mulching-

Mulching is very important for ginger. It enhances organic matter, improves the physical properties of soil. Green leaves are the best material for mulching. The first mulching should be done soon after planting and second and third mulching at 40 and 90 days after planting. The first mulching requires about 125 q green leaves/ha whereas, 50 q green leaves/ha are sufficient for second and third mulching.

Weeding and Earthing-

Mostly hand weeding is done. Earthing up of ridges upto 30 cm should bedone after

second and third mulching.

Harvesting-

The crop is harvested 180 days after planting for the production of green ginger. However, for dry ginger it is harvested 240-260 after planting with the leaves turn yellow and start drying. The rhizomes are harvested with the help of spade or digging fork.

Yield-

Average yield of fresh ginger varies from 150-200 q/ha.

Preservation-

Ginger is vegetively propagated crop. It is propagated through rhizomes, which are called seed rhizomes. At the time of harvesting the healthy, disease and insect free seed rhizomes are selected for seed purpose. The seed rhizomes are treated in the solution of 0.1% Qunalphos + 0.25% Dithane M-45 for 45 minutes and then dried in shade before their storage in pits. The cow dung + loamy soil may be used to coat the walls of pits. In pits, the rhizomes are stored in layers; each layer followed by the layer of dry sand or saw dust leaving sufficient space at the top of pits to facilitate proper aeration. Thereafter, the pits are covered with wooden plank or other material leaving one or two small holes for aeration.

Preparation of Dry Ginger (Curing)-

After harvesting the rhizomes are soaked in fresh water for 12 hours and then washed. After cleaning the outer skin of rhizomes are removed followed by washing. Then the washed rhizomes are dried in sun for 6-8 days. These dried rhizomes are rubbed together to get the rhizomes free from the dirt or last bit and called unbleached ginger. The yield of cured ginger is 15-25% of fresh ginger. After drying, ginger is graded into two grades, (a) fibrous or Calicut grade and (B) free from fibers or Cochin grade. There is high demand of Cochin grade in international trade.

Insect-pests

Shoot borer (*Conogethes punctiferalis***)-**

Larvae bore into the pseudo-stem or rhizomes and feed on growing shoots resulting

in yellowing and drying of the infected shoots.

Control-

- Spray Malathion @ 0.1% or Monochrotophos @ 0.05% during July-October.

Rhizome Scale (*Aspiodiotus hartii*)-

They suck the sap of rhizome n field as well as storage. The affected rhizomes wither and dry.

Control-

- Dip the seed rhizome in 0.1% Qunalphos or Rogor @ 0.03%.

Diseases-

Soft rot rhizome rot (*Pythium aphanidermatum*)-

Rotting start from collar region spreads to rhizomes and roots. Leaves become yellow and completely dry. Rhizomes get decomposed and decayed.

Control-

- Usually healthy and disease free seed rhizomes are used for planting.
- Provide good drainage.
- Drench the soil with 0.1% Cerason or Captan.
- Treat the seed rhizomes with 0.25% Dithane M-45 and 0.1% Bavistin for 60 minutes before storage and sowing.

Bacterial wilt (*Pseudomonas solonacearum*)-

Affected rhizomes show a milky ooze when they are pressed. Severely affected rhizomes and plants die.

Control-

- Follow crop rotation.
- Select healthy rhizomes for planting.
- Treat the seed rhizome with Streptocycline @ 200 ppm for 30 minutes.

Turmeric

Turmeric (*Curcuma longa* L.) is an important spice crop. The plants are herbaceous

perennial and native to tropical to South East Asia. The rhizomes contain 1.8-5.4% curcumin pigment and 2.5-7.2% essential oil. With the ban on artificial colour in food industry, the use of curcumin has been widespread. Turmeric is used as condiment and as dye in cosmetic industries. The value of added products of turmeric are oil, oleoresin, curcuminoids and dehydrated turmeric powder. The yellow colouring factor in turmeric is curcumin.

Varieties-

Local, Suguna, Suverna, Sudharshana, CO-1, Roma, Suroma, Ranga, Rasmi, Sugandham, Krishna etc.

Climate-

Turmeric is a tropical crop grown from almost at sea level to 1400 m above mean sea level. The optimum temperature range is 20-30ºC with an annual rainfall of 150-200 cm.

Soil and Field Preparation-

Turmeric can be grown on almost but thrives best in well drained sandy loam to clay loam soils rich in organic matter.

One or two deep ploughing followed by 3-4 light ploughing and planking is essential to get the soil to the fine tilth. Beds of convenient length, 1.0-1.5 m wide and 0.15 m high are prepared just after pre-monsoon showers leaving at spacing of 45 cm between the beds.

Manure and Fertilizers-

Incorporate 100-150 q/ha well rotten FYM or compost at the time of field preparation. Also apply 100-125 kg each of P_2O_5 and K_2O as basal dose at planting. About 75-100 kg N/ha is sufficient. Apply half quantity of N at planting and remaining half in two to four splits at 30, 45, 90 and 120 days after planting as top dressing.

Sowing time-

February-March is the optimum time of sowing. However, it completely depends upon the receipt of pre-monsoon showers.

Seed rate and sowing-

The rate of rhizomes varies from region to region, however in general 13-15 q/ha seed

rhizomes should be free from insect-pest and diseases. Seed rhizomes of 3-5 cm in length, 30-40 g in weight with 2-3 healthy bud eyes are considered best. Before sowing, the seed rhizome should be treated with 0.25% Dithane M-45 or 0.25% Agallol for 30 minutes. The seed rhizomes are sown 5.0 cm deep keeping a spacing of 25-30 cm between rows and 15-20 cm between plants. Seed rhizomes take 20 days to sprout.

Irrigation-

Irrigate the field just after planting and subsequently at an interval of 15-20 days to keep the soil moist.

Mulching-

Mulching is very important for tumeric. It enhances organic matter, improves the physical properties of soil. Green leaves are the best material for mulching. The first mulching should be done soon after planting and second and third mulching at 40 and 90 days after planting. The first mulching requires about 125 q green leaves/ha whereas, 50 q green leaves/ha are sufficient for second and third mulching.

Weeding and Earthing-

Mostly hand weeding is done. Depending upon the weed intensity 3-4 weeding at 40, 80, 110 and 150 days after planting are sufficient.

Harvesting-

The turmeric is harvested 240-260 after planting. Ploughing is done upto the depth and are picked by hand or the clumps are carefully lifted with a spade and cleaned.

Yield-

Average yield of fresh turmeric varies from 150-200 q/ha.

Insect-pests

Shoot borer (*Conogethes punctiferalis*)-

Larvae bore into the pseudo-stem or rhizomes and feed on growing shoots resulting in yellowing and drying of the infected shoots.

