THE NEOTIA UNIVERSITY
ज्ञानम् आत्म प्रदीपाय

PRODUCTION TECHNOLOGY FOR VEGETABLE AND SPICES PRACTICAL MANUAL

Course code- CCAGL-222Course credit-(1+1)

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Exercise-1: Identification of Vegetable seeds

Introduction:

Seeds are the basic unit of identification of crop species and cultivars can be distinguished from one another either by morphological or physiological or biochemical characteristics and these characteristicsaretobereproducibleonrepeatedcultivationundernormalagroclimaticconditions formaintenanceofseedqualityintermsofgeneticpurity.Botanicallyseedisdefinedasaripened ovule containing an embryo in arrested state of development usually with a food reserve and a protective coat. In seed technological term, the part of a plant used for sowing to raise the crop or any propagative material is known as seed. Although some vegetables like potatoes are vegetativelypropagated, mostareestablishedfromseeds.Usingqualityseedsisaprerequisitefor successful vegetableproduction.

Objectives:

1. To identify the Seeds based on the length, width andthickness.
2. To identify the Seeds based on shape (main diagnostic character). The seeds may be globose or sub-globose or oblong or orbicular or round or flat or rectangular, square, elliptic,etc.
3. To identify the Seeds based on surface texture. Seed surface varies from very smooth and glossy to rough and fibrous. Botanical terms applied to the seed surface are smooth, glabrous, wrinkled, ribbed, punctuate, reticulate, pulp, tomentose andhairy.
4. To identify the Seeds based on external structures such as seed coat, pericarpetc.

Materials required:

Seeds of vegetablecrops

Common name	Botanical name	Family

Exercise-2: Identification of Spices and their seeds

Introduction:

Spicesconstituteanimportantgroupofagriculturalcommoditieswhicharevirtuallyindispensable in the culinary art. India is known as the '**The home of spices'.** According to the International Organization for Standardization (ISO); The term 'spices and condiments' applies to such natural plant or mixtures thereof, in whole or ground form, as are used for imparting flavor, aroma and piquancy to and for seasoning of foods". Spices such as black pepper, cumin, small cardamom, fenugreek,fennel,dill,ajwain,clove,cinnamonetc.haveawidevarietyofbiofunctionsandtheir additive or synergistic actions are likely to protect the human body against a variety of health hazards.

Objectives:

1. To identify the spices based on the different plant part i.e. leaf, seed, bark, rhizome, flowerbud etc.
2. To identify the seed spices based on shape (main diagnostic character). The seeds maybe globose or sub-globose or oblong or orbicular or round or flat or rectangular, square, elliptic,etc.
3. To identify the spices based on surface texture. Seed surface varies from very smoothand glossy to rough and fibrous. Botanical terms applied to the seed surface are smooth, glabrous, wrinkled, ribbed, punctuate, reticulate, pulp, tomentose andhairy.
4. To identify the Seeds based on external structures such as seed coat, pericarpetc.

5. To identify the spices based on aroma, pungency, phenolic compounds present in it andcolour.

Materialsrequired: Differentplantpartsofspicescropsuchasseed,flowerbud,fruit,bark.

Common name	Botanical name	Family

Exercise-3: Nursery raising of Vegetable and Spices

Introduction:

Nursery is a place where seedlings are grown before transplanting them in the main plots. Generally, seed are to grow vegetables and to raise seedlings. Therefore, quality of seed is very important based on which the vegetables and spices seed are sown. There are some vegetables which cannot grow directly by sowing the seed in to the plot. For example, for vegetable such as tomato, eggplant, cabbage and cauliflower, seedling first need to be raised and then transplanted intheplot.Generally,theseedsarecoveredwithalayerofsoilaftersowing.Whiletherearesome other vegetables whose seed need to be direct sowing in the main plot such as okra, legumes etc. Inmanycases,iftheseedaresowntooclosetothesurfacetheriskisgreaterthattheywillbedried out by the sun or eaten by birds or rodents. There are several different types of vegetable seeds based on their size and it is important to maintain to correct distances between plant to plant and row to rowdistances.

