Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna (M.P.)

Statute No. 9, Faculty Board of Studies, Section-15 (3)

For M.Sc.(Hort.) in Vegetable Science Course

Session 2023-24, Onward

Minutes of the Meeting

The meeting of the Board of Studies for M.Sc.(Hort.) in Vegetable Science programme is held on 17.04.2023 at 11.00 A.M. in the Dean office, Faculty of Agriculture. The committee for Board of Studies of M.Sc.(Hort.) in Vegetable Science constituted as follow :-

S.N.	Name of the Members	Designation & Address	Committee position	Signature
1.	Dr. D. P. Rai	Prof &Dean, Faculty of Agriculture	Chairman	
2.	Dr. Kanhaiya Singh,	Principal Scientist, Division of Fruits and Horticultural Technology; ICAR-Indian Agricultural Research Institute ,(IARI), New Delhi-110012	External Expert	
3.	Dr. S.P. Mishra	Assoc. Prof. (Ag. Biochemistry) & Head, Deptt. Of Crop Sciences	Member	
4.	Dr. U.S. Mishra	Associate Prof. (Soil Sci.) & Head, Deptt. of NRM	Member	
5.	Dr. Y.K. Singh	Associate Prof. and Head, Deptt. of Transfer Technology	Member	
6	Dr. K. K. Singh	Prof. (Ag. Ext.) Deptt. of Transfer Technology	Member	
7	Dr. H.S. Kushwaha	Prof.(Agronomy) Deptt. of NRM	Member	17/04/2023
8	Dr. Pawan Sirothia	Asso.Prof. (Soil Sci.) Deptt. of NRM	Member	
9	Dr. S.S. Gautam	Associate Prof. (Agril. Statistics)	Member	
10	Dr. S. S. Singh	Asst. Prof. (Horticulture)	Member Secretary	17/4/23

All the Committee Members discussed on the name of course and suggested that, the name of Degree should be M.Sc.(Hort.) in Vegetable Science as per the BSMA of ICAR has revised and restructured Post-graduate on the basis of National Education Policy-2020 as per the ICAR Rule.

1. The Committee Members discussed thoroughly on the course contents and semester wise breakup of the course. The valuable advice of the members were incorporated in the light of course breakup as per prescribed by the ICAR has revised and restructured Post-graduate to finalize the syllabus of M.Sc. (Hort.) in Vegetable Science course.
2. Course will be effective from Academic Session 2023-24 and onward.

The meeting ended with a vote of thanks to the esteemed external members, Faculty members and the chair.

17/9/2023

12/9/23

M.Sc. (Hort.) in Vegetable Science
Framework of Courses

As per the recommendation of ICAR BSMA Report

M.Sc (Hort.)in Vegetable Science	
Major Courses	**20**
Minor Courses	**08**
Supportive Courses	**06**
Common Courses	**05**
Seminar	**01**
Thesis	**30**
Grand Total	**70**

Semester wise course distribution

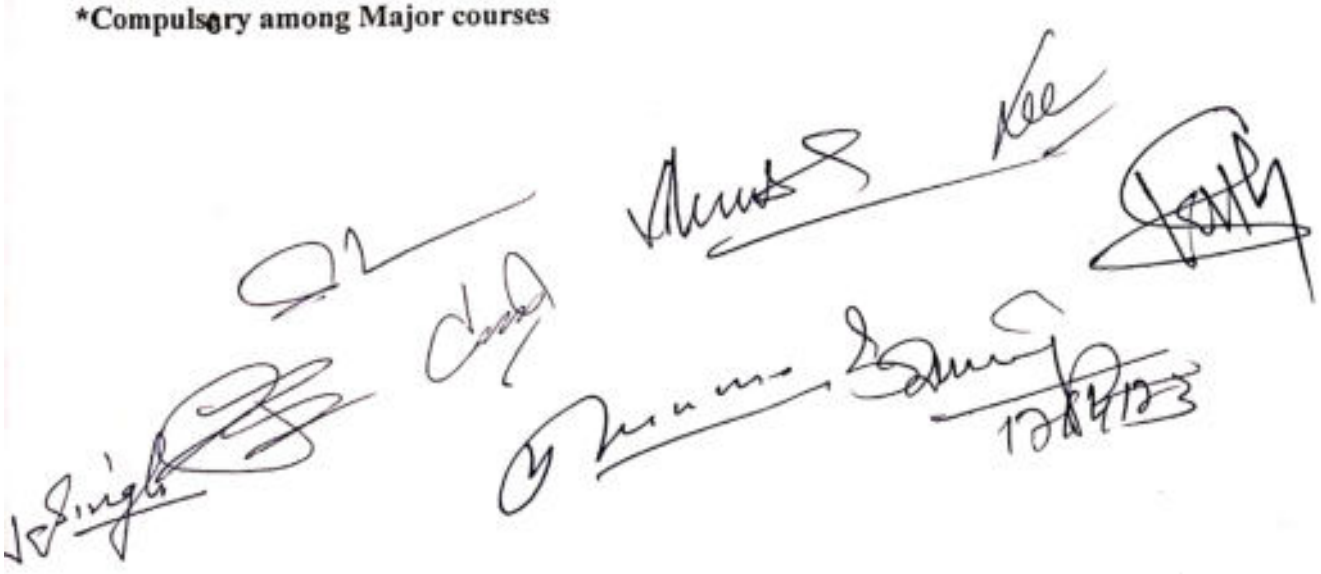
Semester – I				
Sl.	**Course**	**Name of the course**	**Code**	**Credit**
1.	Major course*	Production of Warm Season Vegetable Crops	VSC 502	3(2+1)
2.	Major Course*	Principles of Vegetable Breeding	VSC-504	3(3+0)
3.	Minor Course	Basic Biochemistry	BIOCHEM-501	4(3+1)
4.	Supporting course	Statistical Methods For Applied Science	STAT- 502	4(3+1)
5.	Common course	Technical Writing and Commutation Skills	PGS-502	1(0+1)
6.	Common course	Basic Concept in Laboratory Techniques	PGS-504	1(0+1)
		Total Credit-		**16(11+5)**
Semester – II				
1.	Major course*	Production of Cool Season Vegetable Crops	VSC-501	3(2+1)
2.	Major Course	Breeding of Self Pollinated Vegetable Crops	VSC-505	3(2+1)
3.	Major Course	Seed Production of Vegetable Crops	VSC-508	3(2+1)
4.	Minor course	Soil Fertility and Fertilizer Use	SOIL-502	3(2+1)
5.	Supporting course	Experimental Design	STAT- 511	3(2+1)

17/4/2023

18/4/23

6.	Common Course	Library and Information Services	PGS-501	1(0+1)
7.	Common Course	Intellectual Property and its Management in Agriculture	PGS-503	1(1+0)
		Total Credit-		**17(10+7)**
Semester – III				
1.	Major course	Breeding of Cross Pollinated Vegetable Crops	VSC-506	3(2+1)
2.	Major Course*	Growth and Development of Vegetable Crops	VSC503	3(2+1)
3	Major Course	Systematics of Vegetable Crops	VSC 510	2(1+1)
4	Common Course	Agricultural Research, Research Ethics and Rural Development Programme	PGS-505	1(1+0)
5	Major course	Seminar	VSC-591	1(0+1)
		Total Credit-		**10(6+4)**
Semester-IV				
2.	Minor course	Analytical Techniques and Instrumental Methods in Soil and Plant Analysis	SOIL-508	2(0+2)
3.	Major course	Masters Research/Thesis	VSC-599	30 (0+30)
		Total Credit-		**32(0+32)**
		I, II, III, & IV Semester	**Total Credit**	**75(27+48)**