Control-

- Spray Malathion @ 0.1% or Monochrotophos @ 0.05% during July-October.

Rhizome Scale (*Aspiodiotus hartii*)-

They suck the sap of rhizome n field as well as storage. The affected rhizomes wither and dry.

Control-

- Dip the seed rhizome in 0.1% Qunalphos or Rogor @ 0.03%.

Diseases-

Soft rot rhizome rot (*Pythium aphanidermatum*)-

Rotting start from collar region spreads to rhizomes and roots. Leaves become yellow and completely dry. Rhizomes get decomposed and decayed.

Control-

- Usually healthy and disease free seed rhizomes are used for planting.
- Provide good drainage.
- Drench the soil with 0.1% Cerason or Captan.
- Treat the seed rhizomes with 0.25% Dithane M-45 and 0.1% Bavistin for 60 minutes before storage and sowing.

Anthracnose or leaf spot (*Colletotrichum capsici*)-

About 4-5 cm long and 2-3 cm wide oblong brown spots with grey centers can be seen on the leaves. The affected leaves turn yellow and dry.

Control-

- Spray Dithane Z-78 (0.25%) at monthly interval.

Learning Process and support material:

- By using power point slide.
- Listening and writing the important points explained by instructors in the class.i.e. Class note is important.
- Observing the disease infected vegetable field in order to understand the symptoms of different disease.
- Making biopesticide by using locally available resources such in tite pati, neem

etc.

- Structure of the vegetables infected by insect and disease can be shown in projector to visualize the symptoms.
- krishi Diary

Assessement Process and support materials:

Very short questions:

Q.N.1 Give the scientific name and family of potato.

Q.N.2 Give the scientific name and family of tomato.

Q.N.3 Give the optimum temperature for growing Brinjal.

Q.N.4 what do you mean by blanching in cauliflower?

Q.N.5 Deficiency of which micronutrients causes whiptail and buttoning in cabbage?

Q.N.6 how much is the optimum ph required for growing radish?

Q.N.7 what is the casual organism for bacterial wilt in brinjal?

Short Questions:

Q.N.1 Give the climate, fertilizer manure requirement, time of planting and varieties of tomato.

Q.N.2 Enlist the major insect pest found in the potato field and explain control method for any two of them.

Q.N.3 explains about causal organism, symptoms and control method of early blight and late blight of tomato.

Q.N.4 what are the different physiological disorder observed in cauliflower?

Q.N.5 what are the major weeds found in onion field and how can you manage them?

Q.N.6 how can you identify the harvesting stage of broadleaf mustard and spinach?

Long Questions:

Q.N.1 Write in detail about the cultivation practices of tomato.

Q.N.2 Enlist major insect pest of Brinjal and their management.

Q.N.3 what are the major diseases of cole crops? How can you manage them in the field?

Glossary:

- germination= the beginning of vegetation or growth from a seed or spore
- Earthing up= providing support to the plant by bring soil in a base of the plant.
- Quarantine measures= safety measures
- Blossom= A flower, especially indicative of fruit as seen on fruit tree.
- Aphid= insect having piercing and sucking types of mouth parts.
- collar region= region of plant part that is near the neck region
- Rot= to suffer decomposition due to biological action, especially by fungi or bacteria.
- topple= to push, throw over, overturn
- Soak= to be saturated with liquid by being immersed in it.
- Incidence= occurrence or attack by disease causing organism.
- Volatile= evaporating or vaporizing readily under normal condition.
- pungency= The state of being pungent, a foul order
- Evaporation= the process of a liquid converting to the gaseous state.
- Dieback= the browning and death of a plant shoot starting at the tip due to disease or climatic conditions.

Reference:

- Singh, K.P. and R.R. Bhandari. 2015 Vegetable crops production Technology, Samiksha Publication, Kathmandu, Nepal.
- An Agriculture Information Book, Martyr Mitramani Acharya Library and Museum, IAAS, Rampur Chitwan.
- www.agrifarming.in
- www.agriinfo.in

UNIT - 5.

Off season vegetable production

(VSQ= 2, SQ=1, LQ= 1, TQ= 4)

Objective:

- To know about the principles and techniques of off- season vegetable production.
- To be able to produce off-season vegetable in off season.
- To know about the specialized structures for producing off season vegetable production.

Content elaboration:

Meaning- Off-season vegetable farming refers to the production of vegetables after or before their normal season.

Opportunities- Nepal have diversified climatic conditions and the natural resources bases are conductive to produce various crops including off-season vegetables. At present more than 200 vegetables are grown in different climatic zones of Nepal and out of which 50 species and their varieties are grown on the commercial basis. The off-season vegetables produced within the country, especially in the peri-urban areas are marketed in the respective urban centers. However some attempts are made in past to export the tomatoes and capsicum in India and Bangladesh. Agro Enterprise Centre (AEC) has been actively involving in collection, compilation and dissemination of price and other market information of vegetables regularly. This facility helps to the growers to gain more price of their produce by analyzing the suitable market.

Major opportunities are as follows-

- Increasing demand of off-season vegetables in the domestic markets, possibility of export market to different countries.
- Climatic suitability of hills to produce some unique vegetables with specific taste and quality, production potential of cauliflower, tomato and beans in the early winter month.
- Supply potentials at attractive prices of cauliflower, cabbage, capsicum and

tomato in the summer and early winter months in terai and northern border markets of India.

Problems-

Major problems faced by the farmers in off-season vegetable production are-

- Unavailability of suitable/adequate seeds and varieties.
- Unavailable of appropriate production technology and slow adaptation rate.
- Small size of production pockets.
- Inadequate support for marketing extension.

Technique of off-season farming

Selection of crops for off-season- Off- season vegetable production is a costly production technology than normal once so it is necessary that the vegetables selected for off-season must be high price generating crop. The production season of off-season vegetables may vary depending upon climates and topographic conditions of the pocket areas. However the common season of growing of some major off season vegetables are given below-

Off-season vegetables	Season
Cabbage	Year around
Cauliflower	January - March
Cucumber	April - November
Tomato	Year around
Radish	January - March
Brinjal	Year around
Carrot	January - March
Swiss Chard	Year around
Zucchini	March – May

Hot bed preparation- Hot bed is a low growing structure that uses a heating system to provide the warmth needed for growing. Propagation and hardening of the plant under controlled conditions. Hot bed consists of three parts *viz.* the frame, the cover and heating system. The frame is made up of wood, steel or aluminium and covered

with plastic or glass. The heat is usually provided artificially below the growing medium by the flow of hot water. A thermostat is used to regulate the temperature. Hot beds are used to raise the plants.