Objectives:

The development of seedling in nursery is not only reduces the crop span but also increase the uniformity of the crop and thus, harvesting as compared to direct sown crops. Transplanting of seedling are also eliminate the need of thinning and providing good opportunities for virus free vigorousoffseasonnursery,ifgrownunderprotectedcondition.Nurseryishelpfulandconvenient tomanageseedlingundersmallareaandgrowercangettimelyplantprotectionmeasuresarewith minimalefforts.Developmentofanurseryprovidesfavourableclimatetoemergingplantsfortheir better growth and development. The effective utilization of unfavourable period by preparing nursery under protected condition. Seed cost of some crops like hybrid vegetables and spices can be economized through nursery. Nursery production help in maintaining effective plants stand in shortest possible time through gapfilling.

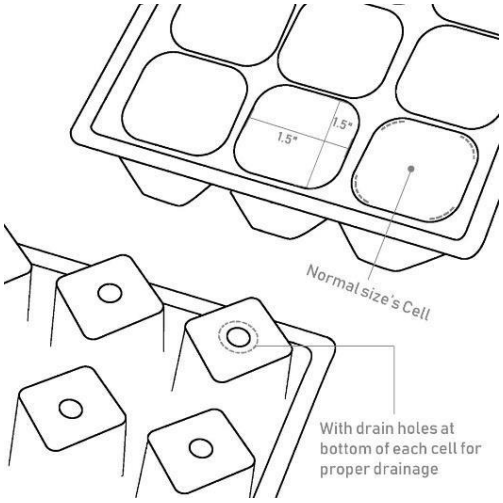
Criteria for selecting Nursery:

1. Site for nursery should be selected at such places where abundant sunshine and proper ventilation isavailable.
2. Nursery site should be on higher location so that water stagnation isavoidable.
3. In humid and rain prone areas nursery place should be well protected from heavy rains through protectedstructures.
4. The site should be nearer to irrigation facilities andaccessible.
5. It should be protected from stray animals, snail, ratsetc.
6. SoilshouldbesandyloamorloamywithpHrangeof6to7andrichinorganicmatterand free from pathogenicinoculums.

Materials required for raising plug tray nursery: Good quality seeds, plug tray/poly tray, coco peat, vermicompost, Nursery net, mulching sheet, rose can etc.

Procedure:

1. The seedling tray (pro tray) is filled with the growing medium (cocopeat/Soil).
2. A small depression (0.5 cm) is made with fingertip in the centre of the cell of the pro tray for sowing. One seed per cell is sown and covered withmedium.
3. After sowing 10 trays are kept one over other for 3 to 6 days, depending on the crops.The entirestackwillbecoveredusingpolyethylenesheetorpaddystrawtoensureconservation of moisture untilgermination
4. Thetraysareirrigatedlightlyeverydaydependinguponthepreva ilingweatherconditions byusing a fine sprinkling rose can. Drenching the trays with fungicides as a precautionary measure against seedling mortality is also beingdone.
5. he seedlings at right stage of planting are hardened by withholding irrigation andreducing the shade before transplanting or selling to the growers. Systemic insecticides are sprayed 7 - 10 days after germination and before transplanting for managing the insectvectors.
6. The seedlings would be ready in about 21-30 days for transplanting to the main field depending upon thecrop.



Conclusion:

Production and timely distribution of quality seedlings of vegetables/spices would be a greater scopetomeetthe growingdemand.Moreprofitcanbeearnedifthistechnologyisadoptedbythe farming community. More income, more production of quality disease free seedlings, more employment and entrepreneurship development can beachieved.

Exercise-4: Direct seed sowing and transplanting of vegetable crops

Introduction:

There are two methods of planting to raise a crop *viz.* direct seeding and transplanting. To briefly distinguish, 'direct seeding' means planting at the crop area with the use of seeds while 'transplanting' is planting with the use of pre-grown seedlings or plants that had been propagated from seeds. Therefore, the two methods of planting can also be described as 'direct planting' and 'indirect planting'. For transplanting, it is indirect because the seeds are not immediately sown on the field. Instead, these seeds are first used to raise seedlings in pots or in any temporary place and only when they reach the right age are they out planted. The actual field planting may be accomplished either manually or by mechanicalmeans

Objectives:

The choice of direct seeding or transplanting for field planting depends on many factors. Among others, these include: (1) the crop species to be grown, (2) ease in planting and survival rate,(3) farmer'sfamiliarity,(4)timeliness,(5) financialcapabilityofthefarmer,and(6)returnon investment.

Materialsrequired: Goodqualityseedsasplantingmaterial,NPKfertilizer,leafmould,spade, nirani, shovel, rose can, mulching material such as paddy straw, plastic mulchetc.