***Compulsory among Major courses**



Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 1

Horticultural Sciences
– Vegetable Science

Course Title with Credit Load
M.Sc. (Hort.) in Vegetable Science

Course Code	Course Title	Credit Hours
	Major Courses (20 Credits)	
VSC 501*	Production of Cool Season Vegetable Crops	2+1
VSC 502*	Production of Warm Season Vegetable Crops	2+1
VSC 503*	Growth and Development of Vegetable Crops	2+1
VSC 504*	Principles of Vegetable Breeding	3+0
VSC 505	Breeding of Self Pollinated Vegetable Crops	2+1
VSC 506	Breeding of Cross Pollinated Vegetable Crops	2+1
VSC 507	Protected Cultivation of Vegetable Crops	1+1
VSC 508	Seed Production of Vegetable Crops	2+1
VSC 509	Production of Underutilized Vegetable Crops	2+1
VSC 510	Systematics of Vegetable Crops	1+1
VSC 511	Organic Vegetable Production	1+1
VSC 512	Production of Spice Crops	2+1
VSC 513	Processing of Vegetable	1+1
VSC 514	Postharvest Management of Vegetable Crops	2+1
	Minor Courses	08
	Supporting Courses	06
	Common compulsory courses	05
VSC 591	Seminar	0+1
VSC 599	Research	0+30
	Total Credits	**70**

*Compulsory among major courses

Preamble

(Vegetable Science)

Vegetables are important constituents of Indian diet and play an important role ensuring nutritional security. They are generally of short duration, high yielding, nutraceuitically rich, economically viable and generating substancial on-farm and off-farm employment. Vegetables have aprestine place in Indian agricultural economy. The country is being blessed with diverse agro-climatic conditions ranged from the tempearate to arid more than 60 cultivated and 30 lesser known vegetables are being grown.

The country has witnessed a tremendous growth in vegetable production and productivity as a result of improved varieties/ F1 hybrids/ technologies through systematic research coupled with their large scale adoption by the farmers and developmental policies of government compared to area (2.84 m ha), production (16.5 mt) and productivity (5.8 t/ha) in 1950–51 there had been phenomenal increase in area (>3 folds; 10.1 m ha), production (>10 folds; 185 mt) and productivity (>3 folds; 18.0 t/ha) during 2017–18. Increasing per capita income, health conciousness, urbanisation, shifting of farmers to high value vegetables due to higher income, favourable income elasticity of demand and annual growth rate of domestic demand for vegetables are also important factors fueling its growth in the country.

During 2016–17, the total exports including potato and onion accounted for ₹ 5,922 crores sharing 35% of total horticultural exports. With the current level of vegetable production in the country (171 mt), population (1.3 billion) and considering 25% post harvest losses and 5% export and processing, the per capita availability of vegetable production in our country is 250 g as against 300 g recommended dietary allowance (RDA). With projected population of 1.45 billion by 2030, India has to produce 210 mt of vegetables. The targeted production needs to be achieved through utilizing scientific technological and traditional strength in a sustainable manner without much increasing area under vegetables.

Looking in to the above scenario in vegetable production, there is a need to update the knowledge among the post-graduates of Vegetable Science. An effort is therefore made to encompass the adavances made in the vegetable production by revisting the post-graduate curriculum for delivering and assuring quality education. The proposed curriculum aims to develop a competent human resource equipped with holistic and updated knowledge and skill in the field of Vegetable Science.

The course curriculum has been restructured to cover the current requirement of vegetable production and post harvest management to increase capabilities of students. In order to accomplish the task, either new courses have been formulated or existing course contents are upgraded to include latest developments in vegetables production.

In line with national policies, the existing course contents have been upgraded and five new courses, viz., Principles of vegetable breeding, Breeding for special triats in Vegetable crops, Biodiversity and conservation of Vegetable crops, Biotechnological approaches in Vegetable crops and Advanced laboratotory techniques for vegetable crops have been added. A course on Vegetable Breeding has been divided into two courses one for self-pollinated crops and another for cross pollinated vegetable crops. New components, viz., hydroponics, aeroponics, grafting technique and precision farming have been added in appropriate courses. The overall upgradation of course contents as well as addition of courses are in line with national policy priorities like doubling of farmer's income, more crop per drop, jaivik krishi, soil health, skill development, entrepreneurship development, startup initiatives, etc.

Course Title with Credit Load
M.Sc. (Hort.) in Vegetable Science

Course Code	Course Title	Credit Hours
	Major Courses (20 Credits)	
VSC 501*	Production of Cool Season Vegetable Crops	2+1
VSC 502*	Production of Warm Season Vegetable Crops	2+1
VSC 503*	Growth and Development of Vegetable Crops	2+1
VSC 504*	Principles of Vegetable Breeding	3+0
VSC 505	Breeding of Self Pollinated Vegetable Crops	2+1
VSC 506	Breeding of Cross Pollinated Vegetable Crops	2+1
VSC 507	Protected Cultivation of Vegetable Crops	1+1
VSC 508	Seed Production of Vegetable Crops	2+1
VSC 509	Production of Underutilized Vegetable Crops	2+1
VSC 510	Systematics of Vegetable Crops	1+1
VSC 511	Organic Vegetable Production	1+1
VSC 512	Production of Spice Crops	2+1
VSC 513	Processing of Vegetable	1+1
VSC 514	Postharvest Management of Vegetable Crops	2+1
	Minor Courses	08
	Supporting Courses	06
	Common compulsory courses	05
VSC 591	Seminar	0+1
VSC 599	Research	0+30
	Total Credits	**70**

*Compulsory among major courses

Course Contents
M.Sc. (Hort.) in Vegetable Science

I. Course Title : Production of Cool Season Vegetable Crops

II. Course Code : VSC 501

III. Credit Hours : (2+1)

IV. Why this course ?

Cool season vegetables are a major source of dietary fibres, minerals and vitamins. Some of these vegetables also contribute protein, fat and carbohydrate. Most of the leafy and root vegetables are rich in minerals, especially in micro-elements such as copper, manganese and zinc. Vegetables differ in their temperature requirement for proper growth and development. Most of the winter vegetable crops are cultivated in cool season when the monthly mean temperature does not exceed 21°C. Even in temperate climate, these vegetables are cultivated in spring summer in hilly tracks where the daytime temperature in summer is less than 21°C. The students of vegetable science need to have an understanding of production technology of important cool season vegetable crops and their management.

V. Aim of the course

To impart knowledge and skills on advancement in production technology of cool season vegetable crops.

The course is constructed given as under:

Sr.	Block	Unit
1.	Production of cool season vegetable crops	I. Bulb and tuber crops II. Cole crops III. Root crops IV. Peas and beans V. Leafy vegetables

VI. Theory

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery, sowing/ planting time and methods, hydroponics and aeroponics, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marketing), pest and disease management and production economics of crops.

Unit I

Bulb and tuber crops—Onion, garlic and potato.

Unit II

Cole crops—Cabbage, cauliflower, kohlrabi, broccoli, Brussels sprouts and kale.

Unit III

Root crops—Carrot, radish, turnip and beetroot.

Unit IV

Peas and beans—Garden peas and broad bean.

Unit V

Leafy vegetables—Beet leaf, fenugreek, coriander and lettuce.

VII. Practical

- Scientific raising of nursery and seed treatment;
- Sowing and transplanting;
- Description of commercial varieties and hybrids;
- Demonstration on methods of irrigation, fertilizers and micronutrients application;
- Mulching practices, weed management;
- Use of plant growth substances in cool season vegetable crops;
- Study of nutritional and physiological disorders;
- Studies on hydroponics, aeroponics and other soilless culture;
- Identification of important pest and diseases and their control;
- Preparation of cropping scheme for commercial farms;
- Visit to commercial farm, greenhouse/ polyhouses;
- Visit to vegetable market;
- Analysis of benefit to cost ratio.

VIII. Teaching Methods/ Activities

- Classroom lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

IX. Learning outcome

After successful completion of this course, the students are expected to:

- Appreciate the scope and scenario of cool season vegetable crops in India
- Acquire knowledge about the production technology and post-harvest handling of cool season vegetable crops
- Calculate the economics of vegetable production in India

X. Suggested Reading

Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. *Vegetable crops*. Vols. I-III. Naya udyog.

Bose TK, Som MG and Kabir J. (Eds.). 1993. *Vegetable crops*. Naya prokash.

Chadha KL and Kalloo G. (Eds.). 1993-94. *Advances in horticulture* Vols. V-X. Malhotra publ. house.

Chadha KL. (Ed.). 2002. *Hand book of horticulture*. ICAR.

Chauhan DVS. (Ed.). 1986. *Vegetable production in India*. Ram prasad and sons.