Regulation of microclimate- The climate surrounded the crop is called micro-climate. In off-season vegetable production technology the climate surround the crop is regulated by adopting different technology like making of plastic house, tunnels, glass house and green house. These hi-techs are creating the favourable climate to the plant in off season which helps them to grow smoothly.

Plant protection measures- Off- season vegetable production is the growing of vegetables after or before the normal season means they are unfavourable for the specific crop this might be due to abnormal temperature, higher incidence of diseases or pest, high rainfall condition etc.

The abnormal temperature and other climatic conditions can be easily avoided by regulating micro-climatic conditions. The incidence of insect-pests and diseases at the time of off- season production is higher and to minimize them we must adopted crop rotation, mulching of crops, solarized the soil and also can spray specific pesticide to control them.

Use of plastic in vegetable farming- The plastic is one of the major component of vegetable production especially for the off- season vegetable production. It is widely used to make polybag for cucurbits, as a mulching material in different crops, for making tunnels and plastic house for off-season vegetable production. Currently it is popularized for the solarization of soil to control the soil borne pests. It is also used after drench the soil to cover the beds.

Learning Process and support material:

- By observing the off-season vegetable farm in the field.
- By visualization method
- By searching different techniques of off- season vegetable farming in the internate.
- By doing practical of hot bed preparation in the school field.
- krishi Diary

Assessement:

Very Short Questions

Q.N.1 Define off-season vegetable farming.

Q.N.2 Define hot bed.

Q.N.3 In which month off season production of tomato results better yield?

Short Questions:

Q.N.1 Explain how can you prepare hot bed?

Q.N.2 what are the plant protection measures in off- season vegetable farming?

Q.N.3 How can you select crops for off-season vegetable farming?

Long Questions:

Q.N.1 Explain in detail about the techniques of off- season vegetable farming.

Q.N.2 why off-season vegetable farming is important for Nepalese economy.

Q.N.3 what are the major problems of off-season vegetable farming in Nepal? How can we overcome these problems??

Glossary:

- Regulation= Control
- Microclimate= the climate of a particular crop is called microclimate.
- generate= Create
- Thermostat= A device that automatically responds to changes in temperature by activating a heating or cooling system to maintain the temperature at a desired setting.

Refrences:

- Singh, K.P. and R.R. Bhandari. 2015 Vegetable crops production Technology, Samiksha Publication, Kathmandu, Nepal.
- An Agriculture Information Book, Martyr Mitramani Acharya Library and Museum, IAAS, Rampur Chitwan.
- www.agrifarming.in
- www.agriinfo.in

UNIT- 6

Medicinal & Aromatic Plants

(MAP)(VSQ=1, SQ=1, LQ=1 TQ=4)

Objective:

- To understand the basic concepts of medicinal and aromatic plants.
- To became able to identify some medicinal and aromatic plants.
- To became able to classify different medicinal and aromatic plants.
- To understand cultivation practices of major medicinal and aromatic plants.

Content elaboration:

Meaning: Plants having medicinal value and specific odor which is used raw or after processing and cure various diseases is called MAP.

Importance:

- These plants possess medicinal value used in curing various diseases.
- It helps to establish various pharmaceutical industries and processing plant.
- The extracted from aromatic plants are used in preparing perfumes which has reached to the hands of poor people.
- Raw or oils are highly demanded in foreign country and helps in earning foreign exchange.
- Due to diversified climatic condition all type of MAP can be cultivated from terai to high hills.
- Nepal is wealthy in MAP diversity.

Comparative Advantage:

- It is used after processing but other crops are directly used.
- The oil extracted possesses good aroma and are highly demanded in the national & international market than other crops.
- It requires small processing plant at the site of production, but other is commonly used raw.
- It has wider market nationally and internationally than any other crop.
- MAP bear medicinal value and are used by different pharmaceutical industries.

Classification of MAPs

MAP is classified on the basis of:

A) Habit B) Habitat C) Use D) Economic value

A) Classification on the basis of Habit: On the basis of its growing habit, it is classified as follows:

- Tree: eg. Sugandhakokola, Tejpat, Amala, Ritha, Rudraksha etc.
- Shrubs : eg. Asuro, Kanthakari, Black Musli, Chiraito, Nirmasi etc.
- Herbs: eg. Lemon grass, Citronella, Bojho, Jatamasi etc.
- Runners: eg. Indrayani, Nagveli, Pipla, Majito etc.

B) Classification on the basis of Habitat*: It is found from tropical to temperate region and are classified acoordingly as follows:*

- High Himalayan: eg. Chiraito, Jatamasi, Kutki, Uatish, Vish, Jhyau etc.
- Mid Hills: eg. Timbur, Pairathrum, Rudraksha, Cinnamon, Weladona, Titepati, Sugandhkokila, Bojho, Wild garlic, Jatamasi, Chiraito etc.
- Tarai: eg. Sarpagandha, Pipla, Sikakai, Harrobarro, Amala, Neem etc.

C) **Classification on the basis of Use:** Various parts of MAP possess medicinal value and are used accordingly. Thus, on the basis of its part used, it is classified as under:

1.Plants with medicinal value / use:-

- Root Used: PanchAula, Jatamasi, Sugandhawal, Bhyakur, Bojho, Kurilo,Sarpagandha, Khaskhas, Kesar, Indreni etc.
- Leaves Used: Tejpat, Kumkum, Lothsalla, Titepati, Asuro, Ghsingre etc.
- Seed & fruit used: eg. Pipla, Rudraksha, Katus, Lapsi, Ritha, Sugandhakokila, Sikakai, Indrayani, Amala, Kusum etc.
- Plant Used: eg. Yarsagumba, Majito, Chiraito, Titepati, Gujargano, Nagveli, Ghodtapre, Somlata etc.
- Bark used: eg. Okhar, Kafal, Cinnamon, Totalo, Palas, Arjun, Neem etc.
- Flower used: eg. Sugandhakokila, Gurans, Nageswar, Bunki, Aak, Aasuro etc.
- Aromatic oil used:- eg. Sugandhakokila, Mentha, Gerenium, Sayapatri,

Eukalyptus, Kumkum, Sugandhawal etc.

- Miscellaneous:- Bramhi, Asuro, LAlgeda, Nagveli, Shikakai, Ritha etc.

2. **Economic value:-** MAP bear economic value because raw parts or processed form are demanded nationally and internationally and earn foreign exchange too. Thus, on the basis of price & demand, it is classified as under:

- high economic value: Yarsagumba, Panchaunla, Kutki, Chiraito, Sugandhveli, Lauthsalla, TAlispatra, Sugandhkokila etc.
- MAP of low economic value: Citronella, Ritha, Lemongrass, Garlic, Chamomile etc.

