PONDICHERRY UNIVERSITY PUDUCHERRY – 605 014



6th PG BOARD OF STUDIES IN AGRICULTURAL SCIENCES

M.Sc. (Horti.) Vegetable Science REGULATIONS AND CURRICULUM

(Effective from 2022-23 batch onwards)



PANDITJAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE (PAJANCOA&RI) (A Government of Puducherry Institution) KARAIKAL – 609 603

PONDICHERRY UNIVERSITY PUDUCHERRY – 605 014

REGULATIONS AND CURRICULAM

for

M.Sc. (Agriculture/Horticulture)

(Effective from 2022-23)

REGULATIONS

PONDICHERRY UNIVERSITY POSTGRADUATE DEGREE PROGRAMME (Agriculture/Horticulture)

SEMESTER SYSTEM – REGULATIONS

1. SYSTEM OF EDUCATION

- 1.1 The rules and regulations provided herein shall govern Masters degree programmes [M.Sc. (Agri.) or M.Sc. (Hort.)] offered by Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA&RI), Karaikal under Pondicherry University.
- 1.2 The duration of Master's programme is two academic years (4 semesters). The first year of study shall be the first and second semesters after admission. The second year of study shall be the third and fourth semesters.

2. COMMENCEMENT

These regulations shall come into force from the academic year **2022-23**

3. DEFINITIONS

- 3.1 **'PG Coordinator'** means a teacher of a department who has been nominated by the Head of the Department to coordinate the postgraduate programmes in the department. The coordinator looks after registration, time table preparation, regulation of credit load, maintenance of individual student's files, *etc.*,
- 3.2 **'Semester'** means a period consisting of 110 working days inclusive of the midsemester and practical examinations but excluding the study holidays and final theory examinations.
- 3.3 **'Academic year'** means a period consisting of two consecutive semesters including the inter-semester break as announced by the Dean.
- 3.4 **'Curriculum'** is a group of courses and other specified requirements for the fulfillment of the postgraduate degree programme.
- 3.5 **'Curricula and syllabi'** refer to list of approved courses for postgraduate degree programmes wherein each course is identified with a three-letter code, a course number, outline of the syllabus, credit assigned and schedule of classes.
- 3.6 **'Course'** is a teaching unit of a discipline to be covered within a semester having a specific number and credits as detailed in the curricula and syllabi issued by the University.
- 3.7 **'Major Course'** means the subject of Department or discipline in which the student takes admission. Among the listed courses, the core courses compulsorily to be registered shall be given '*' mark.

- 3.8 'Minor Course' means the course closely related to a student's major subject.
- 3.9 **'Supporting Course'** means the course not related to the major course. It could be any course considered relevant for student's research work or necessary for building his/her overall competence.
- 3.10 **'Common course'** means a course which is compulsorily registered by the postgraduate student for the completion of postgraduate degree programme. The marks obtained by the student in a common course will also be taken into account for calculating OGPA.

Some of the common courses are in the form of e-courses/MOOCs. The students may be allowed to register these courses/similar courses on these aspects, if available online on SWAYAM or any other platform. If the student has already completed any of the common courses during UG, he/she may be permitted to register for other related courses with the prior approval of the Head of the Department/Board of Studies.

- 3.11 **'A credit'** in theory means one hour of class room lecture and a credit in practical means two and half hours of laboratory or workshop or field work per week.
 - *Explanation* : A 1+1 course (2 credits) means 1 hour theory and 2.5 hours practical per week.
 - A 0+1 course (1 credit) means 2.5 hours practical per week
 - A 1+0 course (1 credit) means 1 hour theory per week
- 3.12 **'Credit Load'** of a student during a semester is the total number of credits of all the courses including common courses, that a student register during that particular semester.
- 3.13 **'Grade Point'** means the total marks in percentage obtained in a course divided by 10 and rounded to two decimals.
- 3.14 **'Credit Point' means** the grade point multiplied by the credit load of the course.
- 3.15 **'Overall Grade Point Average (OGPA)'** means the total credit point of the courses completed by the student divided by total credits of the courses studied. The OGPA is to be worked out by rounding to nearest two decimals.
- 3.16 **'Arrear examination'** is an examination written for the failed course by a student without undergoing regular classes in that course.
- 3.17 **'Transcript Card'** is the consolidated report of academic performance of a student issued by the University on completion of the curriculum fulfillment. The format of Transcript Card is furnished in *Annexure-1*.

4. **POSTGRADUATE PROGRAMMES**

The list of various postgraduate programmes offered in various dicipline of the College is as follows:

M.Sc. (Agri.) Agricultural Economics
M.Sc. (Agri.) Entomology
M.Sc. (Agri.) Agronomy
M.Sc. (Agri.) Genetics and Plant Breeding
M.Sc. (Agri.) Soil Science
M.Sc. (Hort.) Vegetable Science

5. ADMISSION

5.1 **Eligibility for admission:**

- i. Candidates seeking admission to master degree programme should have a four year bachelor's degree from State Agricultural Universities (SAU) or from other universities recognized by UGC/ICAR.
- ii. Candidate who has undergone the course credit system with an OGPA of 3.00 out of 4.00 or 7.00 out of 10.00 or 70 percent aggregate alone is eligible to apply for various Master's degree programmes in this Institute. Whereas, for SC/ST/PWD candidates the said requirement is an OGPA of 2.50 out of 4.00 or 6.00 out of 10.00 or 60 per cent aggregate. However, this will not apply to State Department nominees. Just a pass in the concerned degree is sufficient for them.
- iii. Prescribed minimum qualification from a recognized University for admission to Master's degree programme:

SI.No.	Discipline	Requirement for Master's Degree			
1.	Agricultural Economics	B.Sc.(Ag./Hort./Agrl. Marketing and			
		Cooperation/Forestry) or B.Sc.(Hons)			
		Agriculture/Horticulture/ Agrl. Marketing			
		and Cooperation/Forestry			
2.	Agronomy	B.Sc. (Ag.) or B.Sc.(Hons) Agriculture			
3.	Entomology	B.Sc.(Ag./Hort./Forestry/Sericulture) or			
		B.Sc. (Hons) Agriculture/Horticulture/			
		Forestry / Sericulture			
4.	Genetics and Plant Breeding	B.Sc.(Ag./Hort./Forestry) or			
		B.Sc. (Hons) Agriculture/Horticulture/			
		Forestry or B.Tech. (Biotechnology)			
5.	Soil Science	B.Sc.(Ag./Hort) or B.Sc. (Hons)			
6.	Horticulture (Vegetable Science)	Agriculture/Horticulture			

5.2 Method of selection:

- i. Candidates shall be required to be present on the specified date for a written test at their own expenses. If selected, they should come prepared to pay fees and get admitted immediately.
- ii. The students will be ranked based on total marks scored by them in the categories mentioned below

Category	Weightage of marks (%)
OGPA in Bachelor's degree programme	50
Entrance	50
Total	100

iii. Written test with objective type (multiple choices) questions in the specific subject will be of one and half hour duration. A minimum of 50% (25 marks) is must for considering the candidate for admission. However, in case of SC/ST candidates, a minimum of 40% (20 marks) is must for considering the candidate for admission into that category. Note: If a SC/ST candidate seeks admission under other categories a minimum of 50% (25 marks) in entrance test is must

- iv. Candidates applied for two subjects should write the examination for both subjects continuously for two hours.
- v. Seats are reserved for candidates belonging to scheduled Castes/Scheduled Tribes/Other Backward Classes as per the norms of Government of Puducherry.
- vi. Two seats of the total sanctioned strength, irrespective of the discipline, are reserved for the in-service candidates of Department of Agriculture and Farmers Welfare, Government of Puducherry.

6. LANGUAGE REQUIREMENT

The medium of instruction is English. The postgraduate students should have adequate knowledge in English to read, write and speak in English and able to prepare high quality research papers in English.

7. RESIDENTIAL REQUIREMENT

- 7.1 The minimum residential requirement for Masters' degree shall be two academic years (four semesters) and the course should be completed within the maximum period of <u>five academic years (ten semesters)</u> from the date of admission.
- 7.2 In case a student fails to complete the degree programme within the maximum duration of residential requirement (five years), his/her admission shall stand cancelled.

8. **REGISTRATION**

The list of courses offered to the student in each semester shall be sent by the Dean to the Controller of Examinations for Registration of examination as instructed by the University from time to time.

9. DISCONTINUANCE AND READMISSION

As per University Regulations.

10. ADVISORY COMMITTEE

10.1 Each Postgraduate student shall have an advisory committee to guide the student in carrying out the programme. Only recognized teachers are eligible for teaching PG courses and guiding thesis research.

10.2 Chairman/Guide:

- i. The approved guides by the Dean of the college only can be the guide for the students.
- ii. Every student shall have a Chairman of the Advisory Committee who will be from his/her major field of studies.
- iii. The Head of the departments will allot the masters students among the recognized guides.
- iv. A teacher should have a minimum of two years of service before retirement for

allotment of Master's students.

v. At any given time, a PG teacher shall not be a chairman of Advisory Committee (including Master's and Ph.D. programmes) for more than five students.

10.3 Chairman/ Co-guide/ Member from other collaborating University/ Institute/ Organization:

- i. The University / Institute may enter into Memorandum of Understanding (MOU) with other Universities / Institutions / Organizations for conducting research.
- ii. The proposed faculty member from the partnering institution can be allowed to act as Co-guide / Member of Student Advisory Committee

Note: In special cases the proposed faculty member from the partnering institution can be allowed to act as Chairperson.