Fageria MS, Choudhary BR and Dhaka RS. 2000. *Vegetable crops: production technology*. Vol. II. Kalyani publishers.

Gopalakrishanan TR. 2007. *Vegetable crops*. New India publ. agency.

Hazra P and Banerjee MK and Chattopadhyay A. 2012. Varieties of vegetable crops in India. (Second edition). Kalyani publishers, Ludhiana, 199 p.
Hazra P. 2016. Vegetable Science. 2nd edn, Kalyani publishers, Ludhiana.
Hazra P. 2019. Vegetable production and technology. New India publishing agency, New Delhi.
Hazra P, Chattopadhyay A, Karmakar K and Dutta S. 2011. Modern technology for vegetable production. New India publishing agency, New Delhi, 413p.
Rana MK. 2008. Olericulture in India. Kalyani publishers, New Delhi.
Rana MK. 2008. Scientific cultivation of vegetables. Kalyani publishers, New Delhi.
Rana MK. 2014. Technology for vegetable production. Kalyani publishers, New Delhi.
Rubatzky VE and Yamaguchi M. (Eds.). 1997. World vegetables: principles, production and nutritive values. Chapman and Hall.
Saini GS. 2001. A text book of oleri and flori culture. Aman publishing house.
Salunkhe DK and Kadam SS. (Ed.). 1998. Hand book of vegetable science and technology: production, composition, storage and processing. Marcel Dekker.
Shanmugavelu KG. 1989. Production technology of vegetable crops. Oxford and IBH.
Singh DK. 2007. Modern vegetable varieties and production technology. International book distributing Co.
Singh SP. (Ed.). 1989. Production technology of vegetable crops. Agril. comm. res. centre.
Thamburaj S and Singh N. (Eds.). 2004. Vegetables, tuber crops and spices. ICAR.
Thompson HC and Kelly WC. (Eds.). 1978. Vegetable crops. Tata McGraw Hill.

I. Course Title : **Production of Warm Season Vegetable Crops**

II. Course Code : VSC 502

III. Credit Hours : (2+1)

IV. **Why this course ?**

Unlike cool-season vegetables, warm-season vegetable crops require higher soil and air temperatures, thus, they are always planted after the last frost date ranging from late spring after the last frost date to late summer. Daytime temperatures may still be warm enough but drop so much at night-time that the weather is not suitable for warm-season crops any longer. In general summer vegetables require a little higher temperature than winter vegetables for optimum growth. In summer vegetables, the edible portion is mostly botanical fruit. The students of vegetable science need to have an understanding of production technology of important warm season vegetable crops and thereafter their management.

V. **Aim of the course**

To impart knowledge and skills on advancement in production technology of warm season vegetable crops.

The course is constructed given as under:

No.	Block	Unit
1	Production of warm season vegetable crops	1. Fruit vegetables 2. Beans 3. Cucurbits 4. Tuber crops 5. Leafy vegetables

VI. **Theory**

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and

seed treatment, raising of nursery including grafting technique, sowing/ planting time and methods, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices namely hydroponics, aeroponics, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marking), pest and disease management and economics of crops.

Unit I

Fruit vegetables—Tomato, brinjal, hot pepper, sweet pepper and okra.

Unit II

Beans—French bean, Indian bean (Sem), cluster bean and cowpea.

Unit III

Cucurbits—Cucumber, melons, gourds, pumpkin and squashes.

Unit IV

Tuber crops—Sweet potato, elephant foot yam, tapioca, taro and yam.

Unit V

Leafy vegetables—Amaranth and drumstick.

VII. Practical

- Scientific raising of nursery and seed treatment;
- Sowing, transplanting, vegetable grafting;
- Description of commercial varieties and hybrids;
- Demonstration on methods of irrigation, fertilizers and micronutrients application;
- Mulching practices, weed management;
- Use of plant growth substances in warm season vegetable crops;
- Study of nutritional and physiological disorders;
- Studies on hydroponics, aeroponics and other soilless culture;
- Identification of important pest and diseases and their control;
- Preparation of cropping scheme for commercial farms;
- Visit to commercial farm, greenhouse/ polyhouses;
- Visit to vegetable market;
- Analysis of benefit to cost ratio.

VIII. Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

IX. Learning outcome

After successful completion of this course, the students are expected to:

- Appreciate the scope and scenario of warm season vegetable crops in India
- Acquire knowledge about the production technology and post-harvest handling of warm season vegetable crops
- Calculate the economics of vegetable production in India

Suggested Reading

Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. *Vegetable crops*. Vols. I-III. Naya udyog.
Bose TK, Som MG and Kabir J. (Eds.). 1993. *Vegetable crops*. Naya prokash.
Chadha KL and Kalloo G. (Eds.). 1993-94. *Advances in horticulture* Vols. V-X. Malhotra publ. house.
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Hazra P. 2019. *Vegetable production and technology*. New India publishing agency, New Delhi.
Hazra P, Chattopadhyay A, Karmakar K and Dutta S. 2011. *Modern technology for vegetable production*, New India publishing agency, New Delhi, 413p
Rana MK. 2008. *Olericulture in India*. Kalyani Publishers, New Delhi.
Rana MK. 2008. *Scientific cultivation of vegetables*. Kalyani Publishers, New Delhi.
Rubatzky VE and Yamaguchi M. (Eds.). 1997. *World vegetables: principles, production and nutritive values*. Chapman and Hall.
Saini GS. 2001. *A text book of oleri and flori culture*. Aman publishing house.
Salunkhe DK and Kadam SS. (Ed.). 1998. *Hand book of vegetable science and technology: production, composition, storage and processing*. Marcel dekker.
Shanmugavelu KG., 1989. *Production technology of vegetable crops*. Oxford and IBH.
Singh DK. 2007. *Modern vegetable varieties and production technology*. International book distributing Co.
Singh SP. (Ed.). 1989. *Production technology of vegetable crops*. Agril. comm. res. centre.
Thamburaj S and Singh N. (Eds.). 2004. *Vegetables, tuber crops and spices*. ICAR.
Thompson HC and Kelly WC. (Eds.). 1978. *Vegetable crops*. Tata McGraw-Hill.

I. Course Title : Growth and Development of Vegetable Crops

II. Course Code : VSC 503

III. Credit Hours : (2+1)

IV. Why this course ?

In agriculture, the term plant growth and development is often substituted with crop growth and yield since agriculture is mainly concerned with crops and their economic products. Growth, which is irreversible quantitative increase in size, mass, and/ or volume of a plant or its parts, occurs with an expenditure of metabolic energy. Plant development is an overall term, which refers to various changes that occur during its life cycle. In vegetable crops, development is a series of processes from the initiation of growth to death of a plant or its parts. Growth and development are sometimes used interchangeably in conversation, but in a botanical sense, they describe separate events in the organization of the mature plant body. The students of vegetable science need to have an understanding of growth and development of vegetable crops.

V. Aim of the course

To teach the physiology of growth and development of vegetable crops

The course is constructed given as under:

No.	Block	Unit
1.	Growth and development of vegetable crops	1. Introduction and phytohormones 2. Physiology of dormancy and germination 3. Abiotic factors 4. Fruit physiology 5. Morphogenesis and tissue culture

VI. Theory

Unit I

Introduction and phytohormones—Definition of growth and development; Cellular structures and their functions; Physiology of phyto-hormones functioning/ biosynthesis and mode of action; Growth analysis and its importance in vegetable production.

Unit II

Physiology of dormancy and germination—Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellins, cyktokinins and abscisic acid. Application of synthetic PGRs including plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production.

Unit III

Abiotic factors—Impact of light, temperature, photoperiod, carbon dioxide, oxygen and other gases on growth, development of underground parts, flowering and sex expression in vegetable crops; Apical dominance.

Unit IV

Fruit physiology—Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening.

Unit V

Morphogenesis and tissue culture—Morphogenesis and tissue culture techniques in vegetable crops. Grafting techniques in different vegetable crops.