8.3 Natural distribution of MAPs in ecological zones of Nepal-

Distribution pattern, population density, regeneration status and biomass production of five most important high altitude MAPs (*Aconitum orochryseum*, *Dactylorhiza hatagirea*, *Nordostachys grandiflora*, *Pichorrhiza scorphulariiflora*, and *Rheum australe*) were assessed in three different natural sites of the Gyasumdo valley in Manang district of Nepal. All there medicinal plants generally grow above timberline (3500 m).

Manang district is rich in diverse MAPs in its Trans-Himalayan Zone. The average maximum temperature of 16.6ºC and the average minimum temperature of 4.8ºC have been recorded in Gyasumdo valley of Manang. Crosspondence to climatic condition there are also occur a change in vegetation types from sub-tropical to temperate, xerophilos to alpine formation. The forest vegetation includes oak (*Quercus spp.*), Confiers (*Pinus wallichiana, Picea smithiana, Taxus baccata, Tsugu dumosa* and *Abies spectabilis*) and birch (*Betula utilis*) in the upper belt. The vegetation above timberline is enriched by steppe-communities mostly of Berberies, Coraguna, Rosa and Juprinus. All there localities represent sub-alpine and alpine ecozones (3500 m sL) above the timberline.

Economic importance, potential, efforts and activities of NTFP development in Nepal-

MAPs in Nepal have been considered as one of the Non-Timber Forest Product (NTFP) contributing to the national economy. There plants have also become the important source of medicine for the local healers in the village, as well as the basic raw materials for Ayurvedic, Tibetan, Homeopathic and Alleopathic medicines. It has been estimated that approximately 80% of the developing world relay on traditional medicines contain plant and their extracts. In Nepal about 70-80% of population in the mountain region depends on traditional medicines for health care. The recorded list of MAPs found in Nepal is about 700 species consisting 10% of the total flower plant species in Nepal flora.Rapid increase of international links in herb marketing has exerted intensive pressure on their Himalayan herbs. Over 50 items of crude herbs and aromatic plants of Nepal are in the traditional herbal trade to India and China. The current trade status of NTFP, especially the MAPs and estimated that about 10-15 thousand tones, composed of 100 species of MAPs, with a border of value $ 8.6 million are exported from Nepal annually. It is estimated that 4,70,000 households are involved in commercial medicinal plant collection in Nepal and the annual export value is estimated at $ 22-70 million. The trade of MAPs also supports economically a large number of people in the rural area like collectors, porters and traders. In Nepal, most of the collection of MAPs is done indiscriminately and not in accordance with any regulatory procedure or recognized management practice. This has threatened the survival of some species and reduced the quality of many more. Threats to the MAP of Nepal also come from habitat destruction from gazing, deforestation and fire. More than 25 species of MAP have been considered as threatened species in Nepal.

PROCESSING OF MAP

Essential oils are complex mixture of odoriferous and steam volatile compounds which can be separated by distilling with water. This process is known as hydro-distillation. There are three type of hydro-distillation briefly discussed below:

1. Water Distillation: It is simple method in which the plant material to be distilled comes in direct contact with boiling water in a distillation still. It is best for material of powdered form.

2. Water and Steam Distillation: It is improved method in which plant material is supported on a perforated grid or false bottom above the bottom of distillation steel. The lower part of the still is filled with water to a level below the false bottom. When heated, the wet steam rises through the material at low pressure. In this method hydrolysis is fairly at a low rate, while distillation is rapid, the oil yield is also better and the physio-chemical properties of the oil are also good.
3. Direct Steam Distillation: This method is similar to the second method except that no water is kept in the bottom of the still. Live steam saturated or super heated steam with pressure higher than atmospheric, is passed through the bottom of the still. The rate of distillation is very high and any yield and quality of oil are also good in this method.

CULTIVATION PRACTICES OF SOME CULTIVATED MAP

1. Lemon Grass (B.N.- Cymbopogon flexus; Family: Graminae)

Use: Chief constituent of oil is called *Citral*. Oil is used in making synthetic vitamin A, insecticide, mosquito coil, phenyl etc.

Climate: Warm and humid climate with annual rainfall of 250-280 cm is required.

Soil: All type of soil with good drainage facility and rich in organic matter with soil pH 4.5-7.5 is required for optimum cultivation.

Raising of seedling: 15-20 kg seed/ ha is required. It is sown in nursery bed at 10 cm spacing. 2 month old seedling are transplanted on a well prepared land at spacing 15 cm x 10 cm. Split from clumps are also planted.

Manuring: FYM or compost @ 20-25 t/ha. & N: P : K @ 60 kg: 50 kg: 30kg/ha.

Harvesting: The crop become ready for harvest at 90 day after planting and then at 55-60 day interval. Grass is cut 10cm above the ground and 5-6 cutting/ year. It yields 25 lit oil/ Year/ha in first year and 80-100 lit oil/year/ha from 2^{nd} to 6^{th} year.

2. Citronella grass (B.N.- Citronella winterianus; Family: Graminae)

Use: Oil contain citronella, citronellal, Geranial. Used in preparing soap, pesticide, detergent, mosquito coil, phenyl etc.

Climate: Warm & humid climate with annual rainfall of 200-250 cm is required. It cannot tolerate drought condition.

Soil: Loamy soil with pH 6-6.5 is ideal.

Propagation: Rooted slips are used for planting. Planting in the month of April/ May is recommended.

Manuring: FYM or compost 20t/ha and N: K: P @ 125: 62: 50 kg/ ha is recommended.

Harvesting: Harvesting 5 month after planting and then at 2 month interval before winter period. Two cuttings in Nov. to Feb. is practiced.

Yield: 1st Yr - 140-150 kg / ha

2nd -3rd Yr - 200-300kg / ha

4th Yr - 200kg/ha

5th Yr - 100kg/ha

3. Palmarosa (BN- Cymbopogon martini; Family: Graminae)

Use: Oil contain 75-90% geranial, used in soap, cream, lotion, perfume etc.

Climate: It is a hardy plant and can be cultivated in varied range of altitude with an annual rainfall of 75-150 cm. Cannot tolerate water logging condition.

Soil: Sandy loam to clay loam is ideal.

Raising of seedling: generally 2.5 kg of seed/ha is recommended. It is sown from April to Sep in a nursery and become ready for transplanting when it attains 15 cm height.

Planting: It is transplanted on a well prepared land at a spacing 40 cm x 15-30 cm.

Manuring: FYM or compost @ 15-20 t / ha and N:P:K @ 60:40:40kg / ha is recommended.

Harvesting: It becomes ready for harvesting 6 month after transplanting. It require several cutting at regular interval. It yields about 50-60 kg oil/ha/Yr.

ASPARAGUS

B. N.:- Asparagus officinalis Family: Liliaceae

Nutritive value: It is a rich source of protein, carbohydrate, potassium, phosphorus, magnesium, calcium and iron.