10.4 Members :

- i. The advisory committee shall comprise a Chairman and two members. One member shall be from the concerned department and another member shall be from other department or discipline related to field of thesis research. Staff having UG teaching experience of four years or more may be included as the members of the Student Advisory Committee.
- ii. In thesis topics involving more of inter-disciplinary approach, the number of advisory committee members from other disciplines may be increased by one with prior approval of the Dean.

10.5 **Formation of advisory committee:**

- i. For Master's Programme the advisory Committee Chairman and members will be in the cadre of Professors, Associate Professors and Assistant Professors having three years of experience.
- ii. Only recognized teachers are eligible for teaching PG Courses and guiding thesis research.
- iii. A proposal for the formation of the advisory committee (Form 1) of the student shall be forwarded by the Heads of the Department to the Dean for approval within one month from the commencement of the first semester.

10.6 Changes in advisory committee:

- i. The proposal for changes in the advisory committee (Form 1a) is to be sent to the Dean for approval, if it is keenly felt that such changes are absolutely necessary. The reason for such change should be indicated.
- ii. The changes may be effected immediately, when the existing members are transferred elsewhere or resigned or retired.
- iii. If a guide goes abroad or within India for more than 6 months, to attend any training or on leave for more than six months, the Chairman of the Advisory Committee has to be changed immediately. The same conditions will apply to members also.

10.7 Absence of member during qualifying/final viva-voce examination:

i. Conducting qualifying and thesis final viva voce examination in the absence of

members is not allowed.

- ii. Under extra-ordinary circumstances if the qualifying/final viva-voce examination to postgraduate student has to be conducted in the absence of one or two advisory committee members, permission to conduct the examination by coopting another member in such contingencies should be obtained from the Dean in advance.
- iii. The co-opted member should be from the same department of the member who is not attending the examinations.
- iv. In the absence of the Chairman of advisory committee, respective Heads of Departments should act as Co-Chairman with prior permission of Controller of Examinations.

10.8 **Duties and responsibilities of the advisory committee**:

- i. Drawing the student's academic plan for postgraduate programme.
- ii. Guidance throughout the programme of the student.
- iii. Guiding the student in selecting a topic for thesis research and seminar.
- iv. Evaluation of research and seminar credits.
- v. Correction and finalization of thesis draft
- vi. The members should meet together along with the student for all the above purposes and sign the appropriate documents.

11. PLAN OF COURSE WORK:

The student's plan for postgraduate course work (Form 2) drawn up by advisory committee shall be sent for the approval of the Dean before the commencement of the mid semester examination during the first semester.

12. PROGRAMME OF RESEARCH WORK

The proposal for research programme of the student, in the prescribed format (Form 3) and approved by the advisory committee, shall be sent for approval of the Dean before the end of the semester in which the research credits are registered for the first time or before taking up of the research work whichever is earlier.

13. CREDIT REQUIREMENTS

13.1 **Minimum credit requirement:** A postgraduate student should complete a minimum of 70 credits as detailed below for award of the Master's degree.

Details	Minimum Credits
Major courses	20
Minor courses	08
Supporting courses	06
Common courses*	05
Seminar	01
Research	30
TOTAL	70

* List of Common courses

Course code	Course Title	Credit hour
PGS 501	Library and information services	0+1
PGS 502	Technical writing and communication skills	0+1
PGS 503	Intellectual property and its management in	1+0
	agriculture	
PGS 504	Basic Concepts in Laboratory techniques	0+1
PGS 505	Agricultural research, research ethics and rural	1+0
	development programmes	

- 13.2 **Maximum credit load:** A postgraduate student can register a maximum of 22 credits per semester including common courses, seminar and research. However, research credits registered per semester should not exceed 15.
- 13.3 **Comprehensive qualifying examination and thesis:** A postgraduate student should successfully complete a comprehensive qualifying examination and thesis in the major field of study and submission of thesis thereon.

13.4 Extra Credits:

- i. Over and above the prescribed minimum credit requirements, extra course credits up to a maximum of six can be registered for Master's programme.
- ii. The extra credits registered will be accounted for calculation of OGPA.

14. ATTENDANCE REQUIREMENTS

- 14.1 i. A minimum of 80 per cent attendance separately in theory and practical of the concerned course is a must, failing which the student shall not be permitted to appear for both final theory and final practical examinations in the course concerned and grade 'E' (incomplete) will be awarded.
 - ii. If a student falls short of the required attendance to an extent of 10 per cent or less, the shortage may be condoned by the Dean on the recommendation of the Advisory Committee and the concerned Head of the Department, on the condition that such shortage in attendance was due to unavoidable circumstances (on medical grounds) and such absence was continuous.
- 14.2 The student securing 'E' grade in a course must re-register the course when offered again with the permission of the University.

14.3 Calculation of Attendance

a) THEORY:

- i. Number of classes conducted for a course from the first instructional day as per the time table to the last theory class of that semester is to be construed as the total number of theory classes conducted by the course teacher.
- ii. The mid-semester examinations are normally conducted during class hours.
- iii. The attendance for mid semester examination shall be counted as a theory class for calculating attendance.

b) PRACTICAL:

i. Number of practical classes conducted for a course from the first instructional

day as per the time table to the last practical class of that semester is to be construed as the total number of practical classes conducted by the course teacher.

- ii. The final practical examination will be conducted after the completion of 96 working days as per the schedule.
- iii. The attendance for practical examination shall not be counted for calculating the attendance for practical.
- 14.4 For calculating 80 per cent attendance the number of instructional days may be calculated only from the date of joining of the student for first year first semester only.
- 14.5 The students failing to attend the classes / examinations on non-official ground will be treated as absent.
- 14.6 Students deputed for sports, cultural meets *etc.*, with prior permission of the Dean of the college shall be given attendance for the period of absence. However, students under this category must have attended a minimum of 50 per cent classes in the total theory and practical classes conducted.

15. EVALUATION OF STUDENT'S PERFORMANCE

15.1 **Distribution of marks**:

- i. All students shall abide by the rules for evaluating the course work under the semester system of education, as prescribed from time to time by the university. The weightage of Theory and Practical shall be in the ratio of 80:20 respectively.
- ii. The student should secure a minimum of 50 per cent marks in theory as well as in practical with an aggregate of 70 per cent to secure a pass in a course.
- iii. The student should secure a minimum of 50 per cent marks in the final theory examination conducted by the University for securing a pass in a course.

Examination	Courses with theory and practical	Courses with only theory	Courses with only practical
Mid Semester (Internal)	20	30	30
Term paper (Internal)	10	10	10
Final Theory (External)	50	60	
Final Practical	20		60
TOTAL	100	100	100

iv. In each course, examinations will be conducted for 100 marks as detailed below.

15.2 Mid Semester Examination (Internal Assessment):

- i. Writing the mid-semester examination is a pre-requisite for writing the final theory and final practical examinations.
- ii. Student failing to write mid-semester examination(s), shall not be permitted to attend the classes further in the course(s) concerned and the student will be awarded 'E' grade.
- iii. The mid-semester examinations shall be conducted for a duration of one hour and for 20 or 30 marks.

- iv. The Head of the Department with the help of the concerned PG coordinator shall prepare and announce the schedule of mid-semester examinations.
- v. The mid-semester examinations shall be conducted from the 56th working day of the semester.
- vi. The mid-semester examination shall be conducted and evaluated internally by the concerned course teacher(s).
- vii. The mid-semester examination mark list should be sent by the course teacher to the academic section of the college 10 days prior to the commencement of final practical examinations along with term paper mark.

15.3 Missing Examination:

- i. Missing examination shall be permitted only for mid-semester examination in deserving cases on the recommendation of the course teacher/Chairman and Head of the department and on prior approval by the Dean.
- ii. The missing tests are not allowed for final theory and final practical examinations.
- iii. The student shall write, in advance, to the Dean through the Chairman, PG coordinator and Head of the Department stating the reason for missing the midsemester examination(s). Based on the recommendation of the Chairman, PG coordinator and the Head of the Department, the Dean shall permit the student for missing the mid-semester examination(s).
- iv. A student missing mid-semester examination(s) with the prior approval of the Dean shall be permitted to take up missing examination of the particular course, subject to payment of the prescribed missing examination fee for each missing mid-semester examination.
- v. Students deputed for official programmes of the College/University are exempted from paying the fee for missing test.
- vi. Such missing examinations should be completed outside the regular class hours within 15 working days after the respective examinations.
- vii. Attendance will not be given for taking up missing examinations.

15.4 **Final Theory Examination:**

- i. An examination schedule prepared by the Controller of Examination for the final theory examinations shall be the final. The schedule of examinations shall be adhered strictly.
- ii. The duration of final theory examinations will be two and half hours for courses with theory and practical (50 marks) or three hours for courses with only theory (60 marks).
- iii. The final theory examinations shall be conducted by the University. Evaluated by two examiner, one by internal and one by external. However, in case of Non-credit e-courses, the final theory examination shall be conducted internally by the course teacher.
- iv. In the evaluation process, if deviation is more than 20 per cent between the first and second evaluator, the paper shall be referred to third examiner who shall also be an external examiner.