VII. Practical

- Preparation of plant growth regulator's solutions and their application;
- Experiments in breaking and induction of dormancy by chemicals;
- Induction of parthenocarpy and fruit ripening;
- Application of plant growth substances for improving flower initiation, changing sex expression in cucurbits and checking flower and fruit drops and improving fruit set in solanaceous vegetables;
- Growth analysis techniques in vegetable crops;
- Grafting techniques in tomato, brinjal, cucumber and sweet pepper.

VIII. Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)

(10)

- Student presentation
- Hands on training of different procedure
- Group discussion

IX. Learning outcome

After successful completion of this course, the students are expected to:

- Acquire knowledge about the growth and development of plants in vegetable crops
- Distinguish between primary and secondary growth in plant stems
- Understand how hormones affect the growth and development of vegetable crops

X. Suggested Reading

Bleasdale JKA. 1984. *Plant physiology in relation to horticulture* (2nd Edition) MacMillan.
Gupta US. Eds. 1978. *Crop physiology*. Oxford and IBH, New Delhi.
Kalloo G. 2017. *Vegetable grafting: Principles and practices*. CAB International
Krishnamoorti HN. 1981. *Application growth substances and their uses in agriculture*. Tata McGraw Hill. New Delhi.
Leopold AC and Kriedemann PE. 1981. *Plant growth and development*, Tata McGraw-Hill, New Delhi.
Peter KV and Hazra P. (Eds). 2012. *Hand book of vegetables*.Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA. 678p.
Peter KV. (Eds). 2008. *Basics of horticulture*. New India publication agency, New Delhi.
Rana MK. 2011. *Physio-biochemistry and Biotechnology of Vegetables*. New India Publishing Agency, Pritam Pura, New Delhi.
Saini *et al.* (Eds.). 2001. *Laboratory manual of analytical techniques in horticulture*. Agrobios, Jodhpur.
Wien HC. (Eds.). 1997. *The physiology of vegetable crops*. CAB International.

I. Course Title : Principles of Vegetable Breeding
II. Course Code : VSC 504
III. Credit Hours : (2+1)

IV. Why this course ?

Plant breeding has been practiced for thousands of years, since beginning of human civilization. Vegetable breeding, which is an art and science of changing the traits of plants in order to produce desired traits, has been used to improve the quality of nutrition in products for human beings. A breeding programme, which is needed if current varieties are not producing up to the capacity of the environment, can be accomplished through many different techniques ranging from simply selecting plants with desirable characteristics, make use of knowledge of genetics and chromosomes to more complex molecular techniques. When different genotypes exhibit differential responses to different sets of environmental conditions, a genotype x environment (GxE) interaction is said to occur. Breeding high yielding open pollinated varieties and hybrids, and exploitation of location specific component of genotypic performance are the only options left to reduce this increasing gap between the production and requirements in view of decreasing land resources. Noevertheless, vegetable breeding is an integral part of plant breeding but this will be re-modeled to suit to breeding of different vegetables crops. The students of vegetable science who are having breeding as major subject need to have an understanding of vegetable breeding principles.

V. Aim of the course

To teach basic principles and practices of vegetable breeding

The course is constructed given as under:

No.	Block	Unit
1.	Principles of vegetable breeding	I. Importance and history II. Selection procedures III. Heterosis breeding IV. Mutation breeding V. Polyploid breeding VI. Ideotype breeding

VI. Theory

Unit I

Importance and history- Importance, history and evolutionary aspects of vegetable breeding and its variation from cereal crop breeding.

Unit II

Selection procedures- Techniques of selfing and crossing; Breeding systems and methods; Selection procedures and hybridization; Genetic architecture; Breeding for biotic stress (diseases, insect pests and nematode), abiotic stress (temperature, moisture and salt) resistance and quality improvement; Breeding for water use efficiency (WUE) and nutrients use efficiency (NUE).

Unit III

Heterosis breeding- Types, mechanisms and basis of heterosis, facilitating mechanisms like male sterility, self-incompatibility and sex forms.

Unit IV

Mutation and Polyploidy breeding; Improvement of asexually propagated vegetable crops and vegetables suitable for protected environment.

Unit V

Ideotype breeding- Ideotype breeding; varietal release procedure; DUS testing in vegetable crops; Application of *In-vitro* and molecular techniques in vegetable improvement.

VII. Practical

- Floral biology and pollination behaviour of different vegetables;
- Techniques of selfing and crossing of different vegetables, viz., Cole crops, okra, cucurbits, tomato, eggplant, hot pepper, etc.;
- Breeding system and handling of filial generations of different vegetables;
- Exposure to biotechnological lab practices;
- Visit to breeding farms.

VIII. Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

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IX. Learning outcome

After successful completion of this course, the students are expected to:

- Acquire knowledge about the principles of vegetable breeding
- Improve yield, quality, abiotic and biotic resistance, other important traits of vegetable crops
- Understand how the basic principles are important to start breeding of vegetable crops

X. Suggested Reading

Allard RW. 1960. *Principle of plant breeding*. John Willey and Sons, USA.
Kalloo G. 1988. *Vegetable breeding* (Vol. I, II, III). CRC Press, Fl, USA.
Kole CR. 2007. *Genome mapping and molecular breeding in plants-vegetables*. Springer, USA.
Peter KVand Pradeep Kumar T. 1998. Genetics and breeding of vegetables. ICAR, New Delhi, p. 488.
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Singh BD. 2007. *Plant breeding-principles and methods* (8th edn.). Kalyani Publishers, New Delhi.
Singh Ram J. 2007. *Genetic resources, chromosome engineering, and crop improvement-vegetable crops* (Vol. 3). CRC Press, Fl, USA.

I. Course Title : Breeding of Self Pollinated Vegetable Crops

II. Course Code : VSC 505

III. Credit Hours : (2+1)

IV. Why this course ?

Self-pollination, which is considered the highest degree of inbreeding a plant can achieve, promotes homozygosity of all gene loci and traits of the sporophyte and restricts the creation of new gene combinations (no introgression of new genes through hybridization). The progeny of a single plant is homogeneous due to self pollination. A population of self-pollinated species comprises a mixture of homozygous lines. New genes may arise through mutation but such change is restricted to individual lines or the progenies of the mutant plant. Since a self-pollinated cultivar is generally one single genotype reproducing itself, breeding of self-pollinated species usually entails identifying one superior genotype (or a few) and its multiplication. Specific breeding methods commonly used for self-pollinated species are pure-line selection, pedigree breeding, bulk populations and backcross breeding. The students of vegetable science who take breeding as a minor subject need to have an understanding of breeding of self pollinated vegetable crops.

V. Aim of the course

To impart comprehensive knowledge about principles and practices of breeding of self pollinated vegetable crops

The course is constructed given as under:

No.	Block	Unit
1.	Breeding of self pollinated vegetable crops	I. Potato II. Fruit vegetables III. Garden peas and cowpea IV. Beans V. Leafy vegetables

VI. Theory

Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination and fertilization mechanism, sterility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, breeding for protected environment and quality improvement, molecular markers and marker's assisted breeding; QTLs, PPV and FR Act.

Unit I

Tuber crops: Potato.

Unit II

Fruit vegetables- Tomato, eggplant, hot pepper, sweet pepper and okra.

Unit III

Leguminous vegetables- Garden peas and cowpea.

Unit IV

Leguminous vegetables: French bean, Indian bean, cluster bean and broad bean.

Unit V

Leafy vegetables- Lettuce and fenugreek.