Use: It is consumed as vegetable and soup. Green and steamed asparagus is also consumed as salad. A white crystalline substance called asparagine obtained from juice of young shoot is considered to be good diuretic and is used specially in cardiac dropsy and chronic gout.

Variety: Mary Washington, Martha Washington, Argentenil, Jersey Queen, Perfection, Tainan-1, 2 & 3 etc.

Soil: It prefers sandy, silt loam or alluvial soil but a high level of organic material in the soil is essential with proper drainage facility. A soil pH of 6-7.5 is ideal.

Climate: In Nepal it can efficiently cultivated from mid-hills to terai. It is semi-perennial crop and prefers hot and dry weather for optimum growth and development. It requires a temperature range of 16-24ºC for most of the growing season for good spear production. But lower temperature is necessary for 60-90 days of the year during winter at the time of dormancy.

Raising of seedling: It require seed rate of 2-3 kg for one hectare area or 50000-70000 crown or spear/ ha. It can be cultivated by three methods:

- *One year old Spear planting method:* A small sized spear from mother plant is detached and used for planting.
- *Direct seed sowing method:* In this method seeds are directly sown in a field at recommended spacing. But this method requires extensive care due to this it is oftenly practiced.
- *Seedling transplanting method:* It is the most popular method practiced for cultivating asparagus. The seeds are soaked in water overnight and then sown in a poly-bag enriched with growing media. When seedling attain 25-30 cm height than it is transplanted in a ridges on a well prepared land at a spacing of 120 cm X 25-60 cm.

Sowing time*:* Falgun – Chaitra or Bhadra- Asoj is time for sowing seed and transplanted in Asad or Mangsir.

Manuring: The recommended dose of FYM/compost is 25 t/ha and N:P:K is @ 60 kg:100 kg:80kg /ha. N: P: K is applied in two split doses i.e. 1st at the time of planting or transplanting and again topdressing at the end of winter is practiced to get optimum yield.

Irrigation: It requires light irrigation depnding upon the moisture present in soil. But it should be avoided 3 weeks before harvest.

Harvesting and Yield: In the first year the spear are harvested partially to get bushy appearance. From second year, it is harvested commercially. When spear becomes 8-12cm tall then it is harvested. The harvesting is practiced from Baisakh to Asad. Depending upon the variety, it yields about 4-8 tonne/ha.

Diseases:

1. Asparagus rust: (C.O. - *Puccinia asparagi*)

Symptom: Small reddish-yellow spots on the main stem and branches enlarge into patches until the whole plant has a reddish-brown or orange colour and ultimately the top of the plant are destroyed.

Control: Use resistant variety like Jerssy Gaint and UC 157.

Remove and destroy infected part.

Spray Blitox-50 @ 2.5 gm/lt of water thrice at 7 days interval.

2**. Wilt**: (C.O:- *Fusarium sp*.)

Symptom: Infected plant show brown discoloration and become wilted and stunted and later on whole plant dies.

Control:

- *Maintain proper drainage.*
- *Use healthy seed.*
- *Uproot and destroy infected plant.*
- *Spray on plant and drench in soil Blitox-50 @ 2.5 gm/lt of water thrice at 7 days*

interval.

Insect-pest:

1. Asparagus beetle:

M.O.A.:

Asult and larva feed on leaf, shoot and stem and cause severe damage.

Control:

- Collct and destroy egg and larva.
- Spray malathion or nuvan @ 0.1% to reduce the insect population.

2. Garden Centipede:

It makes large number of small holes on stem and spear below the ground and spear become unfit for canning.

Control:

- Flooding the field is the only means of checking the population.

Learning process and support materials:

- By making herbarium file in the practical.
- Visiting herbal processing industry (if possible)
- By doing questionnaire survey in the local vicinity to know how the medicinal plants are utilized by using traditional method.
- Power point presentation of MAPs.
- krishi Diary

Assessment:

Very Short Questions:

Q.N.1 Define MAPs.
Q.N.2 Give the scientific name of Asparagus.
Q.N.3 what is the botanical name of lemon grass?
Q.N.4 what is the full form of NTFP?

Short Questions:

Q.N.1 Classify MAPs on the basis of habitat.

Q.N.2 Why NTFP is important in our daily life?

Q.N.3 how can you classify MAPs on the basis of use?

Q.N.4 Give the climate, soil and manure and fertilizer for growing palma Rosa.

Long Question:

Q.N.1 what are the efforts and activities of NTFP development in Nepal?

Q.N.2 Explain in detail about the cultivation practices of Citronella grass.

Q.N.3 Explain different techniques of processing of MAPs.

Q.N.4 Write the causal organism, symptoms and control method of diseases that appears in Asparagous.

Glossary:

Pharmaceutical= relating to pharmacy

Conifer = a plant belonging to the conifers; a cone- bearing seed plant with vascular tissue, usually a tree.

Homeopathy = A system of treating diseases with small amounts of substances which, in larger amounts, would produce the observed symptoms.

Allelopathy = the release by a plant of a toxin to suppress growth of nearby competing plants.

Curative = Possessing the ability to cure, to heal or treat illness.

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UNIT- 7

Vegetable Seed Production

(VSQ=1, SQ=0, LQ= 1 TQ= 3)

Objective:

- To know the basic principles of vegetable seed production.
- To know the mode of pollination in different vegetables.
- To became able to know the seed production techniques of major vegetable crops.
- To know about the varietal maintenance and seed multiplication techniques.

Content elaboration:

Classification based on mode of pollination

It is very important to know the mode of pollination of different vegetable crop for seed production as it leads to the success of quality seed production. Therefore, it is necessary to know either particular crop is self pollinated or cross pollinated before seed production. Thus, on the basis of mode of pollination, vegetable crops are classified as follows:

A. Highly cross pollinated crop:

- Wind-pollinated: The crops mostly pollinated by wind falls under this category. Eg. Amaranthus, Beet-leaf, Spinach, Garden beet, Sugar beet etc.
- Insect-pollinated: Here cross pollination is commonly observed by various insects. Eg. All Cucurbits, All Cole crop, Radish, Turnip, Carrot, Onion etc.

B. Often Cross pollinated:

Generally self pollinated due to floral structure but some Time crossing is observed due to insect pollinator. Eg. Brinjal, Okra, Chilli, sweet Pepper etc.

C. Highly Self-pollinated:

Due its floral structure, vegetable crops are self pollinated Strictly without any hindrance of insect or wind. Eg. Cluster Bean, French Bean, Cow pea, Garden Pea, Fenugreek, Lettuce, tomato etc.