Procedure:

A. Direct seedsowing:

1. Seeds can be sown in a variety oy ways such as furrows, line sowing, mounds, or by simply poking holes in the soil and dropping theseeds.
2. In case of direct seeded crop, requires loose, friable soil for proper germination of seeds.Soitshouldbesowninwellpulverizedfieldbyploughingfirstwithsoilturning plough and afterwards with 4 to 5 ploughings with countryplough.
3. Ploughing should be followed bylevelling.
4. FYM @20-25tonnes per ha should be applied at the time of fieldpreparation.
5. In addition, apply Nitrogen, phosphorus (P_2O_5) and (K_2O) kg per hectare depending upon the fertility status of thesoil.
6. Half of nitrogen and full dose of phosphorus and potassium should be applied at the timeofsowingandremainingnitrogencanbetopdressedintwosplitdosesatspecific interval depending upon the crop aftersowing.
7. Interculture operations should be performed followed byweeding.
8. Irrigations should be applied as and whennecessary.

B. Transplanting:

1. Seed beds are prepared finely, well drained, 15-20 cm raised, 1.0m wide and of convenientlength.
2. FineandfullydecomposedFYMorcompost@3-4Kg/m^2shouldbewellmixedtothe beds.
3. Drench the beds with formaldehyde (4%) or Captan @ 2-3g/litre and covered with polythene sheet for 7 to 10 days to avoid damping offdisease.
4. Treat the seed with Captan or Thiram@2-3 g per kg of seeds beforesowing.
5. Seedsaresownatshallowdepth5.0cmapartintherowandcoveredwithfinelysieved leaf mould and sprinkle waterregularly.
6. Hardening of the seedlings by withholding water at least 4-6 days beforetransplanting
7. Seedlings are ready for transplanting when they attain a height of 12-15cm with 4 leaves in 4-5 weeks. Plantation is done on flat or raised (rainfall prone areas)beds.

Classification based on methods of raising

I. **Direct sown crops:** Okra, Carrot, Radish, Beans and Peasetc.

II. **Transplanted crops:** Tomato, Brinjal, Chilli, Cabbage, Caulifloweretc.

Conclusion:

Though both method of planting as well as raising seedling has some pro and cons but has been proven effective and adaptive to the farmers.

Exercise-5: Study of morphological characters of different vegetables and spices

Introduction:

Vegetables and spices are the products of herbaceous plants which are annuals, biennial and perennials (mostly annual) whose plant parts such as fruits, leaves, roots, stems, petiole, flower etc.areusedforculinarypurposesorconsumedasraw.Thevegetableandspicesplantsdifferwith respect to each other in their morphological characters. It is essential to know the different parts of the plants before undertaking the identification. The knowledge of different plant parts serves as the foundation for identifying the vegetable and spices crop plants at different growth stages. Some crops are very similar in their morphological characters and it is difficult to identify them especially during early stages of their growth. Keen and frequent observations on vegetative and reproductive parts of the plants help in easy and cleariden tification.

Objectives:

1. To study the morphological characters of different vegetable crops based on root system, stem characteristics, leaf characteristics, inflorescence, economic part.
2. Tostudythemorphologicalcharactersofdifferentspicescropsbasedonrootsystem,stem characteristics, leaf characteristics, inflorescence, economicpart.

Procedure:

1. Critically observe the morphological characteristics of the specimen. To identify plants, look for morphological features such as size, shape and color of the leaves as well as unusual characteristics like aroma orhair.
2. Draw the sketch of theplant.
3. Record the observations with respect to root, stem, leaf, inflorescence and fruit characteristics in the data sheet.