15.5 Final Practical Examination:

- i. The Dean shall announce the commencement of final practical examinations. The Heads of the Departments shall prepare the schedule for practical examination.
- ii. The final practical examinations shall be conducted after the completion of minimum of 96 working days.
- iii. Submission of bonafide practical records certified by the Course Teacher is a prerequisite for appearing in a practical examination failing which 'F' grade will be awarded.
- iv. For conducting final practical examination in each course, an *external examiner* (faculty of the Department other than the course teacher) shall be nominated by the Dean and the course teacher will be the *internalexaminer*.
- v. In the event of external/internal examiner nominated for practical examination could not conduct the examination, then the Dean shall nominate an alternative examiner to conduct practical examination.
- vi. The duration of final practical examination shall be two and half hours.
- vii. The practical examinations shall be jointly conducted by the internal and external examiners with mutual co-operation.
- viii. They shall evaluate the candidates appearing at the examination according to their performance and the Forms so prepared shall be signed by both the examiners.
- ix. The practical examination marks should be communicated to the University/ uploaded in the university website within 10 days after conduct of examination duly signed by all the examiners and hard copy forwarded to the university thereon.

15.6 Arrear examination:

- i. Arrear examination is permitted for the final theory and final practical examinations only.
- ii. The students are permitted to write the arrear examinations as and when conducted by the University.
- iii. A student is permitted to write the final theory and practical examinations only two times during 5 years duration excluding the regular final examination (Mid-semester marks and Term paper marks shall be retained as such).
- iv. In the event of a student failing to secure pass in the two arrear examinations permitted, he/she has to re-register the course along with the juniors as and when the course(s) are offered with the permission of the University and on payment of the prescribed fees.

15.7 **Evaluation of course**:

- i. Each course shall carry a maximum of 100 marks. The results of the course shall be indicated by the grade points ranging from 0 to 10.
- ii. The total marks in percentage obtained by the student in a course shall be divided

by 10 and rounded to two decimal places to get the grade point.

- iii. The minimum Grade Point to be secured for the successful completion of a course shall be 7.00.
- iv. In case of courses with theory and practical, minimum of 50 per cent mark separately in theory and practical with an aggregate of 70 per cent is essential.
- v. Securing a grade point less than 7.00 in a course will be treated as 'F' (Failed) and the Grade Point will be 0.00 for calculating the GPA/OGPA. The following symbols may be used
 - E INCOMPLETE (Lack of 80 per cent Attendance/other reasons)
 - F FAILED

15.8 Question paper pattern for theory examinations :

15.8.1 The question paper pattern for mid semester (internal) examinations are indicated below:

Part	Type of question	Number of questions	Number of questions to be answered	Mark per question	Total marks		
	Courses with theo	ry and practic	al (1+1 or 2+1 co	ourses)			
	(20 M	arks & 1 hour	duration)				
А	Objective*	20	20	0.5	10		
В	Definitions/Concepts	12	10	1.0	10		
	TOTAL				20		
	Courses with only theory (1+0 or 2+0 courses)						
	(30 Ma	arks & 1½ hou	r duration)				
А	Objective*	30	30	0.5	15		
В	Definitions/Concepts	18	15	1.0	15		
	TOTAL				30		
Courses with only practical (0+1 courses)							
(30 Marks & 1½ hour duration)							
А	Objective*	30	30	0.5	15		
В	Definitions/Concepts	18	15	1.0	15		
	TOTAL				30		

* Questions should be Fill-up the blanks, Choose the best among four options, True / False or Match the following type with equal number of question in each type and one or two more questions in any one type if examination is conducted for 30 marks

Part	Type of question	Number of questions	Number of questions to be answered	Mark per question	Total marks		
	Courses with theory and practical (1+1 or 2+1 courses)						
	(50 M	arks & 2.5 hc	ours duration)				
А	Objective (MCQ's only)	20	20	0.5	10		
В	Definitions/Concepts	12	10	1.0	10		
С	Paragraph answers	7	5	2.0	10		
D	Essay type answers	5	5	4.0	20		
	(<u>EITHER OR </u> type) - One						
	main question from each						
	unit shall have one choice						
	TOTAL				50		
	Courses with only theory (1+0 or 2+0 courses)						
	Final Theory Examina	ation (60 Mar	ks & 3.0 hours du	, ration)			
Α	Objective (MCQ's only)	20	20	0.5	10		
В	Definitions/Concepts	18	15	1.0	15		
C	Paragraph answers	7	5	2.0	10		
D	Essay type answers	5	5	5.0	25		
	(<u>EITHER OR </u> type) - One						
	main question from each						
	unit shall have one choice.						
	TOTAL				60		

15.8.2 The question paper	pattern	final theory	(external)	examinations	are indicated below:
13.0.2 me question paper	pattern	mar theory	(CALCI Hal)	chaimations	

15.9 **Question paper pattern for final Practical Examination**: The following distribution of marks shall be adopted in conducting the final practical examinations.

Details	Courses with Theory and Practical	Courses with only Practical
Practical Field work / Lab Work / Written exam	20 (2.5 hrs)	60 (3 hrs)
Total	20	60

For conducting practical examinations, the type and number of questions can be decided by the concerned internal and external examiners. Choice may be given to the extent of 20 per cent under subjective type questions.

15.10 Term Paper:

- i. Submission of a term paper by the students is a must.
- ii. The term paper topics shall be assigned by the course teacher. Term papers should cover a wide range of subjects within the course limits.
- iii. The term paper shall be evaluated by the course teacher.

15.11 Return of evaluated answer papers:

i. The evaluated answer papers of mid-semester shall be shown to the students after the examination. Discrepancies if any, in awarding marks, the student can approach the teacher concerned immediately for rectification. ii. The answer paper should be retained by the course teacher for 6 months or declaration of results by Pondicherry University, whichever is earlier and then disposed off.

16. COMPREHENSIVE QUALIFYING EXAMINATION

- 16.1 i. Only those postgraduate students who successfully complete the comprehensive qualifying examination shall be admitted to candidacy of the degree.
 - ii. The qualifying examination consists of written and oral examination in major subjects only and the students should be allowed after completion of 80 per cent of total course credit load including major and minor courses.
 - iii. The qualifying examination shall be conducted only in the major courses as per the norms given below:

Question paper setting	-	External
Evaluation of answer book	-	External
Qualifying marks	-	60 per cent
Viva Voce	-	External
Grading	-	Satisfactory/Not Satisfactory

16.2 Selection of examiner:

- i. The Head of the concerned PG Department shall send a panel of examiners for conducting the qualifying examination (Form 4). However, the University can draw its own panel of examiners.
- ii. The panel of examiners for qualifying examinations shall be given three months before the date of completion of the student's course work.

16.3 Written examination:

- i. Normally the qualifying examination shall be completed before the end of third semester of the postgraduate programme.
- ii. The controller of examination shall conduct the qualifying written examination
- iii. The written examination shall be conducted for major courses only.
- iv. The question paper for the written examination shall be of 3 hours duration and each question need not be restricted to any particular topic in a course but it should be a comprehensive of the syllabus of each course.
- v. The question paper pattern for the written examination is given below.

Part	Type of question	Number of questions	Number of questions to be answered	Mark per question	Total marks
А	Paragraph answers	7	5	5	25
В	Essay type answers	7	5	15	75
				TOTAL	100

16.4 **Oral examination**:

i. Only those students who secure 'SATISFACTORY' grade in written qualifying

examination shall be permitted to attend the oral qualifying examination

- ii. The advisory committee shall conduct the oral examination with one external examiner, who sets the question paper for the written qualifying examination.
- iii. The performance of the student(s) in the qualifying viva-voce examination shall be graded as "Satisfactory" or "Not satisfactory".
- iv. If the performance of the student is "Not Satisfactory" in the oral examination, he/she has to appear for the oral examination again.

165 **Communication of results of qualifying examination**:

- i. The Chairman of the advisory committee shall act as Chairman for the examination committee.
- ii. The Chairman of the advisory committee shall be responsible for communicating the results of the examination to the Controller of Examinations in the prescribed format (Form 5).

16.6 **Failure/absence in qualifying examination**:

- i. A student is permitted to write the qualifying examination only three times including the regular attempt.
- ii. A student who fails or absents in the comprehensive qualifying written/viva-voce examination shall apply to the University with the recommendation of the Chairman of the advisory committee, Head of the Department and the Dean for re-examination.
- iii. A student who applies for re-examination should attend written examination and viva-voce after paying the prescribed re-examination fee.
- iv. Re-examination shall not take place earlier than three months after the previous qualifying examination.
- v. If a student fails even in the second re-examination (third attempt), he/she cannot continue as a student in the University for Award of Master's degree in the University.
- vi. The research credits registered in the final semester shall not be evaluated unless he/she successfully completes the qualifying examination.

17. CREDIT SEMINAR

- 17.1 Seminar is compulsory for all the postgraduate students and each postgraduate student should register and present one seminar with 0+1 credit.
- 17.2 Registration of seminar credits is not allowed in the first semester.

17.3 Seminar topic:

- i. The seminar topic should be only from the major field and should not be related to the area of thesis title.
- ii. The seminar topics are to be assigned to the students by the Chairman at the beginning of the semester in which he/she registers seminar credits and the progress made by the student should be monitored.