VII. Practical

- Floral mechanisms favouring self and often cross pollination;
- Progeny testing and development of inbred lines;
- Selection of desirable plants from breeding population, observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations;
- Palynological studies, selfing and crossing techniques;
- Hybrid seed production of vegetable crops in bulk;
- Screening techniques for biotic and abiotic stress resistance in above mentioned crops;
- Molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques;
- Visit to breeding farms;

VIII. Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

IX. Learning outcome

After successful completion of this course, the students are expected to:

- Acquire knowledge about the breeding of self pollinated vegetable crops
- Improve yield, quality, abiotic and biotic resistance and other important traits of vegetable crops
- Understand how to start the breeding of self pollinated vegetable crops

X. Suggested Reading

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Basset MJ. (Ed.). 1986. *Breeding vegetable crops*. AVI Publ.
Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005. Plant genetic resources: horticultural crops. Narosa Publ. House.
Fageria MS, Arya PS and Choudhary AK. 2000. *Vegetable crops: Breeding and seed production*. Vol. I. Kalyani.
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Hayes HK, Immer FR and Smith DC. 1955. *Methods of plant breeding*. McGraw-Hill.
Hayward MD, Bosemark NO and Romagosa I. (Eds.). 1993. *Plant Breeding-principles and prospects*. Chapman and Hall.
Hazra P and Som MG. 2015. Vegetable science (Second revised edition). Kalyani publishers, Ludhiana, 598 p.
Hazra P and Som MG. 2016. *Vegetable seed production and hybrid technology* (Second revised edition), Kalyani Publishers, Ludhiana, 459 p
Kalloo G. 1988. *Vegetable breeding*. Vols. I-III. CRC Press.
Kalloo G. 1998. *Vegetable breeding*. Vols. I-III (Combined Ed.). Panima Edu. Book Agency.
Kumar JC and Dhaliwal MS. 1990. *Techniques of developing hybrids in vegetable crops*. Agro Botanical Publ.
Paroda RS and Kalloo G. (Eds.). 1995. *Vegetable research with special reference to hybrid technology in Asia-Pacific Region*. FAO.
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Simmonds NW. 1978. *Principles of crop improvement*. Longman. Singh BD. 1983. Plant Breeding. Kalyani Publishers, New Delhi.
Singh PK, Dasgupta SK and Tripathi SK. 2004. *Hybrid vegetable development*. International Book Distributing Co.
Swarup V. 1976. *Breeding procedure for cross-pollinated vegetable crops*. ICAR.

I. Course Title : Breeding of Cross Pollinated Vegetable Crops
II. Course Code : VSC 506
III. Credit Hours : (2+1)

IV. Why this course ?

The important methods of breeding in cross-pollinated vegetable species are (i) mass selection, (ii) development of hybrid varieties and (ii) development of synthetic for many traits and lose vigour as they become purebred (homozygous), a goal of each of these breeding methods is to preserve or restore heterozygosity in cross pollinated vegetable crops. The students of vegetable science who take breeding as a minor subject need to have an understanding of breeding of cross pollinated vegetable crops.

V. Aim of the course

To impart comprehensive knowledge about principles and practices of cross pollinated vegetable crops breeding.

The course is constructed given as under

No.	Block	Unit
1	Breeding of cross pollinated vegetable crops	I Cucurbitaceous crops II Cole crops III Root and bulb crops IV Tuber crops V Leafy vegetables

VI. Theory

Origin, botanic taxonomy, cytogenetics, genetics, types of pollination and fertilization, mechanism, sterility and incompatibility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation, polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs, PPV and FR act

Unit I

Cucurbitaceous crops—Gourds, melons, cucumber, pumpkin and squashes

Unit II

Cole crops—Cauliflower, cabbage, kohlrabi, broccoli and brussels sprouts

Unit III

Root and bulb crops—Carrot, radish, turnip, beet root and onion

Unit IV

Tuber crops—Sweet potato, tapioca, taro and yam

Unit V

Leafy vegetables—Beet leaf, spinach, amaranth and coriander

VII. Practical

- Floral mechanisms favouring cross pollination;
- Development of inbred lines
- Selection of desirable plants from breeding population;
- Observations and analysis of various quantitative and qualitative traits in germplasm, hybrids and segregating generations;
- Induction of flowering, pollenological studies, selfing and crossing techniques
- Hybrid seed production of vegetable crops in bulk, screening techniques for biotic and abiotic stress resistance in above mentioned crops;
- Demonstration of nik mating and mixed population;
- Molecular marker techniques to identify useful traits in vegetable crops and special breeding techniques
- Visit to breeding blocks

VIII. Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation individual or in group
- Hands on training of different procedures
- Group discussion

IX. Learning outcome

After successful completion of this course, the students are expected to:

- Acquire knowledge about the breeding of cross pollinated vegetable crops
- Improve yield, quality, abiotic and biotic resistance, and important traits of cross pollinated vegetable crops
- Understand how to start the breeding of cross pollinated vegetable crops

X. Suggested Reading

Allard RW. 1999. *Principles of plant breeding*. John Wiley and Sons.

Basset MJ. (Ed.) 1986. *Breeding vegetable crops*. AVI Publ.

Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005. *Plant genetic resources: horticultural crops*. Narosa publ. house.

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I. Course Title : **Protected Cultivation of Vegetable CropS**

II. Course Code : **VSC 507**

III. Credit Hours : **(2+1)**

IV. Why this course ?

India is the second largest producer of vegetable crops in the world. However, its vegetable production is much less than the requirement, if a balanced diet is provided to every individual. There are different ways and means to achieve this target. Protected cultivation, which is the modification of the natural environment to achieve optimum plant growth. Is the most intensive form of crop production

with a yield per unit area up to ten times superior to that of a field crop. During winter under north east Indian conditions, it is difficult to grow tomato, capsicum, cucurbits, french bean, amaranth, etc. in open field. However, various types of protected structure have been developed for growing some high value crops by providing protection from the excessive cold. Production of off-season vegetable nurseries under protected structure has become a profitable business. The main purpose of raising nursery plants in protected structure is to get higher profit and disease free seedlings in off-season to raise early crop in protected and open field condition. The low cost polyhouse is economical for small and marginal farmers, who cannot afford huge cost of high-tech polyhouse. Besides supplying the local markets, the production of polyhouse vegetables is greatly valued for its export potential and plays an important role in the foreign trade balance of several national economies. The students of vegetable science need to have an understanding of protected cultivation of vegetable crops.

V. Aim of the course

To impart latest knowledge about growing of vegetable crops under protected environmental conditions.

The course is constructed given as under:

No.	Block	Unit
1	Protected cultivation of vegetable crops	I Scope and importance II Types of protected structures III Abiotic factors IV Nursery raising V Cultivation of crops VI Solutions to problems

VI. Theory

Unit I

Scope and importance: Concept, scope and importance of protected cultivation of vegetable crops. Principles, design, orientation of structure, low and high cost polyhouses/ greenhouse structures.

Unit II

Types of protected structure: Classification and types of protected structures- greenhouse/ polyhouse, plastic-non plastic low tunnels, plastic walk in tunnels, high roof tunnels with ventilation, insect proof net houses, shed net houses, rain shelters, NVP climate control greenhouses, hydroponics and aeroponics. Soil and soilless media for bed preparation. Design and installation of drip irrigation and fertigation system.

Unit III

Abiotic factors: Effect of environmental factors and manipulation of temperature, light, carbon dioxide, humidity, etc. on growth and yield of different vegetables.

Unit IV

Nursery raising: High tech vegetable nursery raising in protected structures using pluga and portrays, different media for growing nursery under protected cultivation. Nursery problems and management technologies including fertigation.

Unit V

Cultivation of crops- Regulation of flowering and fruiting in vegetable crops; Technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, including varieties and hybrids, training, pruning and staking in growing vegetables under protected structures.

Unit VI

Solutions to problems- Problems of growing vegetables in protected structures and their remedies, physiological disorders, insect and disease management in protected structures; Use of protected structures for seed production; Economics of greenhouse crop production.

VII. Practical

- Study of various types of protected structure;
- Study of different methods to control temperature, carbon dioxide and light;
- Study of different types of growing media, training and pruning systems in greenhouse crops;
- Study of fertigation and nutrient management under protected structures;
- Study of insect pests and diseases in greenhouse and its control;
- Use of protected structures in hybrid seed production of vegetables;
- Economics of protected cultivation (Any one crop);
- Visit to established green/ polyhouses/ shade net houses in the region.

VIII. Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

IX. Learning outcome

After successful completion of this course, the students are expected to:

- Appreciate the scope and scenario of protected cultivation of vegetable crops in India
- Acquire knowledge about the effect of abiotic factors on growth, flowering and production of vegetable crops
- Gaining knowledge about the designing of various low cost protected structures
- Adopting the raising of vegetable seedlings in low cost protected structures as entrepreneur

X. Suggested Reading

Chadha KL and Kalloo G. (Eds.). 1993-94. *Advances in horticulture*. Malhotra Pub. House.