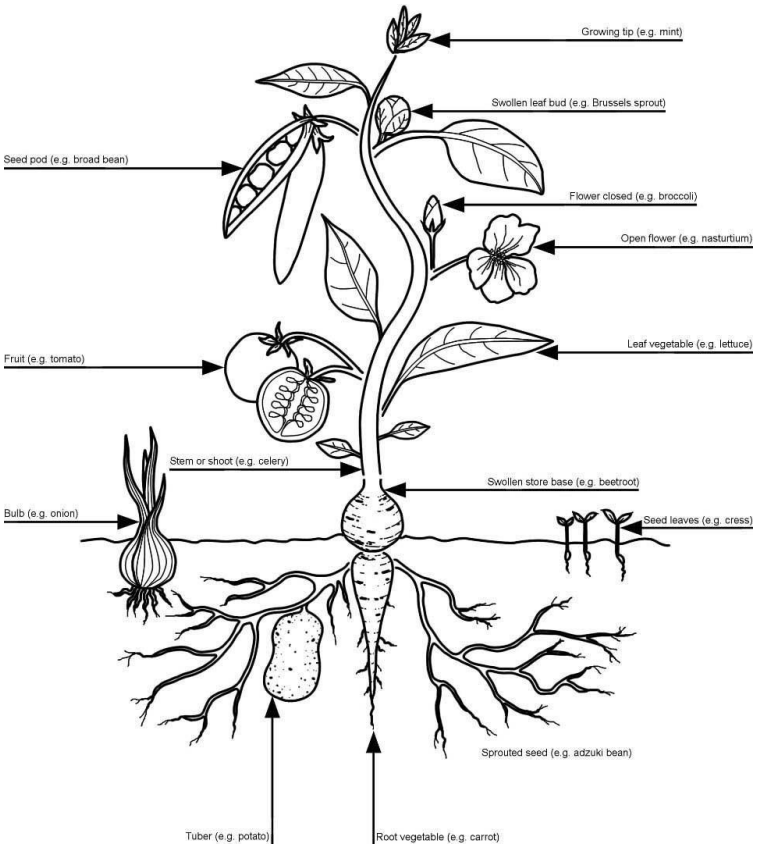


Fig: Edible parts of different vegetable crops

Materials required: Forceps, hand lens, paper sheet, paper and pen

Conclusion:

Morphological characters play a very important role in distinguishing characters of important vegetable and spices crops. It takes time and exposure to learn to identify different vegetable and spices plants.

Exercise-6: Fertilizer application for Vegetable crops as per recommendation for N, P &K

Introduction:

Vegetable crops require nutrients for its growth and development which are absorbed from the soil. The most important nutrients are nitrogen (N), phosphorus (P) and potassium (K) and soils donothaveenoughofthesethreenutrientstomeetthecroprequirement.Hence,thesearerequired in relatively large amounts for plant growth. The recommendation of these nutrients is available from various sources. Recommendations are always made in terms of nutrients and not in terms of fertilizers directly because different fertilizers contain nutrients in different amounts. We have to calculate the amount of a particular fertilizer based on the recommended dose of N, P-K nutrients to a particular crop on the basis of nutrient status of the soil of a particular area/state. It is always advisable to go for soil testing and accordingly N-P-K or other additional nutrient requirement can be made. Fertilizer bags are labelled by providing information with regards to percentage of nitrogen (N), available phosphate (as P_2O_5) and soluble potash (as K_2O) and represent nitrogen, phosphorous and potassium, commonly referred to as N-P-K. These elements are symbolically represented as N- P_2O_5-K_2O.

Objectives:

1. To study the method of fertilizer application for vegetablecrops.
2. To calculate the amount of fertilizer required for vegetablecrops.

Procedure:

Before calculating the fertilizer dose, one should have the knowledge about

1. The recommended dose of N- P_2O_5- K_2O for a crop for which the fertilizer doses have tobe calculated.

2. Different growth stages of the crop at which fertilizers are to beapplied.

3. The source of fertilizers from which the N-P-K requirements have to be met e.g.CAN/Urea, SSP, MOP etc.

Source of fertilizers supplying nutrients: Different fertilizer grade refers to the guarantee minimum percentage of N, P_2O, and K_2O contained in the fertilizer material. For example

Fertilizer	Composition (%)		
	N	**P_2O**	**K_2O**
Urea	46	-	-
CAN	25	-	-
SSP	-	16	-
Double super phosphate	-	32	-
Diammonium phosphate	18	46	
MOP	-	-	60

Calculation:

If the recommended dose of nutrient and the percentage content of that nutrient in the fertilizer are known,the quantity of fertilizer required can be calculated by using following formula.

$$\text{Quantity of fertilizer required (kg)} = \frac{(\text{Recommended dose of nutrient application}) \times 100}{(\%\ \text{Nutrient content present in the fertilizer})}$$

Table: Represents recommended dose of nutrient for important vegetable crops (the doses may vary according to growing area, varieties and cultural practices).

Table: Recommendation of primary nutrients (NPK) for different vegetable crops

Crop	**Recommended dose of primary nutrients**		
	N	**P_2O**	**K_2O**
Tomato	75-100	50-75	50-60
Brinjal	75-100	60-80	50-60
Potato	120	80	60
Onion	60-150	35-150	25-120
Cucumber	100	60	60
Cabbage	220	100	220
Chilli	100-120	70-80	50-60

Materials required: Fertilizers (to apply in field)**,** Paper sheet and pen to note down the calculation procedure.