17.4 **Evaluation of seminar**:

- i. The students should prepare a seminar paper after reviewing all the available literature and present the seminar after completion of 80 per cent attendance in the semester in the presence of the Advisory committee, staff and postgraduate students of the concerned department.
- ii. The circular on the presentation of the seminars by the postgraduate students may be sent to other departments to enable those interested to attend the same.
- iii. After carrying out the corrections/suggestions, the student should submit two copies of the seminar papers, one to the Chairman and the other to the department.
- iv. The performance of the student in the credit seminar has to be evaluated for 100 marks by the Advisory Committee. Grade Point may be given based on the following norms:

Particulars	Marks
Coverage of literature	40
Presentation	30
Use of audio-visual aids	10
Capacity to participate in discussion and answer the questions	20
TOTAL	100

- 17.5 The students who fail to present the seminar must be awarded 'F' grade and the student should again register the seminar credits and present the seminar in the subsequent semester. The minimum of 80 per cent attendance requirement for presenting the seminar after re-registration need not be insisted.
- 17.6 Presenting a seminar is a must for the award of the degree.

18. THESIS RESEARCH

18.1 Selection of topic:

- i. With the guidance of the advisory committee the students should identify the tentative area of research and include it in the plan of work.
- ii. The advisory committee should guide the students in selecting a specific topic in the identified research area and for preparing a detailed proposal. While selecting the topic for thesis research, the specialization and competency of teachers, thrust area identified by the department, external funded schemes operated in the department and also the aptitude of the student may be taken into consideration.
- iii. The topic for thesis research for the students of Master's programme should be of such a nature as to indicate a student's potentialities for conducting research and to train him in research.
- iv. The thesis shall be on a topic falling within the field of the major specialization and shall be the result of the student's own work.
- v. A certificate to this effect duly endorsed by the Chairman of the Advisory Committee shall accompany the thesis.

18.2 **Research proposal:**

- i. The research proposal has to be presented by the student in a meeting organized by the Head of the department to get the opinion/suggestions of the teachers of the department for improving it.
- ii. Three copies of the research proposal in the prescribed format (Form 3) should be sent to the Dean through the Head of the department for approval before the end of the semester in which the student has registered research credits for the first time or before taking up the field / laboratory experiments whichever is earlier.

18.3 **Evaluation of thesis research**:

- i. After assigning the research problem, for each semester the student has to submit a detailed programme of work to be carried out by him/her during the semester in the prescribed proforma (Proforma-1). After scrutiny and approval, a copy of the programme has to be given to the student for carrying out the work during the semester.
- ii. Attendance register must be maintained in the department for all the PG students to monitor whether the student has 80 per cent of attendance in research.
- iii. After completion of 80 per cent attendance for research and on or before the last day of the semester, the advisory committee should evaluate the progress of research work as per the approved programme and award 'SATISFACTORY or NOT SATISFACTORY' depending upon quantity and quality of work done by the student during the semester. The procedures of evaluating research credits under different situations are explained hereunder.
 - a. SITUATION I: The student has completed the research credits as per the approved programme and awarded 'SATISFACTORY' by the advisory committee. Under the said situation the student can be permitted to register fresh block of research credits in the subsequent semester. If the student is awarded 'NOT SATISFACTORY' he/she has to reregister the same block of research credits in the subsequent semester.
 - **b. SITUATION II**: If the student has not secured the minimum attendance of 80 percent, then the grade 'E' should be awarded. The student has to reregister the same block of research credits for which 'E' grade was awarded in the following semester with prior permission from the University. Until the completion of reregistered credits, the student should not be allowed to register for fresh block of research credits.
 - **c. SITUATION III**: The student could not complete the research work as per the approved programme of work for reasons beyond his/her control such as,
 - Failure of crop.
 - Non-incidence of pests or disease or lack of such necessary experimental conditions.
 - Non-availability of treatment materials like planting materials chemicals, *etc*.
 - Any other impeding/unfavorable situation for carrying out research.

Under the said situations III, Grade 'E' should be awarded. The student has to

reregister the same block of research credits for which 'E' grade was awarded in the following semester with prior permission from the University. Until the completion of re-registered credits, the student should not be allowed to register for fresh block of research credits.

- **d. SITUATION IV:** When the student failed to complete the work even in the 'Second time' registration, the student will be awarded '**NOT SATISFACTORY'** and he/she has to reregister the same block of research credits in the subsequent semester with the prior permission from the University.
- e. SITUATION V: If a student can not complete qualifying examination till the end of final semester, the research credits registered in the final semester shall not be evaluated unless he/she successfully completes the qualifying examination. The research credits registered by the student during the final semester shall be evaluated within 15 days from the date of declaration of result of the qualifying examination.
- f. SITUATION VI: If a student secures 'F' grade in one or more course(s) and can not complete the course(s) till the end of final semester, the research credits registered in the final semester shall not be evaluated unless he/she successfully completes the course(s) in which he/she secures 'F' grade. The research credits registered by the student in the final semester shall be evaluated within 15 days from the date of declaration of result of the failed course(s). If the student fails to complete the course even in 1+2 attempts, 'E' grade shall be awarded for the research credits registered in the final semester and the student has to re-register the same block of research credits along with the re-registration of failed courses, with the approval of the University
- 18.4 **Re-registration of research credits**: Students have to obtain prior permission of the University for re-registering the research credits. However, the University can permit the registration of research credit only three times. Permission to register for the fourth time shall be given only by the Academic Council.

19. SUBMISSION OF THESIS

- i. The research credits registered in the last semester of postgraduate programmes should be evaluated only at the time of the submission of thesis by the advisory. committee. Students can submit the thesis at the end of the final semester. The list of enclosures to be submitted along with the thesis is furnished in *Annexure-2*.
- ii. If a postgraduate student has completed the thesis before the closure of the final semester, the Chairman can convene the advisory committee meeting and take decision on the submission of the thesis provided the student satisfies 80 per cent attendance requirement.
- iii. Copy of the thesis to be sent for evaluation should be submitted in paper pack.
- iv. After incorporating the suggestions of the examiners and those received at the time of viva-voce, the thesis should be submitted to the College/university in hard bound copies (four copies) and soft copies (in pdf format) in CDs (two copies).
- v. During submission of thesis for external evaluation, it is mandatory to enclose

certificates for plagiarism check and reference management (Proforma-12). Maximum of 20% plagiarism is permitted.

19.1 **Grace period:**

- i. Students can avail a grace period upto three months for submission of thesis after the closure of final semester by paying prescribed fine to the University.
- ii. If a student is not able to submit the thesis within three months grace period, the student has to re-register the credits in the forthcoming semester.
- iii. The student who re-register the credits after availing the grace period will not be permitted to avail grace period for the second time.
- iv. The Heads of the Departments can sanction the grace period based on the recommendation of advisory committee and a copy of the permission letter along with the receipt for payment of fine should accompany the thesis while submission.
- 19.2 **Re-registration and submission of thesis:** The minimum of 80 per cent attendance requirement for submitting the thesis after re-registration need not be insisted for those students who have fulfilled the minimum academic and residential requirement *i.e.* 2 years (4 semesters) and completed the minimum credit requirements with 80 per cent attendance.
- 19.3 **Publication of articles:** Part of thesis may also be published in advance with the permission of the Chairman. If any part is published, the fact should be indicated in the certificate given by the Chairman that the work had been published in part/ full in any referred scientific or popular journals, proceedings, *etc*.

20 EVALUATION OF THESIS

- 20.1 The thesis submitted in partial fulfillment of a Master's degree shall be evaluated by an external examiner nominated by the Controller of Examinations. However, the Dean can send panel of three examiners (Form 6).
- 20.2 An oral examination will be conducted by the Advisory Committee after the thesis is recommended by the external examiner and carrying out the corrections/suggestions made by the external examiner by the student.
- 20.3 The Chairman of the advisory committee shall communicate the date of final thesis viva-voce examination to the student and advisory committee members. The thesis final viva-voce examination shall be completed within three months from the date of receipt of the report from the external examiner.
- 20.4 The Chairman shall send the recommendations of the advisory committee (Form 7) along with necessary certificate/documents in duplicate to the University.
- 20.5 i. In case, the External examiner does not recommend the thesis for the award of the degree, the advisory committee may send their recommendation for scrutiny of the thesis by another external examiner, through the Dean to Controller of Examinations within one month from the date of receipt of the thesis. The Controller of Examinations may, on the recommendation of the advisory committee and Dean, refer the thesis for scrutiny and independent judgment to a second external expert chosen by him.

- ii. If the second external expert recommends the thesis for acceptance, this recommendation may be accepted.
- iii. If the second examiner also does not recommend the thesis for acceptance, the degree shall not be awarded.

21 REVISION OF THESIS

- 21.1 If an examiner recommends for revision of thesis the following norms will be adopted.
 - i. For revision of draft, the thesis should be resubmitted after a minimum of one month from the date of communication from the Dean.
 - ii. If the revision is recommended for repeating lab experiments, field trial *etc*, resubmission must be after a minimum period of six months.
- 21.2 At the time of resubmission, the advisory committee should give a certificate for having carried out the corrections/recommendations. The resubmitted copies of thesis should have incorporated the necessary corrections as indicated by the external examiners.

22 FAILURE TO APPEAR FOR FINAL VIVA/NON-SUBMISSION OF THESIS AFTER VIVA

If a candidate fails to appear before the examining committee for final thesis vivavoce, on the date fixed by the Chairman the following are the time-frame and penalty.