Seed Production Technique of Tomato & Potato

1. Potato: Cultivation practices are same as commercial cultivation.

Care during seed Production:

- When plant reaches maturity, it requires about 18 hrs to flower i.e. 5-6 hour of photoperiod is provided by placing vapour light around the field.
- After flowering pollen are collected from individual flower carefully and then pollinated manually and skillfully after 4-5 day.
- Virus infected plants are rouged out and suitable control measures for vector is adopted.
- Collected mature fruit are fermented for certain period and then seeds are collected, cleaned, dried and packed.
- It yield about 10-15 kg / ha.

2. Tomato: It is self pollinated crop and requires isolation distance of 25 m.

Manuring, seed rate, planting time, spacing is same as commercial cultivation.

Care during seed production:

Tomato mosaic virus is a serious problem in tomato, so regular rouging and suitable control measure against vector white fly is practiced when necessary.

Fully mature fruits are harvested and then placed in a container for fermentation for certain period and separated seed is collected, washed, dried and packed.

It yields about 50-100 kg seed / ha.

3. Cabbage and Cauliflower: Cultural operation is similar to commercial cultivation.

***Planting Time*:** It is very sensitive to frost during curd formation and bolting stage. Therefore, crop should be planted at the end of August.

Manuring: Recommended dose of FYM or compost is @ 50 t/ha and N:P:K @ 140kg:50kg:50 kg/ha. Basal dose is applied @ Full P, K and 50 kg N. Similarly the crop should be top dressed thrice i.e. 1st 30 kg N at 30 DATP; 2nd 30 kg N at curd formation; 3rd 30 kg at during bolting.

Method of seed production of Cole crops:

a) **Seed to seed method:** The plants with good curd or head are left in the field, where they flower and produce seed. The crop is grown as usual as for market crops except later the crop is allowed to bolt, flower and produce seed. This is the standard method followed for commercial seed production. This is not followed for breeder/foundation seed because in this case no proper selection is possible and can be done. However, in early cauliflower, this method yields relatively well.

b) **Head to Seed Method:** The selected heads of cabbage or curds of cauliflower are uprooted carefully and replanted in a compact block for seed production. Replanting is done in coming favourable season at appropriate spacing. At the time of replanting, appropriate spacing should be maintained and cross incision in the middle of head or curds is given for efficient bolting, flowering and fruit/seed setting.

c) **Stump Method:** When the crop attain marketable maturity, heads or curds after judging their trueness to type are beheaded just below the base, keeping the non-wrapper leaves and stem intact. The heads or curds are marketed for vegetable purpose and the stump either left in-situ or stored is replanted. In the following season when dormancy is broken, the bud sprouts from the axis of all leaves and leaf scars. In this method there is profuse flower shoot development which requires proper staking and yields higher.

Care of seed crop:

- Isolation distance of 1600 m for Foundation seed and 1000 m for certified seed is provided or maintained.
- Bee population should be maintained during flowering.
- Crop should be protected from aphid & cabbage butterfly.
- Rouging as and when practiced.
- Avoid spraying during flowering.
- Harvest at 70% maturity and cure properly.
- Dry seed at 8% moisture level and then store.
- Try to harvest & store before monsoon.
- It yields about 250-300 kg seed / ha.

Seed production technique for peas and beans

The cultivation practice for seed crop of peas and beans are more or less the same as for green pods. Although as a self pollinated crop, pea is well known for producing off type plants. Hence careful rouging must be undertaken at flowering and fruiting stage. When almost 90% pods on the plants mature and turn dry, the whole plants are uprooted and collected. After about a week the seeds are separated out from the pods by threshing and winnowing. The ripe and dry pods can also be picked up by hand and threshed. Usually the moisture contents of seeds at this time are higher. Therefore, the drying must be resorted to maintain the specified moisture contained of these crop. On an average from a hectare of seed crop about 1,500 kg peas, 1000kg french beans, 1000 kg cowpea, 700 kg Dolichos beans, 700 kg cluster bean seeds can be obtained.

Seed production technique for Onion

Onion is a biennial crop taking 2 full seasons to produce seeds. In the first year, bulbs are produced and in second year seed stalks are produced. Onion is a long day plant but in seed production it is day neutral. It requires cool conditions during early development of the crop and again prior to and during early growth of seed stalk. Varieties bolt readily between 10-15ºC. During harvesting and curing of the seed, fairly high temperature and low humidity are desirable.Onion is largely cross pollinated crop with up to 93% natural cross pollination, but self pollination does occur. It is chiefly pollinated by honey bees. For seed production the field should be isolated from fields of other varieties of onion or fields of the same variety not confirming to varietals standard, at least by 1,000 m for foundation seed and 500 m for certified.Mostly bulb-to-seed method is used for seed production. Seed-to-seed method is used if bulbs have lower keeping quality.Well-matured bulbs should be harvested, and topped, leaving 1.27 cm mark. Before storage, a through selection and curing of bulbs should be done. The time required for curing depends on weather conditions and may takes 3-4 weeks. The mature bulb should be stored in well ventilated, cool stores (0-4.5o^{C}) until 3-4 weeks prior to planting.The best time for planting of bulb is the second fortnight of October. The rouging carried out in the field when the bulbs are not harvested. After harvesting, true to type bulbs are selected. Seed is ready for harvesting when first formed seed in the heads get blackened. A total

of 2-3 picking may be necessary to harvest the heads. Seed heads are cut, snapped off, keeping a small portion of the stalk attached. Seed heads after harvesting should be thoroughly dried. Seeds from heads are removed. After that seeds are cleaned by putting them in water and dried under the sun or by drier and stored. The moisture content should not be more than 6-8%. Seed yield is 850-1,000 kg/ha.

Seed production technique for Radish and Carrot

The method of cultivation is nearly the same as for fresh roots. However, the seed is produced by seed-to-seed method or transplanting root-to-seed method. Transplanted root-to-seed method is better since it gives an opportunity to rogue out off type roots at the time of transplanting, maintaining only true-to-type plants for seed production. Its seed crop should be harvested when most of the pods turn yellow. After that it is dried and seeds are threshed out from the pods. A hectare of radish seed crop yields 600-1,000kg seed.In carrot, the seeds are formed in umbels. The first and largest umbel is formed on main flowering stalk and is known as primary or king umbel. Second umbels are formed at the terminus of branches from the main flowering stem and flower in a sequence from the top to the bottom of the inflorescence. Tertiary umbels originated on secondary umbel stem. The seeds form primary umbels are heavier, more mature together; harvesting is done 2-3 times. However, the seed crop can be harvested when all the secondary umbels mature and tertiary umbels turn yellow. A hectare of carrot seed crop yields 450-500 kg/ha.