Chandra S and Som V. 2000. *Cultivating vegetables in green house*. Indian horticulture 45:17-18.

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Parvatha RP. 2016. *Sustainable crop protection under protected cultivation*. E-Book Springer.

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Resh HM. 2012. *Hydroponic food production*. 7thEdn. CRC Press.

Singh B. 2005. *Protected cultivation of vegetable crops*. Kalyani publishers, New Delhi

Singh DK and Peter KV. 2014. *Protected cultivation of horticultural crops* (1st Edition) New India publishing agency, New Delhi.

Singh S, Singh B and Sabir N. 2014. *Advances in protected cultivation*. New India publishing agency, New Delhi.

Tiwari GN. 2003. *Green house technology for controlled environment*. Narosa publ. house.

I. Course Title : Seed Production of Vegetable Crops

II. Course Code : VSC 508

III. Credit Hours : (2+1)

IV. Why this course ?

Enhancing yield and quality of vegetable crops depends upon a number of factors. The inputs like fertilizers, irrigation and plant protection measures and suitable agronomic practices contribute greatly towards improving yield and quality of the vegetable produce. If good quality seed is not used, the full benefits of such inputs and agronomic practices can not be realized. The use of high quality seed thus, plays a pivotal role in the production of vegetable crops. It is, therefore, important to use the seed conforming to the prescribed standards. A good quality seed should have high genetic and physical purity, proper moisture content and good germination. It should also be free from seed borne diseases and weed seeds. The quality of the produce will deteriorate if these factors are overlooked. Out crossing, physical admixtures and mutations are the prime factors responsible for the deterioration of seed quality. A variety could be saved from deterioration if proper checks are made at different stages of seed multiplication. It is also extremely important to maintain high genetic purity of a variety. The students of vegetable science need to have an understanding of seed production technology of vegetable crops and their essential processing before supplying them to the market or further use.

V. Aim of the course

To impart a comprehensive knowledge and skills on quality seed production of vegetable crops

The course is constructed given as under:

No.	Block	Unit
1.	Seed production of vegetable crops	I. Introduction, history, propagation and reproduction II. Agro-climate and methods of seed production III. Seed multiplication and its quality maintenance IV. Seed harvesting, extraction and its processing V. Improved agro-techniques and field and seed standards

VI. Theory

Unit I

Introduction, history, propagation and reproduction—Introduction, definition of seed and its quality, seed morphology, development and maturation; Apomixis and fertilization; Modes of propagation and reproductive behaviour; Pollination mechanisms and sex forms in vegetables; History of vegetable seed production; Status and share of vegetable seeds in seed industry

Unit II

Agro-climate and methods of seed production—Agro-climate and its influence on quality seed production. Deterioration of crop variation, genetical and agronomic principles of vegetable seed production. Methods of seed production, hybrid seeds and techniques of large scale hybrid seed production. Seed village concept

Unit III

Seed multiplication and its quality maintenance—Seed multiplication ratios and replacement rates in vegetables. Generation system of seed multiplication. Maintenance and production of nucleus, breeder, foundation, certified/ truthful label seeds. Seed quality and mechanisms of genetic purity testing

Unit IV

Seed harvesting, extraction and its processing—Maturity standards; Seed harvesting, curing and extraction. Seed processing, viz., cleaning, drying and treatment of seeds, seed health and quality enhancement, packaging and marketing. Principles of seed storage. Orthodox and recalcitrant seeds; Seed dormancy

Unit V

Improved agro-techniques and field and seed standards—Improved agro-techniques. Field and seed standards in important solanaceous, leguminous and cucurbitaceous vegetables, cole crops, leafy vegetables, bulbous and root crops and okra; clonal propagation and multiplication in vegetative propagated crops. Seed plot technique and true potato seed production in potato

VII. Practical

- Study of floral biology and pollination mechanisms in vegetables;
- Determination of modes of pollination;
- Field and seed standards;
- Use of pollination control mechanisms in hybrid seed production of important vegetables;
- Maturity standards and seed extraction methods;
- Seed sampling and testing;
- Visit to commercial seed production areas;
- Visit to seed processing plant;
- Visit to seed testing laboratories.

VIII. Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

IX. Learning outcome

After successful completion of this course, the students are expected to:

- Appreciate the scope and scenario of seed production of vegetable crops in India
- Acquire knowledge about the complete seed production technology, extraction and post-extraction processing of vegetable seeds
- Adoption of seed production of vegetable crops as entrepreneur

X. Suggested Reading

Agarwaal PK and Anuradha V. 2018. *Fundamentals of seed science and technology*. Brilliant publications, New Delhi.

Agrawal PK and Dadlani M. (Eds.). 1992. *Techniques in seed science and technology*. South asian Publ.

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Rajan S and Markose BL. 2007. *Propagation of horticultural crops*. New India publ. agency.

Singh NP, Singh DK, Singh YK and Kumar V. 2006. *Vegetable seed production technology*. International book distributing Co.

Singh SP. 2001. *Seed production of commercial vegetables*. Agrotech publ. academy.

Singhal NC. 2003. *Hybrid seed production*. Kalyani publishers, New Delhi

I. Course Title : Production of Underutilized Vegetable Crops

II. Course Code : VSC 509

III. Credit Hours : (2+1)

IV. Why this course ?

With increasing population and fast depletion of natural resources, it has become essential to explore the possibilities of using newer indigenous plant resources. Underutilized crops are plant species that are used traditionally by the country people for their food, fibre, fodder, oil, or medicinal properties but have yet to be adopted by large scale agriculturalists. In general, underutilized plants constitute those plant species that occur as life support species in extreme environmental conditions and threatened habitats, having genetic tolerance to survive under harsh conditions and possess qualities of nutritional and/ or industrial importance for a variety of purposes. Underutilized crops are those plant species with under-exploited potential for contributing to food security, health (nutritional or medicinal), income generation and environmental services. Once the underutilized food crops are properly utilized, they may help to contribute in food security, nutrition, health, income generation and environmental services. The underutilized crops can be defined as the crops, which being region specific are less available, less utilized or rarely used. These underutilized crop species have also been described as *rare, minor, orphan, promising* and little-used vegetable crops. The students of vegetable

science need to have an understanding of production technology of underutilized vegetable crops.

V. Aim of the course

To impart knowledge about production technology of lesser utilized vegetable crops

The course is constructed given as under:

No.	Block	Unit
1.	Production of underutilized vegetable crops	I. Stem and bulb crops II. Cole and salad crops III. Gourds and melons IV. Leafy vegetables V. Yams and beans

VI. Theory

Importance and scope, botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting and yield, plant protection measures and post harvest management of:

Unit I

Stem and bulb crops—Asparagus, leek and chinese chive

Unit II

Cole and salad crops—Red cabbage, chinese cabbage, kale, sweet corn and baby corn

Unit III

Leafy vegetables—Celery, parsley, indian spinach (poi), spinach, chenopods, chekurmanis and indigenous vegetables of regional importance

Unit IV

Gourds and melons—Sweet gourd, spine gourd, teasle gourd, round gourd, and little/ Ivy gourd, snake gourd, pointed gourd, kachri, long melon, snap melon and gherkin

Unit V

Yam and beans—Elephant foot yam, yam, yam bean, lima bean and winged bean

VII. Practical

- Identification and botanical description of plants and varieties;
- Seed/ planting material;
- Production, lay out and method of planting;
- Important cultural operations;
- Identification of important pests and diseases and their control;
- Maturity standards and harvesting;
- Visit to local farms.

Teaching Methods/ Activities

- Delivering of lectures by power point presentation
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

Learning outcome

After successful completion of this course, the students are expected to:

- Appreciate the scope and scenario of production of underutilized vegetable crops in India
- Acquire knowledge about the production technology of underutilized vegetable crops
- Adopting production of lesser utilised crops as entrepreneur

Suggested Reading

Bhat KL. 2001. *Minor vegetables-untapped potential*. Kalyani publishers, New Delhi.

Indira P and Peter KV. 1984. *Unexploited tropical vegetables*. Kerala agricultural university, Kerala.

Pandey AK. 2011. *Aquatic vegetables*. Agrotech publisher academy, New Delhi.