- 22.1 The thesis viva-voce must be completed within **five years from the date of first registration** for Master's programmes. The prescribed penalty/fine must be charged to the candidate.
- 22.2 After successful completion of thesis final viva voce, if a student fails to submit the corrected version of the thesis within 15 days he/she will be levied a fine at the time of sending the proposal for result declaration.

23 MALPRACTICES IN EXAMINATION AND MISCONDUCT OF STUDENTS

- 23.1 The Dean of the College shall be responsible for dealing all cases of unfair means by students in writing records, term papers and mid-semester examinations.
- 23.2 In case of final theory and final practical examination, the cases of malpractice will be dealt as per Chapter XV (A) of the Academic Ordinance of the University.
- 23.3 **Ragging rules:** Students found involved in ragging will be dealt as per the orders of the Supreme Court of India. The matter shall be reported to the University.
- 23.4 **Unlawful activities:** In case of students found involved in any unlawful activities either within or outside the Hostel/College Campus, besides, expulsion both from the Hostel and College at the discretion of the Dean, the matter will be reported to the Police of the jurisdiction to be dealt with, in accordance with the appropriate law in force. The matter shall be reported to the University.
- 24 The schedule for the important records to be sent to the Dean is furnished below and should be followed strictly so as to get back the above academic reports in time for maintenance in the students file.

SI.	Particulars	Time Schedule
NO.		
1	Formation of advisory	Within one month of the commencement
	committee (Form 1)	of first semester
2	Plan of course work	Before the commencement of mid
	(Form 2)	semester examination in the first semester
3	Programme of research work	Before the end of the semester in which
	(Form 3)	the student registers the research credit for
		the first time or the commencement of the
		research work whichever is earlier.
4	Proposal for qualifying	Two months before the completion of the
	examination (Form 4)	course work.
5	Qualifying examination result	Immediately
	(Form 5)	
6	Panel of external examiners	Three months before the probable date of
	for thesis evaluation (Form 6)	submission of thesis
7	Final viva-voce result (Form 7)	Fifteen days from the examination

25 AWARD OF DEGREE AND ISSUE OF TRANSCRIPT CARD

- 25.1 **Eligibility for the Award of the Degree:** The successful completion of all the prescribed courses included in the Curricula and Syllabi shall be minimum requirement for the award of the Degree.
- 25.2 **Class Ranking**: In calculation of Class equivalent for OGPA the following classification will be adopted. First class with Distinction and first class shall be awarded to those students who have completed the course without arrear and all others shall be awarded second class

OGPA	Class
9.00 and above	First class with Distinction
8.00 to 8.99	First class
7.00 to 7.99	Second Class

25.3 **Percentage conversion**: For obtaining the percentage equivalent to the OGPA, the OGPA secured by the student shall be multiplied by 10.

25.4 Transcript card:

- i. The Transcript card shall contain entry of all the courses and the Grade Points and OGPA obtained by the candidates indicating the number of times appeared. This will have to be prepared for all the students by the Controller of Examinations.
- ii. For preparation of Transcript card, the Dean should send recent passport size photograph of the students along with filled in proforma and the prescribed fee.

26 **REMOVAL OF DIFFICULTIES:**

26.1 If any difficulty arises in giving effect to the provisions of these regulations, the Vice-Chancellor may issue necessary orders which appear to him to be necessary or expedient for removing the difficulty.

- 26.2 Every order issued by the Vice-Chancellor under this provision shall be laid before the Academic Council of the University in the next meeting after the issuance.
- 26.3 Not-withstanding anything contained in the regulations, the Board of Studies or Academic Council reserve the right to make changes whenever necessary.

27. REGULATIONS GOVERNED BY PAJANCOA & RI

27.1 ADMISSION

27.1.1 Application for admission:

- i. Application for admission shall be made in the prescribed form to be downloaded from the website of the college (<u>www.pajancoa.ac.in</u>) after notification is issued to this effect.
- ii. The admissions shall be regulated and made in accordance with the admission rules and regulations in force.
- iii. Candidates seeking admission to the various Postgraduate degree courses are permitted to apply for only two subjects. Separate applications should be used for each course.

27.1.2 Admission procedure:

- i. The admission is based on the merit category of the candidate and availability of vacancies at the time of counseling.
- ii. All admissions made by this Institute are provisional and subject to the approval of the University.
- iii. The candidates who have offered admission should report to the college on or before the due date mentioned failing which their right of admission is forfeited

27.2 FEE STRUCTURE

- 27.2.1 Fee structure is being revised every year with 10% fee hike. Lodging fees and charges for electricity, water and computer are revised based on the requirements and power tariff prevailing from time to time.
- 27.2.2 In the case of new admissions, the fees for the first semester should be paid at the time of admission.
- 27.2.3 For the remaining semesters, the fees should be paid on the date of registration of the semester.
- 27.2.4 Candidates who discontinue after admission are not eligible for refund of fees except caution money deposit.
- 27.2.5 In case of a student who re-registers with junior batch, he/she has to pay the semester fess applicable to the junior batch in which he/she registers, besides the re-registration fee.

27.3 REGISTRATION

27.3.1 All newly admitted candidates should register during the first semester of the programme. A candidate admitted to the Postgraduate programme should report to the Head of the Department concerned on the date of registration. It is the

responsibility of the candidate to register the courses in person on the due date prescribed for the purpose.

- 27.3.2 **In ABSENTIA** registration will not be permitted on any circumstances.
- 27.3.3 The Head of the Department and the PG coordinator shall help the student in selecting the courses for registration.
- 27.3.4 Admitted candidates shall register with the respective Department at the beginning of each semester and this should be completed within two working days.

27.3.5 Late registration:

- i. Late registration is permitted by the Dean of college within seven working days from the commencement of the semester provided the prescribed late registration fee is paid before registration.
- ii. Registration beyond seven working days is not allowed except for new entrants who are admitted late due to administrative reasons in the first semester.

27.3.6 Registration cards:

- i. A student shall register the courses offered in a semester by writing all the courses in registration card in quadruplicate. The format of registration card is given in *Annexure-4*.
- ii. The Chairman, PG coordinator and Head of the Department are responsible to furnish the registration particulars of the students with their signature in the Registration card to the Dean.
- iii. The Dean shall approve the registration cards.
- iv. The approved registration cards shall be maintained by the Dean, PG coordinator, Chairman and the student concerned.
- v. The list of courses registered by the students in each semester shall be sent by the Dean to the Controller of Examinations/University for preparation of Report Cards
- 27.3.7 The mess dues clearance certificate has to be produced by the student at the time of registration.

27.4 ARREAR EXAMINATION:

- i. The prescribed arrear examination fee should be paid on or before the specified date.
- ii. The Registration for the arrear examination shall be done on the date specified by the Dean. Each registration is considered as an attempt even if the student is absent for the examination.

27.5 QUALIFYING EXAMINATION

The Heads of departments will monitor and coordinate the conduct of both the written and oral qualifying examinations.

27.6 SUBMISSION OF THESIS

The research credits registered in the last semester of postgraduate programmes

should be evaluated only at the time of the submission of thesis by the advisory committee. Students can submit the thesis at the end of the final semester. The list of enclosures to be submitted along with the thesis is furnished in *Annexure-5*.

27.7 REVISION OF THESIS

The prescribed fine for late submission of revised thesis may be collected from the students submitting thesis beyond the due date with the recommendation of the Chairman. The Dean shall ensure that the delay is due to the fault of the student.

27.8. MERIT SCHOLARSHIP/RESEARCH ASSISTANTSHIP

- 27.8.1 PAJANCOA & RI PG fellowship shall be awarded to all the students who are admitted into the Masters programme based on allotment of Government fund. The PG students should be a resident of PAJANCOA & RI hostels. The award of PG fellowship is governed by the approved PG fellowship rules.
- 27.8.2 The Dean shall call for applications and sanction the scholarship every year.
- 27.8.3 The students availing any scholarship/fellowship are permitted to switch over to other fellowship/scholarship only one time during the course of study.

27.8.4 Student SRF/JRF:

- i. The selection of student SRF/JRF in external funded schemes will be made by the existing committee members for selection of regular SRF/JRF.
- ii. The PG coordinator of the concerned department will be an additional member of the committee.
- iii. The panel of names after the selection has to be sent to the Dean for approval in the prescribed Proforma.
- iv. If a student SRF/JRF discontinues before submitting the thesis or switch over to other fellowship/scholarship, the amount already paid has to be recovered in full in one lump sum with 6% penal interest.