VARIETY MAINTENANCE AND SEED MULTIPLICATION

Variety maintenance means the genetical and physical purity maintenance of that variety regularly year after year. Purity of seed (physical & genetic) is an important attribute (desired character) which should be maintained year after year. If varieties are not maintained yearly, due to contamination of another gene, the quality is deteriorated. Thus, it is necessary to maintain the variety on the basis of pollination, the vegetable crops that are classified on particular group are maintained accordingly:-

Variety maintenance of self pollinated crop:- Variety maintenance of highly self pollinated crop are practiced by following ways:

Pedigree Selection: In this method the plant confirming to the character of the variety are individually selected, harvested and seed are collected for next year production. Every year this method is practiced.

Mass selection : In this method field are inspected for several time and off type plants are rogued out , only plants of desired character are left in the field and later on seed are harvested and collected which is used for further seed multiplication. It is practiced every year.

2. Variety maintenance of often cross pollinated crop: The variety out cross with each other to some extent, so selfing is the best method for variety maintenance. In this method, desired plants are selected, flowers are bagged or the plants are caged. This way self pollination takes place and seed collected from this plant are further multiplied. Out crossing can also be minimized by maintaining required isolation distance.

3. Variety maintenance of cross pollinated crop:

Mass Selection: In this method best individual plants are selected from a reasonably pure population grown in isolation and their seed are collected for raising subsequent generation. Selection of large population is practiced.

Mass pedigree method: From source population, select the best plant with desirable character, harvest their seed individually and divide in two halves. Grow one half in replicate progeny rows in the second year. Mix seed of the best progeny in equal quantities from the seed saved in first year. Grow bulk seed in isolation, rogue out undesirable plants before flowering and select plants of desired character, collect seed for multiplication.

SEED MULTIPLICATION:

After producing the vegetable seeds of desired attributes, it is necessary to multiply to fulfill the demand. The seeds are thus multiplied at different stages maintaining the physical as well as genetic purity of seed. The different stages of seed multiplication

are briefly discussed below:

- **Breeder seed:** Breeder seed are 100% genetically pure seed produced by a breeder agencies, either government or private recognized by govt. seed certification agency and research station. This is the first stage in the seed multiplication chain. In this method mass selection often practiced. The label colour breeder seed is golden yellow colour with size 12x6 cm2
- **Foundation seed/Basic seed:** It is the progeny of breeder seed so the genetic purity is strictly maintained (99-100%). Its production is supervised and approved by the certifying agencies and is produced on govt. farm and research station and private seed grower under strict supervision & guidance of experts. It is the source of registered and certified seed. The label colour foundation seed is White colour with size 15x7.5 cm2
- **Certified seed:** It is produced from foundation seed which is genetically pure and produced by progressive farmers, govt. farms and research station under strict supervision & guidance. Here the varieties are registered and then multiplied for certification. The label colour foundation seed is Blue colour with size 15x7.5 cm2
- **Improved seed:** It is a progeny of certified seed. It should maintain physical and genetic purity of required standard. It is grown by progressive farmers and after certification of purity; it is made available to general farmers for commercial cultivation. The genetic and physical purity of certified seed must be maintained to 98%. The label colour foundation seed is Yellow colour with size 15x7.5 cm^2

VEGETABLE SEED TESTING

Seed testing is very important for distinguishing good quality seed from the seed below the prescribed standard to ensure the planting value of seed. The International Seed Testing Association (ISTA), established in 1924, has developed uniform rules and regulation for seed testing. These rules prescribe testing techniques based on scientific evidence, which are accurate within the stated statistical limits and practicable for everyday operation.

The seed testing process for quality assurance can be subdivided into:

1. **Seed Sampling:** A sample from a seed lot is obtained by taking small portions (***primary sample***) at random from different portion in the lot and combining them (***composite sample***). From this sample, smaller samples (submitted sample) are obtained for sending to the laboratory. The samples are obtained preferably with the help of seed drier from the seed lot. A part of the submitted sample is known as ***working sample*** in the laboratory which is subjected to quality test.

2. **Moisture Determination:** The object of moisture determination is to find out the moisture content of seed at the time it was sampled. To ensure this, the sample must be submitted in a moisture-proof container and analyzed without any delay. The moisture can be determined by different method briefly stated below:

- Hot-Air Oven Method: This is the most standard method used commonly. Its principle is the elimination of water from seed by heating under precisely controlled condition. The moisture content is expressed as percentage of the original weight. Non oily seed should be heated at 130ºC and oily seed should be heated at 105ºC.
- Moisture Meter Method: this is the quick method of moisture determination of seeds but this method is not accurate as hot air oven method and cannot calibrate moisture below 8 %.
- Oil Distillation Method
- Electric Moisture Recorder
- Infra-red *Moisture Meter*

3. **Germination Test:** It is very important to know the germination capacity of seed for its quality assurance. The germination capacity is determined in percentage. Usually 400 seeds are tested in replicates of 100 seeds. The seed are planted under prescribed condition favourable for germination and early growth i.e. provided with adequate moisture, a favourable temperature and suitable substratum (growing media) or other special requirement. The substratum used may be germination paper, bloating paper, cloth, cotton, soil, sand etc. The test is carried out by placing seed on ***top of paper***, ***between paper*** and ***paper roll***

method maintaining optimum soil moisture and temperature. Usually the germination test is evaluated at least two times during the test period. Germination test are evaluated as follows:

- Normal Seedlings: are those seedlings possessing morphological and physiological attributes indicative of their ability to produce a normal plant.
- Abnormal seedlings: are those seedlings which are incapable of producing normal plants due to morphological reason.
- Damaged seedling: seedling with no cotyledons, seedling with constriction splits, cracked seedling etc. are considered as damaged seedling.
- Deformed seedling: are weak and unbalanced seedlings with ugly appearance.
- Decayed seedling: are seedlings damaged due to insect pest and pathogen attack and seedling rot.
- Dead seed: are those which do not germinate.
- Hard seed: are live seed but do not absorb water from seed coat.

4. **Physical purity:** The purpose of the test is to determine the physical composition of seed lot. The test is made upon a seed sample of prescribed minimum size which is representative of the lot. The seed quality is considered superior if pure seed percentage is at or above 98%. In purity test the sample is analyzed into three components:

- *Pure seed:* Refers to the species under consideration.
- Other seed: Includes seed and seed like structure of any plant other than that of pure seed.
- Inert matter: Refers to seed like structure from both crop and weed plant and other matter such as soil, stone, chaff, leaves etc.

After the components of purity seed are separated, they are weighed and their proportion of the whole sample is expressed as percentages.