Peter KV. (Eds.). 2007-08. *Underutilized and underexploited horticultural crops*. Vol.1-4, New India publishing agency, Lucknow.

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Rana MK. 2018. *Vegetable crop science*. CRC Press Taylor and Francis Group 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742 ISBN: 978-1-1380-3521-8

Rubatzky VE and Yamaguchi M. 1997. *World vegetables: vegetable crops*. NBPGR, New Delhi.

I. Course Title : Systematics of Vegetable Crops

II. Course Code : VSC 510

III. Credit Hours : (1+1)

IV. Why this course ?

Systematics is fundamental to our understanding of the world around us as it provides basis for understanding the patterns of diversity on earth. Vegetable systematics is the science of botanical diversity of vegetable crops on earth, including variation from the level of genes within an individual to individuals, populations and species. The primary aim of systematics is to discover all the branches of the tree of life, document evolutionary changes occurring along those branches, and describe all the species on earth (the tips of the branches). The secondary aim of systematic is to analyze and synthesize information into a classification that reflects evolutionary relationships, to organize this information into a useful, retrievable form to gain insight into evolutionary processes that lead to diversity.

V. Aim of the course

To impart knowledge on morphological, cytological and molecular taxonomy of vegetable crops

The course is constructed given as under:

No.	Block	Unit
1.	Systematics of vegetable crops	I. Significance of systematics II. Origin and evolution III. Botanical and morphological description IV. Cytology V. Molecular markers

VI. Theory

Unit I

Significance of systematic—Significance of systematics and crop diversity in vegetable crops; Principles of classification; different methods of classification; Salient features of international code of nomenclature of vegetable crops

Unit II

Origin and evolution—Origin, history, evolution and distribution of vegetable crops

Unit III

Botanical and morphological description—Botanical description of families, genera and species covering various tropical, subtropical and temperate vegetables; Morphological keys to identify important families, floral biology, floral formula and diagram; Morphological description of all parts of vegetables

Unit IV

Cytology—Cytological level of various vegetable crops with descriptive keys

Unit V

Molecular markers—Importance of molecular markers in evolution of vegetable crops; Molecular markers as an aid in characterization and taxonomy of vegetable crops

VII. Practical

- Identification, description, classification and maintenance of vegetable species and varieties;
- Survey, collection of allied species and genera locally available;
- Preparation of keys to the species and varieties;
- Methods of preparation of herbarium and specimens.

VIII. Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

IX. Learning outcome

After successful completion of this course, the students are expected to:

- Acquire knowledge on identification, description, classification and maintenance of vegetable species and varieties
- Collecting locally available allied species of vegetable crops
- Preparing herbarium and specimens

X. Suggested Reading

Chopra GL. 1968. *Angiosperms- systematics and life cycle*. S. Nagin

Dutta AC. 1986. *A class book of botany*. Oxford Univ. Press.

Pandey BP. 1999. *Taxonomy of angiosperm*. S. Chand and Co

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Vasistha. 1998. *Taxonomy of angiosperm*. Kalyani Publishers, New Delhi.
Vincent ER and Yamaguchi M. 1997. *World vegetables*. 2nd Ed. Chapman and Hall.

I. Course Title : Organic Vegetable Production

II. Course Code : VSC 511

III. Credit Hours : (1+1)

IV. Why this course ?

Organic vegetable farming is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. Organic farming has been simply defined as a production system working in partnership with nature to produce vegetable crops. The current trend towards increasing popularity of organically produced vegetables is relatively new. The objective of organic farming is to produce safer food and to keep the environment healthy. During the decade of nineties, the interest in organic farming began to creep into the mainstream consumer purchases. Currently, it appears to be an influx of business oriented producers into the organic production field. The increasing popularity of organic food among the elite societies is due to the belief that food produced with this system is free of pesticides and has greater nutritive value than conventionally produced food. The students of vegetable science need to have an understanding of organic vegetable farming technology.

V. Aim of the course

To elucidate principles, concepts and their applications in organic farming of vegetable crops

The course is constructed given as under:

No.	Block	Unit
1.	Organic vegetable production	1. Importance and principles 2. Organic production of vegetables 3. Managing soil fertility 4. Composting methods 5. Certification and export

VI. Theory

Unit I

Importance and principles—Importance, principles, perspective, concepts and components of organic farming in vegetable crops

Unit II

Organic production of vegetables—Organic production of vegetable crops, viz., Solanaceous, Cucurbitaceous, Cole, root and tuber crops

Unit III

Managing soil fertility—Managing soil fertility, mulching, raising green manure

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crops, weed management in organic farming system; Crop rotation in organic production; Processing and quality control of organic vegetable produce

Unit IV

Composting methods—Indigenous methods of composting, Panchyagavvya, Biodynamics preparations and their application; ITKs in organic vegetable farming; Role of botanicals and bio-control agents in the management of pests and diseases in vegetable crops

Unit V

Certification and export—Techniques of natural vegetable farming, GAP and GMP. certification of organic products; Export- opportunity and challenges

VII. Practical

- Methods of preparation and use of compost, vermicompost, biofertilizers and biopesticides;
- Soil solarisation;
- Use of green manures;
- Waste management; Organic soil amendments in organic production of vegetable crops;
- Weed, pest and disease management in organic vegetable production;
- Visit to organic fields and marketing centres.

VIII. Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

IX. Learning outcome

After successful completion of this course, the students are expected to:

- Appreciate the scope and scenario of organic vegetable production in India
- Acquire knowledge about the organic vegetable production technology
- Adopting production of organic vegetable crops a s entrepreneur

X. Suggested Reading

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Palaniappan SP and Annadorai K. 2003. *Organic farming, theory and practice*. Scientific publ.
Pradeepkumar T, Suma B, Jyothibhaskar and Satheesan KN. 2008. *Management of horticultural crops*. New India Publ. Agency.
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I. Course Title : **Production of Spice Crops**
II. Course Code : **VSC 512**
III. Credit Hours : **(2+1)**

IV. Why this course ?

Spices are an important part of human history and played an important role in the development of most cultures around the world. Spice may be a seed, fruit, root, bark,

or any other plant substance primarily used for flavouring, colouring, or preserving food. Spices are distinguished from herbs, which are the leaves, flowers, or stems of plants used for flavouring or as a garnish. Many spices have antimicrobial properties, because of which why spices are more commonly used in warmer climates, which have more infectious diseases, and use of spices is prominent in meat, which is predominantly susceptible to spoiling. The students of vegetable science need to have an understanding of production technology of spices and their processing before supplying them to the market or further use.

V. Aim of the course

To impart basic knowledge about the importance and production technology of spices grown in India

The course is constructed given as under:

No.	Block	Unit
1.	Production of spice crops	1. Fruit spices 2. Bud and kernel spices 3. Underground spice crops 4. Seed spices 5. Tree spices

VI. Theory

Introduction and importance of spice crops- historical accent, present status (national and international), future prospects, botany and taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, site selection, layout, sowing/ planting time and methods, seed rate and seed treatment, nutritional and irrigation requirement, intercropping, mixed cropping, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures, quality control and pharmaceutical significance of crops mentioned below:

Unit I

Fruit spices- Black pepper, small cardamom, large cardamom and allspice

Unit II

Bud and kernel- Clove and nutmeg

Unit III

Underground spices- Turmeric, ginger and garlic

Unit IV

Seed spices- Coriander, fenugreek, cumin, fennel, ajowain, dill and celery

Unit V

Tree spices- Cinnamon, tamarind, garcinia and vanilla

VII. Practical

- Identification of seeds and plants;
- Botanical description of plant;
- Preparation of spice herbarium;
- Propagation;
- Nursery raising;

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- Field layout and method of planting;
- Cultural practices;
- Harvesting, drying, storage, packaging and processing;
- Value addition;
- Short term experiments on spice crops.

VIII. Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

IX. Learning outcome

After successful completion of this course, the students are expected to:

- Appreciate the scope and scenario of production of spice crops in India
- Acquire knowledge about the production technology and processing of spice crops
- Adopting production of spice crops as entrepreneur

X. Suggested Reading

Agarwal S, Sastry EVD and Sharma RK. 2001. *Seed spices: production, quality, export*. Pointer Publication.