27.9 RECOGNITION OF POSTGRADUATE TEACHERS

- 27.9.1 The Dean normally recognizes teachers for offering courses and guiding the students of Master's programme based on the request of teachers and the recommendation of Head of the department.
- 27.9.2 The recognized PG teachers shall offer courses to masters students as required by the concerned Heads of departments, normally, in their own field of specialization unless extra-ordinary circumstances demand for offering other courses.
- 27.9.3 All the recognized guides for Master's programme are competent to guide research work of Master's degree students in their own fields of specialization. The Heads of departments shall assign students to the recognized guides taking into account their specialization. The students should be uniformly distributed instead of all of them taking research topics in one or two specialized branches in the department.
- 27.9.4 **Teachers for Master's programme:** The following faculty shall be recognized as PG teachers for Master's programme

- i. Professors
- ii. Associate Professors
- iii. Assistant Professors: Persons having Ph.D. degree with one year of active experience in the concerned field (or) Persons having a Master's degree with three years of active experience in the field. In case of contingencies, like start of new PG programme, persons having Ph.D. degree in the concerned field may be recognized as PG Teacher.
- 27.9.5 **Guides for Masters programme:** PG Teachers after handling PG courses in two semesters are eligible to guide M. Sc. students. In case of contingencies, like start of new PG programme, persons having Ph.D. degree in the concerned field may be recognized as PG Guide.
- 27.9.6 The Heads of departments will forward the proposals based on the qualification and experience of the teacher as given above. The proposals can be sent when there is acute need for teachers/guide in the prescribed format, given in the *Annexure-6*.
- 27.9.7 While forwarding the application the Head of the Department should consider the seniority of the teacher, number of courses handled and number of research schemes operated.

27.10 GUIDELINES FOR HEADS OF THE DEPARTMENTS IN MONITORING PROGRESS OF POSTGRADUATE STUDENTS

27.10.1 **Student records:** The "Individual student" file (clip file) containing all the academic records of the student concerned with students bio-data shall be maintained by the PG coordinator on behalf of the Institution. In each file a sheet containing the following information has to be attached.

i)	Date of registration	:
ii)	Date of qualifying examination	:
iii)	Due date for thesis submission	:
iv)	Date of submission of thesis	:
v)	Date of viva-voce	:
vi)	Remarks	:

27.10.2 The activities listed out in the following table must be meticulously taken care by the Professor and Head of the Department concerned

SI.No.	Particulars	Time Schedule
1	List of courses to be offered	A week before the commencement of each
	along with time table	semester
2	Course registration particulars	Within 10 working days from the date of
		commencement of each semester
3	Time table for mid-semester	A week before the scheduled date for the
	examinations	examinations notified in the academic
		calendar
4	Mark lists after completing	Within 10 days from the date of conduct of
	examinations	examinations
5.	Class grade chart	Within 7 days from the date of closure of
		each semester

- 27.10.3 The time table for various examinations and evaluations of research credits should be prepared in advance as indicated in the academic calendar of semester concerned and such dates already fixed should not be postponed or changed subsequently.
- 27.10.4 The Heads of the Departments should monitor the progress of the postgraduate students. Each department should maintain a list of thesis produced so far with the abstract of the same in both hard and soft copies.

Form – 1 PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICUL/TURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

FORMATION OF ADVISORY COMMITTEE

(To be sent in triplicate within one month from the commencement of First semester)

- Name of the student :
 Registration No. :
 Degree :
 Subject :
- 5. Advisory committee :

SI.	Advisory	Name, Designation and	Date of	Signature
No.	Committee	Department	Retirement	
1	Chairman			
2	Member 1			
	Member 2			
3	Additional			
	Member			

:

6. Reason for additional member

Signature of the student

PG coordinator

Head of the Department

DEAN

* Additional members may be included only in the allied faculty related to thesis research with full justification at the time of sending proposals (Programme of research) to the Dean for approval.

Form – 1a PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

CHANGE IN ADVISORY COMMITTEE (To be sent in triplicate)

1.Name of the student:2.Registration No.:3.Degree:4.Subject:5.Proposed change:

		Name and designation	Date of retirement	Signature
a.	Existing Chairman/ member			
b.	Proposed Chairman/ member			

6. Reasons for change :

Signature of the student

Chairman of the Advisory Committee

PG coordinator

Head of the Department

DEAN

Form – 2 PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICUL/TURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

PLAN OF COURSE WORK

(To be sent in triplicate before the commencement of mid semester examinations in the first semester)

Name of the student
 Registration No.
 Degree
 Subject
 Course Programme

S. No	Course No	Course Title	Credit Hour
		MAJOR COURSES	
		MINOR COURSES	
		SUPPORTING COURSES	
		NON-CREDIT COURSES	
		SEMINAR	
		RESEARCH	
		TOTAL	

:

6. Tentative area of research (indicate the major field of specialization)

Signature of the student

APPROVAL OF THE ADVISORY COMMITTEE

Advisory committee	Name	Signature
Chairman		
Members	1.	
	2.	
	3.	

PG coordinator

Head of the Department

Form – 3 PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

PROGRAMME OF RESEARCH WORK

(To be sent in triplicate before the end of the semester in which the student registers research credit for the first time or the commencement of research work whichever is earlier)

1.	Name	:
2.	Registration No.	:
3.	Degree	:
4.	Subject	:
5.	Date of joining	:
6.	Title of the research project	:
7.	Objective(s)	:
8.	Duration	:
9.	Location (campus/station)	:
10.	Review of work done	:
11.	Broad outline of work/methodology	:
12.	Semester wise break up of work	:

Signature of the student

APPROVAL OF THE ADVISORY COMMITTEE

Advisory committee	Name	Signature
Chairman		
Members	1.	
	2.	
	3.	

PG coordinator

Head of the Department

Form – 3a PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICUL/TURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

CHANGE IN PROGRAMME OF RESEARCH

(To be sent in triplicate)

Name	:
Registration No.	:
Degree	:
Subject	:
Reason for change	:
Proposed change in the approved	: programme of research
Number of credits completed so far	: under the approved programme
a) Whether already earned credits are	: to be retained or to be deleted
b) If retained, justification	:
	Registration No. Degree Subject Reason for change Proposed change in the approved Number of credits completed so far a) Whether already earned credits are b) If retained, justification

Signature of the student

APPROVAL OF THE ADVISORY COMMITTEE

Advisory committee	Name	Signature
Chairman		
Members	1.	
	2.	
	3.	

PG coordinator

Head of the Department

Form – 4 PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICUL/TURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

PROPOSAL OF QUALIFYING EXAMINATION

(To be sent in triplicate)

1.	Name of the Department	:
2.	Degree	:
3.	Subject	:
4.	Whether all the courses have been completed	:
5.	Number of credits completed	:
6.	Whether the students have an OGPA of not less than 7.00/10.00	:

 List of PG students appearing for qualifying examination

SI. No.	Name	Registration No.	OGPA

:

8. Panel of External examiners :

SI. No.	Name and Designation	Address	Area of specialization
1.			
2.			
3.			

:

9. Remarks

PG coordinator

Head of the Department

DEAN

Form – 5 PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

COMMUNICATION OF RESULT OF QUALIFYING EXAMINATION

(To be sent in triplicate)

- Name of the student 1. : 2. **Registration No.** : 3. Degree • 4. Subject : 5. Date of examination : 6. Date of previous examination : (only in case of re-examination)
- 7. Result (Successful/ Not successful*) :

(*) to be written by the external examiner

EXAMINATION COMMITTEE

	Name in block letters	Signature
Chairman		
Members	1.	
	2.	
	3.	
External Examiner		

Signature of Chairman with name and designation

PG coordinator

Head of the Department

DEAN

Form – 6 PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

PROPOSAL OF EXTERNAL EXAMINERS FOR THESIS EVALUATION (To be sent in duplicate in Confidential cover)

:

:

:

:

:

- 1. Name of the student :
- 2. Registration No.
- 3. Degree
- 4. Subject
- 5. Thesis title :
- 6. Name of the Chairman :
- 7. Panel of external examiners*

SI. No.	Name and Designation	Address	Area of
1.			specialization
2.			
3.			

*Three external examiners should be given

8. Remarks

.

Signature of the Chairman of the advisory committee

Form – 7 PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

RESULT OF FINAL THESIS VIVA-VOCE EXAMINATION

(To be sent in duplicate)

1.	Name of the student	:	
2.	Registration No.	:	
3.	Degree	:	
4.	Subject	:	
5.	Thesis title as in final copy of the thesis	:	
6.	Date and time of <i>viva-voce</i>	:	
7.	Particulars of the External examiner(s)	:	

who has/have evaluated the thesis

Name and Designation of the External Examiner	Remarks of the External Examiner
	RECOMMENDED /
	RECOMMENDED FOR REVISION
	/ NOT RECOMMENDED

8. Recommendation of the Examining committee present at the time of final *viva voce* examination:

a. Recommends/ does not recommend unanimously the award of degree

b. The performance of the candidate in final *viva voce* is assessed as ______(very good/ good/ satisfactory/ not satisfactory)

SI. No.	Capacity of examiner	Name in block letters	Signature
1.	Chairman/Co-opted Chairman*		
2.	Member 1.		
3.	2.		
4.	Additional member		
5.	Co-opted member*		

* If co-opted in the absence of Chairman/Member

The original report(s) from the external examiner(s) is/ are enclosed

Head of the Department

Chairman of the Examining committee / Advisory committee with designation
DETAILS ON FEE TO BE PAID BY THE STUDENT

SI. No.	Particulars	Amount (Rs.)
1.	Late Registration fee	1000
2.	Missing mid-semester examination fee (per course)	1000
3.	Re-registration fee with juniors	1000
4.	Duplicate Hall ticket	200
5.	Fee for Transfer Certificate and Conduct Certificate	200
6.	Re-examination fee for qualifying exam	5000
7.	Fee for availing grace period for submission of thesis	
	a) Upto one month	1000
	b) Up to three months	2500
8.	Penalty for re-viva voce examination for thesis	5000
9.	Fee for late submission of thesis after final viva-voce	5000
10.	Examination fee (per course)	*
11.	Arrear Examination fee (per course)	*
12.	Revaluation fee (per course)	*
13.	Re-totaling fee (per course)	*
14.	Fee for Provisional Degree Certificate	*
15.	Fee for Transcript Card	*
16.	Fee for Degree Certificate	*
17.	Fee for Migration Certificate	*