Conclusion:

Proper amount of fertilizer application in vegetables crops by adopting best possible methods to achieveoptimalnutrientuseefficiency, cropyields,cropquality,andeconomicreturnsisthemain principles of successfulcultivation.

Exercise-7: Harvesting and preparation for market of vegetable crops

Introduction:

Harvesting is the final agricultural operation in field. The time of harvest, among other factors is determinedbymaturityandquality.Itdependsuponkindandvarietyofcrop,weather,conditions at time of sowing, distance of market and the purpose of marketing. Good quality of vegetablesis a combination of flavour, texture appearance and food value which given pleasure or satisfaction to the consumer. Good quality is thus extremely important to all phases of the harvest and post-harvest period. Commercial vegetable growers, wholesalers and retailers are experts at selecting theoptimumharvesttimeandstorageconditionstoensurethatthevegetableswillhavethelongest possible shelflife.

Objectives:

1. To identify the harvesting stage of particularvegetables.
2. To learn harvestingtechniques.
3. To study the grading of variousvegetables.
4. To study the types of packaging forvegetables.

Materials required:

Knife, pen and paper to note down the observations.

Important indices for judging maturity of some common vegetables are:

Crop	Maturity Indices
Potato, onion and garlic	Tops begin to dry out and topple down
Bell pepper	Well-developed shining and green fruits
Tomato	Development of jelly in the locules and at least attain mature green stage
Garden pea	Well filled, green, tender pods that open easily
French bean, cow pea and other beans	Tender pods, desirable size, stringless (without fibre formation) seeds soft and snap easily
Snake gourd and bottle gourd	Desirable size and thumbnail can penetrate flesh readily
Cauliflower	Curd compact, well developed and at least 15 cm in diameter
Cabbage	Compact, well developed at least 750-1000 g
Broccoli	Bud cluster compact, adequate diameter, all florets should be closed.
Radish, turnip and carrot	Large enough and crispy but should not be over mature (pithy)

Packaging:

Packaging is an important consideration in vegetable market. The use of properly designed containers for transporting and marketing of vegetables can significantly reduce their losses and maintain their freshness succulence and quality for longer period. Packaging also provides protection from mechanical damage and undesirable physiological changes and pathological deterioration during storage, transportation and marketing. Many vegetables are transported in gunnybagsofbamboobaskets.Packagingmaterialsuchaspolythenefilms,paperboars,andboxes lived with polythene and other materials can effectively prolong the shelf life of vegetables. By using plastic films vegetables can be protected from dry air. Polythene packaging, provides modifiedatmosphereandconsequentlyreducesdecay,softening,andlossofsolids.Thethickness andpermeabilitytoCO2,O2andwatervapouroffilmsneedstobestandardizedforeachvegetable.

Packaging of vegetables in perforated films significantly reduces weight and water loss in transportation. eg.Carrot.

Procedure/methodology:

Afterbringingfromthefield,thefirstoperationthatusuallyfollowsistheremovalofunmarketable material.Thisisperformedpriortosizingandgrading.Afterremovaloftheunmarketableproducts thegradingisdone.Itconsistsofsortingproductingradesorcategoriesofqualitylikesize,shape, colour,andfirmness.Generally,produceisgradedasA,BorCaspersize,shapeandcolour. The fruit vegetables such as bitter gourd, okra, bell pepper, brinjal, green chill, etc. also graded on the basis of size into three grades as small, medium andlarge.

Conclusion:

Harvest should be completed during the coolest time of the day, which is usually in the early morning, and produce should be kept shaded in the field. Crops destined for storage should be as freeaspossiblefromskinbreaks,bruises,spots,rots,decay,andotherdeterioration. It isessential to grade the produce brought to the market on scientific lines in order to get remunerative prices. Grading not only promotes the international trade but also improves national credentials in the internationalmarket.Itfurthersavestimeandenergyofboththesellerandbuyerintheprocessof marketing. Packaging also provides protection from mechanical damage and undesirable physiologicalchangesandpathologicaldeteriorationduringstorage,transportationandmarketing.