Arya PS. 2003. *Spice crops of India*. Kalyani.

Bhattacharjee SK. 2000. *Hand book of aromatic plants*. Pointer publications.

Bose TK, Mitra SK, Farooqi SK and Sadhu MK. (Eds.). 1999. *Tropical horticulture*.Vol.I. Naya Prokash.

Chadha KL and Rethinam P. (Eds.). 1993. *Advances in horticulture*. Vols. IX-X. *Plantation crops and spices*. Malhotra Publ. House.

Gupta S. (Ed.). *Hand book of spices and packaging with formulae*. engineers India research institute, New Delhi.

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Nybe EV, Miniraj N and Peter KV. 2007. *Spices*. New India Publ. Agency.

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Thamburaj S and Singh N. (Eds.). 2004. *Vegetables, tuber crops and spices*. ICAR.

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Varmudy V. 2001. *Marketing of spices*. Daya Publ. House.

I. Course Title : Processing of Vegetable Crops

II. Course Code : VSC 513

III. Credit Hours : (1+1)

IV. Why this course ?

In India, agriculture is the basis of economy. Agricultural industries and related

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activities, which can be termed as agriculturally based vegetable processing, can account for a considerable proportion of their output. Both established and planned vegetable processing projects aim at solving a very clearly identified developmental problems. The growers sustain substantial losses due to insufficient demand in the market, weak infrastructure, poor transportation and perishable nature of the vegetable crops. During the postharvest glut, the loss is considerable and often some of the produce are fed to the animals or allowed to decay. Even the established vegetable canning industries or small/ medium scale processing centres suffer huge loss due to erratic supplies since the growers like to sell their produce in the open market directly to the consumers, or the produce may not be of enough high quality to process but it might be good enough for the table use, meaning that processing is seriously underexploited. The main objective of vegetable processing is to supply wholesome, safe, nutritious and acceptable food to the consumers throughout the year. Vegetable processing also aims to replace imported products like squash, jams, tomato sauces, pickles, etc., besides earning foreign exchange by exporting finished or semi-processed products. The students of vegetable science need to have an understanding of vegetable processing.

V. Aim of the course

To educate the students about the principles and practices of processing in vegetable crops

The course is constructed given as under

No.	Block	Unit
1	Processing of vegetable crops	I Present status II Spoilage and biochemical changes III Processing equipments IV Quality control V Value additions

VI. Theory

Unit I

Present status—Present status and future prospects of vegetable preservation industry in India

Unit II

Spoilage and biochemical changes—Spoilage of fresh and processed vegetable produce; biochemical changes and enzymes associated with spoilage of vegetable produce; Principal spoilage organisms, food poisoning and their control measures; Role of microorganisms in food preservation

Unit III

Processing equipments—Raw material for processing. Primary and minimal processing; Processing equipments; Layout and establishment of processing industry; FPO license; Importance of hygiene; Plant sanitation

Unit IV

Quality control—Quality assurance and quality control, TQM, GMP; Food standards- FPO, FFA, etc.; Food laws and regulations; Food safety- hazard analysis and critical control points (HACCP); Labeling and labeling act and nutrition labeling

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Unit V

Value addition—Major value added vegetable products; Utilization of byproducts of vegetable processing industry; Management of processing industry waste; Investment analysis; Principles and methods of sensory evaluation of fresh and processed vegetables

VII. Practical

- Study of machinery and equipments used in processing of vegetable produce;
- Chemical analysis for nutritive value of fresh and processed vegetable;
- Study of different types of spoilage in fresh as well as processed vegetable produce;
- Classification and identification of spoilage organisms;
- Study of biochemical changes and enzymes associated with spoilage;
- Laboratory examination of vegetable products;
- Sensory evaluation of fresh and processed vegetables;
- Study of food standards- National, international, CODEX Alimentarius;
- Visit to processing units to study the layout, hygiene, sanitation and waste management.

VIII. Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

IX. Learning outcome

After successful completion of this course, the students are expected to:

- Appreciate the scope and scenario of vegetable processing in India
- Acquire knowledge about the processing technology of vegetable crops
- Adopting processing products of vegetable crops at small or medium scale
- Adopt processing of vegetable crops as entrepreneur

X. Suggested Reading

Arthey D and Dennis C. 1996. *Vegetable processing*. Blackie/ Springer-Verlag.

Chadha DS. 2006. *The Prevention of food adulteration act*. Confed. of Indian Industry.

Desrosier NW. 1977. *Elements and technology*. AVI Publ. Co.

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Fellow's P. 1988. Food processing technology. Ellis Horwood International.

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Hildegrade H and Lawless HT. 1997. *Sensory evaluation of food*. CBS.

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Mahindru SN. 2004. *Food safety: concepts and reality*. APH Publ. Corp.

Ranganna S. 1986. *Handbook of analysis and quality control for fruit and vegetable products*. 2nd Ed. Tata-McGraw Hill.

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Verma LR and Joshi VK. 2000. *Postharvest technology of fruits and vegetables: handling, processing, fermentation and waste management*. Indus Publ. Co.

I. Course Title : **Postharvest Management of Vegetable Crops**
II. Course Code : **VSC 514**
III. Credit Hours : **(2+1)**

IV. Why this course ?

Vegetables are highly perishable crops as they have great quantity and quality loss after harvest. Hence, they require integrated approach to arrest their spoilage, which causes tonnes of vegetable produce annually. Lack of postharvest awareness and inadequacy of equipments are the major problems in postharvest chain, which lead to a serious post-harvest loss in the developing countries every year. A comprehensive understanding of postharvest factors causing deterioration is necessary to overcome these challenges. Pre and postharvest management such as use of improved varieties, good cultural practices, good pre and postharvest handling practices, management of temperature, relative humidity and storage atmosphere according to crop requirement, use of permitted chemicals, design of appropriate packaging material and storage structures are some of the control measures used in reducing postharvest losses, therefore, this course was customized.

V. Aim of the course

To facilitate deeper understanding of principles and to acquaint the student with proper handling and management technologies of vegetable crops for minimizing the post-harvest losses

The course is organized as follows:

No.	Blocks	Units
1.	Post-harvest management of vegetable crops	I Importance and scope II Maturity indices and biochemistry III Harvesting and losses factors IV Packinghouse operations V Methods of storage

VI. Theory

Unit I

Importance and scope—Importance and scope of post-harvest management of vegetables

Unit II

Maturity indices and biochemistry—Maturity indices and standards for different vegetables; Methods of maturity determination; Biochemistry of maturity and ripening; Enzymatic and textural changes; Ethylene evolution and ethylene management; Respiration and transpiration along with their regulation methods

Unit III

Harvesting and losses factors—Harvesting tools and practices for specific market requirement; Postharvest physical and biochemical changes; Preharvest practices and other factors affecting postharvest losses

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Unit IV

Packing house operations—Packing house operations; Commodity pretreatments chemicals, wax coating, precooling and irradiation; Packaging of vegetables, prevention from infestation, management of postharvest diseases and principles of transportation

Unit V

Methods of storage—Ventilated, refrigerated, modified atmosphere and controlled atmosphere storage, hypobaric storage and cold storage; Zero-energy cool chamber, storage disorders like chilling injury in vegetables

VII. Practical

- Studies on stages and maturing indices;
- Ripening of commercially important vegetable crops;
- Studies of harvesting, pre-cooling, pre-treatments, physiological disorders- chilling injury;
- Improved packaging;
- Use of chemicals for ripening and enhancing shelf life of vegetables;
- Physiological loss in weight, estimation of transpiration, respiration rate and ethylene release;
- Storage of important vegetables;
- Cold chain management;
- Visit to commercial packinghouse, cold storage and control atmosphere storage.

VIII. Teaching Methods/ Activities

- Classroom lectures including ppt.
- Students group discussion
- Individual or group assignments (writing and speaking)
- Presentation of practical handwork

IX. Learning outcome

After successful completion of this course, the students are expected to be able to understand:

- Regulation of postharvest losses by using chemicals and growth regulators
- Pre and postharvest treatments for extending shelf life of vegetable crops
- Packinghouse operations for extending the shelf life of vegetable crops
- Successful storage of vegetable crops

X. Suggested Reading

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