(Other than admission fee and semester fee)

* As fixed by Pondicherry University from time to time

Annexure – 2

PONDICHERRY UNIVERSITY PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

STUDENT REGISTRATION CARD - PG

Name of the student	Academic Year	
Registration No.	Semester	
Degree Programme	Date of Registration	
Year of Admission	Date of Commencement	

COURSES REGISTERED

SI. No.	Course Code	Course Title	Credit Hours	Remarks
		TOTAL CREDIT HOURS REGISTERED		

Signature of the Student	Signature of the Chairman	Signature of the Head of the Department	Coordinator of Examinations

APPROVED BY

DEAN PAJANCOA&RI, KARAIKAL

Annexure-3

PONDICHERRY UNIVERSITY PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

LIST OF ENCLOSURES TO BE SUBMITTED ALONG WITH THESIS

A. At the time of sending thesis for External Evaluation:

To be submitted to the university

- 1. One copy of abstract of thesis
- 2. One copy of the summary of research finding in English (within one page)
- 3. One copy of the summary of research finding in Tamil (within one page)
- 4. One page abstract of thesis with key words
- 5. Result of comprehensive qualifying examination
- 6. Permission and fee receipt for availing grace period, if any.

To be submitted to the college along with above list

- 7. Clearance certificates from Hostel
- 8. Clearance certificates from Library
- 9. Clearance certificates from Department
- 10. Clearance certificates from Staff advisor
- 11. Clearance certificates from Physical Education
- 12. Approved registration cards (One set)
- 13. Report cards (one set)
- 14. Course completion certificate (signed by Chairman and HOD)
- 15. Attendance Certificate

B. At the time of submission after final viva-voce:

- 1. Report of the final thesis viva voce examination (To be sent in duplicate)
- 2. External Examiners thesis evaluation report (Two copies original + Xerox)
- 3. Certificate for having carried out the suggestions of the external examiner and advisory committee
- 4. Thesis in hard bound copy One Number.
- 5. Soft copy the thesis in CD (cover to cover in PDF format) Two Number.

Annexure - 4

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

PROPOSAL FOR RECOGNITION OF TEACHERS FOR TEACHING/GUIDING PG STUDENTS

1. Particulars of the teacher seeking recognition

	a.	Name of the teacher	:	
	b.	Date of birth of the teacher	:	
	c.	Designation & present official address of the teacher	:	
	d.	Date of joining service in the entry cadre	:	
	e.	Academic qualifications		
		Date of acquiring Bachelor's Degree	:	
		Date of acquiring Master's Degree	:	
		Date of acquiring Ph.D degree	:	
	f.	Total service as on the date of this proposal		
		(excluding extraordinary leave)	:	
	g.	Date of retirement	:	
2.		Recognition proposal submitted for (tick any one)	a.	Recognition as teacher for Masters Programme
			b.	Recognition as Guide for Masters Programme
3.		Teaching experience as on the date of Application		
		a. No. of UG courses offered	:	
		c. No. of M.Sc courses offered	:	

Signature of the teacher with date

4.	Particulars to be furnished by Head of the Department No. of existing recognized teachers/guides			
	pertaining to this proposal in your department	:		
	Justification for additional requirement of teachers/guide	:		

Signature of the Head of Department

Approval of the Dean

Proforma – 1

PONDICHERRY UNIVERSITY PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

PROFORMA FOR REGISTRATION OF RESEARCH CREDITS

PART- A : PROGRAMME

	Semester : I / II Year :		Date of registration :
1.	Name of the student	:	
2.	Registration No.		
3.	Total research credits completed so for	:	
4.	Research credits registered during the semester	:	
5.	Programme of work for this semester (list out the items of research work to be undertaken during the semester) i)	:	
	ii)		

- iii)
- iv)

APPROVAL OF THE ADVISORY COMMITTEE

Advisory committee	Name	Signature
Chairman		
Members	1.	
	2.	
	3.	

(Approval may be accorded within 10 days of registration)

PROFORMA FOR EVALUATION OF RESEARCH CREDITS

PART - B EVALUATION

(Evaluation to be done before the closure of semester)

:

Date of closure of semester :

Date of evaluation

- Whether the research work has been : carried out as per the approved programme
- 2. If there is deviation specify the reasons :
- 3. Performance * :

(*) Performance may be indicated as SATISFACTORY /NOT SATISFACTORY

APPROVAL OF THE ADVISORY COMMITTEE

Advisory committee	Name	Signature
Chairman		
Members	1.	
	2.	
	3.	

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

PERMISSION FOR LATE REGISTRATION

1.	Name of the student	:	
2.	Registration No.	:	
3.	Degree	:	
4.	Department	:	
5.	Semester and Academic year	:	
6.	Date of commencement	:	
7.	Date of registration without fine	:	
8.	Last date for registration with fine	:	
9.	Date on which registration is sought	:	
10.	Reason	:	
11.	Signature of the student	:	

12. Remarks and recommendation of the : Chairman

Signature of the Chairman

PG Coordinator

Head of the department

DEAN

PONDICHERRY UNIVERSITY PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

WILLINGNESS TO BE GIVEN BY THE STUDENTS TO AVAIL FELLOWSHIP FROM EXTERNALLY FUNDED SCHEMES

1.	Name of the student	:
2.	Registration No.	:
3.	Degree	:
4.	Subject	:
5.	OGPA of Bachelor degree	:
6.	Name of the Chairman	:
7.	Discipline/Department	:
8.	Thesis topic, if allotted	:
9.	Current semester and year in which studying	:
10.	Whether all the course works have been completed , if not indicate the	:

pending courses with credit loads

Undertaking by the student:

- i. I am willing to avail the proposed fellowship under the scheme entitled____
- ii. If I leave in the middle of the tenure of the fellowship, I am willing to repay the fellowship availed with 6% penal interest or any levy/fine imposed by the College/University.
- iii. I am fully aware that in case of campus transfer due the award of the fellowship that I have to loose the research credits already registered.
- iv. I am fully aware that there is no guarantee for the continuation of the courses, which I currently undergo, in the other campus to which I am likely to be transferred.
- v. I am willing to abide by all the rules and regulations laid down by the College/University in this regard.

Date:

Signature of Student

Chairman of the Advisory Committee

Head of the Department

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

ALLOTMENT OF STUDENTS UNDER JRF/SRF STUDENT FELLOWSHIP

(To be submitted to the Dean)

1.	Title of the scheme	:	
2.	Location of the scheme (Department)	:	
3.	Date of sanction of the scheme	:	
4.	Period of the scheme	:	
5.	Type of fellowship	:	JRF/SRF
6.	Period of fellowship (only for the period of research credits registered)	:	
7.	Amount of fellowship	:	Rsp.m
8.	Amount of contingent grant	:	Rsp.a.
9.	Amount of T.A. provided	:	Rsp.a.
10.a.	Whether the technical programme submitted by the student to Dean is the same as envisaged in the scheme proposal	:	Yes / No
b.	If not, whether the revised programme of research is submitted (If yes, date of approval by the Dean)	:	
11.	No. of research credit(s) completed so far by the proposed fellowship awardees (student)	:	
12.	Whether the credits earned earlier are to be retained or to be cancelled?	:	
13.	Whether funds received	:	Yes / No
14.	Name of the student(s) & ID.No.	:	
15.	Number of semesters for which fellowship may be sanctioned	:	
16.	Can the fellowship be sanctioned for grace period also.	:	Yes / No

Principal Investigator Head of the Department Dean

List of Enclosures

- 1. Copy of concurrence of the sponsor of the sponsor to avail student fellowship
- 2. Copy of administrative sanction by Dean
- 3. Student's willingness and undertaking

PONDICHERRY UNIVERSITY PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

SPONSOR'S CONCURRENCE (PROFORMA)

1.	Title of the scheme	:	
2.	Location of the scheme (Department)	:	
3. a.	Name & Designation of the PI	:	
b.	Name and designation of the Co-PI	:	
4.	Type of fellowship	:	JRF/SRF
5.	Period of fellowship	:	
a.	Indicate the period of fellowship to be awarded	:	
b.	Amount of fellowship	:	Rsp.m.
c.	Amount of contingent grant	:	Rsp.a.
d.	Amount of T.A. Provided	:	Rsp.a.
e.	Whether Institutional charges paid	:	Yes/No Rs

Signature of the Sponsor

To The Dean PAJANCOA&RI Karaikal – 609 603

Proforma-6

PONDICHERRY UNIVERSITY PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

DEPARTMENT OF _____

COURSE COMPLETION CERTIFICATE

This is to certify	that Thiru	ı./Selvi/Tn	nt						
Registration No		has	completed	all	the	course	and	resea	arch
credit requirements	on				for	the	awa	ard	of
		de	egree.						