Exercise-8: Economics of vegetable and spices cultivation

Introduction:

The term “cost of Cultivation” and “Cost of production” is used as synonyms for the purposeof cost study. However, nice distinction can be made between the two, the cost of cultivation includesfactorcostsuptothestageofgatheringtheharvestandthatcostofproductiontoinclude factor costs up to the stage of marketing the produce. Cost of production is to be worked out as cost per unit or area and production i.e. per hectare and per quintal/tonnes. The cost of cultivation varies according to the type of the farmers and evenbetween the first and second crop. There may be variations in the cost of cultivation even between two different sample areas. This will have an impact on returns also. Cost of cultivation of any crop covers;cropcost,labourcost,landcost,machinerycostand livestock cost.

Objectives:

1. To calculate cost of production of vegetable and spicescrops.
2. To calculate the cost benefit ratio for vegetable and spicescrops.

Materials required:

Paper sheet and pen to note down the instructions and calculation.

These are the following components for calculating cost of cultivation of vegetable and spices crops per hectare.

i. VariableCost:

1. Nurserymanagement
2. Landpreparation

a) Ploughing
b) Harrowing
c) Preparation of beds and channels

3. Transplanting
4. Manures and fertilizersapplication
5. Intercultureoperations
6. Irrigation
7. Plantprotection
8. Harvesting

a) Picking
b) Grading
c) Packing
d) Transportation

9. Seed
10. Manures andfertilizers
11. PlantProtection
12. Miscellaneous
13. Interest on workingcapital

ii. FixedCost

Land revenue, Rental value of land, Management cost, Risk margin, Depreciation cost, Plough, Harrow, Ridges, Buckets, Pump, Sprayer, Total Fixed Capital, Interest on Fixed Capital.

Therefore,

1. Total cost of cultivation = Total variable cost + Total fixedcost
2. Total income = Yield (kg) × Market price of the produce(Rs./kg)
3. Net Profit = Total Income - Total cost ofcultivation
4. **Benefit cost Ratio** = Cost of totalbenefit

Cost of production

Example: Cost of cultivation of cabbage

SL. No.	Particulars	Cost (Rs)
	(A) Cost of variable Resources: 1. Seed cost for 500 g @ Rs 4000/kg 2. Fertilizers cost: a. FYM 15000kg @ Rs 0.75/kg b. Urea 2.85q @ Rs 500/q c. SSP 8.50q @ Rs 640/q d. MOP 2.25q @ Rs 450/q 3. Plant protection cost: (a) pesticides/insecticides Malathion 500ml @Rs 80/250 ml Metasystox 1L@450Rs./L(b) Fungicide: Dithane M-45 500g @ Rs 180/500g Bavistin 200g @ Rs 60/100g Blitox 500g @ 190Rs/500g 4. Labour cost: (a) Seed treatment (b) Land preparation (b1) Ploughing (b2) Planting (b3) Preparation of ridges and furrows (c) Manures and Fertilizers application (d) Intercultural operations (e) Irrigation	 2000 11250 1425 5440 1012 160 450 180 120 190 520 800 750 1000 500 1000 1000 1000

	(f) Plant protection	3000
	(g) Harvesting	1500
	(h) Transportation	1000
	(i) Packing/electricity charges	
	(j) Nursery cost	1000
	5. Bullock/Tractor cost	1000
	TOTAL COST	36297
	6. Miscellaneous (2% of totalcost)	726
	7. Interest on working capital(5%)	1814
	Total Variable cost	38337
	B) Fixed Cost	
	1. Land Ravenue (Rs 15./ha)	12
	2. Rental Value of Land	1000
	3. Depriciation	100
	No Junk Value	180
	With Junk Value	2000
	4. Management Cost (5% of working capital)	165
	5. Interest on Fixed Capital (5%)	
	TOTAL FIXED COST	3500
	Cost of Cultivation = Total Fixed Cost +Total Variable Cost = 3500 + 38337	41837
	Average Yield of Cabbage	250q/ha
	Sale Rate (Rs /kg)	7
	Total Income/Cost of production/ha	1,75,000
	Net Return = Total Income - Cost of cultivation = 150000 – 41837=	133163
	Benefit Cost Ratio =NET RETURN/ COST OF CULTIVATION = 133163/ 41837	3.18:1

Conclusion:

Cost of cultivation helps to minimize the risk of loss in crop cultivation. It helps in management of different factors during cultivation of crops. It also helps in planning and initiation of any crop cultivation and reveals the requirements for cultivation It increase the sustainability in farmers income.