5. Seed viability test: This test is conducted to determine the viability of seed of certain species which germinate slowly or show a high degree of dormancy by Tetrazolium Test. This is very quick method for determination of viability. In this method seed is soaked overnight and then again soaked in 0.5-1.0% aqueous solution

of 2,3,5-triphenyle tetrazolium chloride at 30ºC in dark for few hours. The tetrazolium comes in contact with embryo of seed. The seed is cleaned 3-4 times with distilled water, if necessary seed coat is removed and then seeds are evaluated for viability on the following basis:

- Completely stained seed as viable
- Partially stained seed
- Un-stained seed as non-viable

INTRODUCTION TO HYBRID SEED PRODUCTION

Depending upon the nature of flowering, development of sex mechanism and mode of pollination of vegetable crops, different crossing methods has been used for commercial hybrid seed production. The types of crossing method deployed for hybrid seed production of different vegetable crops are stated below with example:

a) *Solanaceous* vegetable crops: Mechanism deployed for hybrid seed production are:

- Hand-emasculation and hand pollination (Tomato, Brinjal, Capsicum, Chilli)
- Male sterility and hand emasculation (Tomato, Brinjal, Capsicum, Chilli)

b) *Cucurbits*:

- Artificial pollination
- Removal of male flower and insect-pollination
- Use of male sterile line (musk melon, squash, pumpkin)
- Use of gynoceous line (cucumber)

c) Cole crop:

Use of self incompatibility and insect pollination.

d) *Malvacae:* For Okra.

Manual emasculation and pollination

e) Root vegetable:

- Radish & Turnip: - Use of self incompatibility and insect pollination.
- Carrot:- Use of sterility and insect pollination.

f) *Onion:-* Use of male sterility and insect pollination.

Advantage of hybrid seed:

- High yielding variety can be released.
- Varieties resistant/tolerant to particular disease and insect pest can be produced.
- Early maturing crop can be evolved.
- Better quality crop can be produced.
- The hybrid seed fetches higher price in the market i.e. potato seed costs Nrs. 40000/ kg of seed, hybrid tomato seed costs Nrs. 70000/kg of seed etc.
- Export of hybrid seed can give higher foreign return.

Dis-advantage of hybrid seed:

- Seed extracted from hybrid crop cannot be used in the next year.
- By the use of hybrid variety, the local varieties are getting extinct which is a great threat for hybrid seed producer.

Learning process and support materials:

- Observation of vegetable seed producing farm.
- Listening method
- Practical method.
- krishi Diary

Assessment:

Very short Questions:

Q.N.1 Give two examples of highly cross pollinated vegetable crops.
Q.N.2 give two example of highly self- pollinated vegetable crops.
Q.N.3 Define breeder seed.
Q.N4 why germination test is carried out?
Q.N.5 what is the name of chemical used in tetrazolium test?

Short Questions:

Q.N.1 Enlist the steps of seed production of tomato.
Q.N.2 what are the differences between self pollinated and cross pollinated crops?

Long Questions:

Q.N.1 Explain in detail about the seed production techniques of tomato.

Q.N.2 Explain about the method of seed production of cole crops.

Q.N.3 what are the different techniques of varietal maintenance of self pollinated and cross pollinated crops.

Glossary:

- Seed= a true seed is a fertilized mature ovule that posses an embryonic plant, covered by protective coat, having reserved food materials and have capacity to germinate under favorable condition.
- Monsoon= Any of a number of winds associated with regions where most rain falls during a particular season, start of rainfall
- Attribute = Desirable character
- Inspection = Act of examining something, often closely.
- Progressive = increasing, favoring or promoting progress; advanced.
- Incompatibility = The quality or state of being incompatible; inconsistency; irreconcilability
- Pollination = the transfer of pollen from an anther to a stigma; effected by insects, birds, bats and the wind.
- Evolved= originated
- Fetch = to go and get, to bear toward, to regain or get back something.
- Viability = the ability to live, to succeed, the property of being viable.

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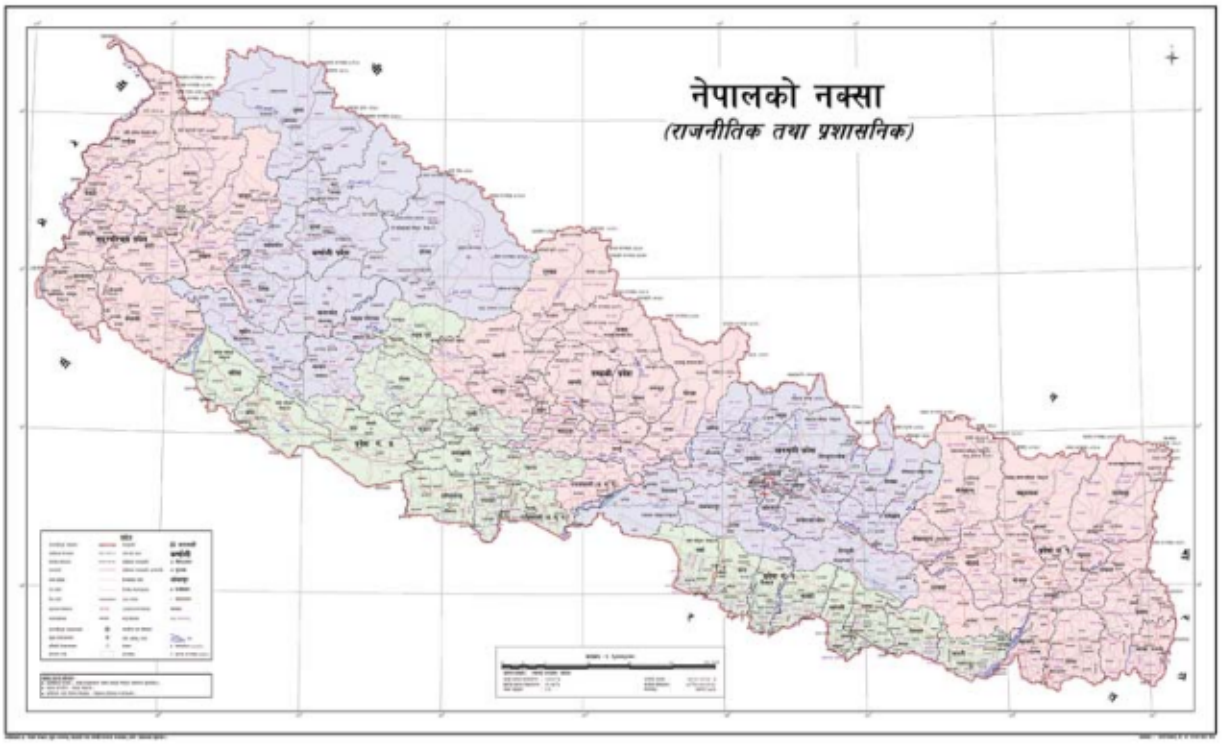

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