Professor and Head

Signature of the Chairman (with Name and designation)

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

JUSTIFICATION FOR LATE SUBMISSION OF THESIS (if applicable)

1.	Name of the student	:	
2.	I.D. No.	:	
3.	Degree	:	
4.	Subject	:	
5.	Date of first registration for the degree	:	
6.	Number of semesters for which the candidate could not register	:	
7.	Reason for not registering and continuing the study	:	
8.	Period of delay in submission of thesis	:	
9.	Period lost due to transfer/ill health	:	
10.	Date of submission of thesis	:	
11.	Specific remarks and recommendation of the Chairman	:	Signature of the student
			Signature of the Chairman with designation
12.	Specific remarks and recommendation of the Head of department	:	
			Signature of the Head
13.	Approval of the Dean	:	
			Signature of the Dean

PONDICHERRY UNIVERSITY PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

PROFORMA FOR EVALUATION OF THESIS

Nam	e of the degree programme:		·
1.	Name and Designation of the examiner	:	
2.	Address of the Examiner	:	
	Telephone/Mobile Fax e-mail	:	
3.	Name of the candidate	:	
4.	Registration No.	:	
5.	Title of the thesis	:	
6.	Date of receipt of the thesis copy	:	
7.	Date of despatch of the detailed report and thesis by the examiner to the Dean	:	
8.	Examiner's recommendations choosing one of the following based on quality of thesis	:	a. Recommended for award b. Recommended for revision
9.	Please state whether a list of questions if any to be asked at the viva-voce examination (Questions to be attached)	:	
	Date : Official Seal :		Signature of the Examiner

<u>Note</u> : Please enclose a detailed report in duplicate duly signed by you giving the merits and demerits of the thesis on the choice of problem, review of literature, methods followed, results and discussion etc.

Proforma-9

PONDICHERRY UNIVERSITY PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

DEPARTMENT OF _____

CERTIFICATE FOR HAVING CARRIED OUT THE SUGGESTIONS OF THE EXTERNAL EXAMINER AND ADVISORY COMMITTEE

(To be enclosed along with result of the final viva voce examination)

Certified that Thiru/Selvi/Tmt _____

Registration No. ______ has carried out all the corrections and suggestions as pointed out by the external examiners(s) and the advisory committee and has

submitted **FOUR** copies of his/her M.Sc. thesis in hard bound cover and **TWO** soft copies

of thesis in PDF format in CDs.

Head of the department

Signature of the Chairman with Name and designation

PONDICHERRY UNIVERSITY PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

PROFORMA FOR OBTAINING PERMISSION TO PRESENT PAPERS IN SEMINAR/SYMPOSIA/TRAINING

(To be sent in triplicate)

1	Name of the student		
1. 2	Pogistration No	•	
2.	Department & College		
5.	Department & College	•	
4.	Name of the Chairman with designation	:	
5.	Whether course work has been completed?		
6.	Title of paper/poster to be presented	:	
	(enclose copy)		
7. a.	Name of the seminar/symposium	:	
b.	Venue	:	
с.	Dates(From-To)	:	
8.	Period of absence (in days) inclusive of	:	
	travel time		
9.	Whether the paper was sent through	:	
	proper channel (copy to be enclosed)		
10.	Cost of travel & registration fee borne by	:	
	the student himself (or) supported by the		
	scheme in which he is drawing		
	fellowship?		
Date:			Signature of the
Student			
Junein			

Specific Recommendations:

Chairman

Professor and Head

PERMISSION TO ATTEND THE SEMINAR/SYMPOSIA

(to be issued by the Dean)

- 1. Permitted without any financial commitment to the College/ University / Not permitted
- 2. Period of absence from to days) is to be treated as duty and can be counted for attendance.
- 3. Period of absence from ______ to _____ (____days) is not treated as duty and cannot be counted for attendance.
- 4. The student should submit a report to the Dean, within 3 days after his return.

PONDICHERRY UNIVERSITY PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL - 609 603

APPLICATION FOR ISSUE OF CONDUCT AND TRANSFER CERTIFICATES

(To be submitted by the student with the recommendation of the Chairman/Head)

1.	Name of the student	:
2.	Registration No.	:
3.	Name of the Chairman	:
4.	Designation of the Chairman	:
5.	Name of the course undergone	:
6.	Year of joining course	:
7.	Year of leaving the course	:
8.	Whether copy of the PC enclosed	:
9.	Whether original clearance certificate from warden enclosed	:

Date:

Signature of the Student

Recommendations:

Certified that the conduct and characters of Mr/Ms.

were ______ during the period of his/her studies. The certificates may be issued accordingly.

Chairman

PG Co-ordinator Professor & Head

Proforma-12

PONDICHERRY UNIVERSITY PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

CERTIFICATE FOR HAVING CARRIED OUT PLAGIARISM CHECK

1	Name of the Student	
2	Registration Number	
3	Degree	
4	Title of the Thesis	
5	Name of the Chairman	
6	Total Word Count in the Document	
7	Initial Submission	Yes / No
	If No	Provide the number of times plagiarism checked along with their plagiarism percent
8	Date of Submission	

Signature of the Student

Signature of the Chairman/Chairperson

Signature of the Head of the Department

COURSE CURRICULA AND SYLLABI

DESCRIPTION OF TERMINOLOGIES

Major Course	The subject of Department or discipline in which the student takes
	admission. Among the listed courses, the core courses compulsorily
	to be registered shall be given '*' mark
Minor Course	The course closely related to a student's major subject
Supporting Course	The course not related to the major course. It could be any course
	considered relevant for student's research work or necessary for
	building his/her overall competence
Common course	Course which is compulsorily registered by the postgraduate student
	for the completion of postgraduate degree programme. The marks
	obtained by the student in a common course will also be taken into
	account for calculating OGPA

Credit Requirements

	Particulars		Credits
(i)	Course Work		
	Major courses		20
	Minor courses		08
	Supporting courses		06
	Common courses		05
	Seminar		01
(ii)	Thesis Research		30
		TOTAL	70

COMMON COURSES

SI No.	Course Code	Course Title		
1	PGS 501	Library and Information Services	0+1	
2	PGS 502	Technical Writing and Communication Skill	0+1	
3	PGS 503	Intellectual Property and its Management in Agriculture		
4	PGS 504	Basic Concepts in Laboratory Techniques		
5	PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0	

PGS 501 LIBRARY AND INFORMATION SERVICES 0+1

AIM OF THE COURSE

To equip the library users with skills, to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

PRACTICAL

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary -Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services - (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing - information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized - library services; Use of Internet including search engines and its resources; e-resources access methods.

PRACTICAL SCHEDULE

- 1. Introduction to library and its services
- 2. Role of libraries in education, research and technology transfer;
- 3. Classification systems and organization of library
- 4. Sources of information- Primary Sources, Secondary Sources and Tertiary Sources
- 5. Intricacies of abstracting and indexing services
- 6. Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);

- 7. Tracing information from reference sources;
- 8. Literature survey

9. Mid-Semester

- 10. Citation techniques/Preparation of bibliography;
- 11. Use of CD-ROM Databases,
- 12. Online Public Access Catalogue and other computerized library services
- 13. Online Public Access Catalogue and other computerized library services
- 14. Use of Internet including search engines and its resources
- 15. Use of Internetincluding search engines and its resources
- 16. E-resources access methods.
- 17. Final practical examination

PGS 502 TECHNICAL WRITING AND COMMUNICATION SKILLS 0+1

AIM OF THE COURSE

To equip the students with skills *Viz.,* writing of dissertations, research papers, etc. andto communicate and articulate in English (verbal as well as writing)

PRACTICAL

Grammar - Tenses, parts of speech, clauses, punctuation marks; Error analysis Common errors; Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers. Proof reading. Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Structure of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

PRACTICAL SCHEDULE

- 1. Grammar (Tenses, parts of speech)
- 2. Grammar (clauses, punctuation marks)
- 3. Error analysis (Common errors); Concord; Collocation;
- 4. Phonetic symbols and transcription;
- 5. Accentual pattern: Weak forms in connected speech
- 6. Participation in group discussion
- 7. Facing an interview; presentation of scientific papers.
- 8. Technical Writing- Various forms of scientific writings- theses, technical papers

9. Mid -semester examination

- 10. Technical Writing- reviews, manuals
- 11. Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion)
- 12. Writing of abstracts, summaries, précis, citations etc
- 13. Commonly used abbreviations in the theses and research communications
- 14. Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustration
- 15. Writing numbers and dates in scientific write-ups
- 16. Editing and proof-reading, writing of a review article.

17. Final practical examination

SUGGESTED READING

- 1. Barnes and Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.
- 2. Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
- 3. Collins' Cobuild English Dictionary. 1995.
- 4. Harper Collins. Gordon HM and Walter JA. 1970. *Technical Writing*. 3rd Ed.
- 5. Holt, Rinehart and Winston. Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
- 6. James HS. 1994. Handbook for Technical Writing. NTC Business Books.
- 7. Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. AffiliatedEast-West Press.
- 8. Mohan K. 2005. Speaking English Effectively. MacMillan India.
- 9. Richard WS. 1969. Technical Writing.
- 10. Sethi J and Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed.Prentice Hall of India.
- 11. Wren PC and Martin H. 2006. *High School English Grammar and Composition*.S. Chand & Co.

PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN 1+0 AGRICULTURE

AIM OF THE COURSE

The main objective of this course is to equip students and stakeholders with knowledge of Intellectual Property Rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

THEORY

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

SUGGESTED READING

- 1. Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
- Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.
- 3. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
- 4. Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
- 5. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
- The Indian Acts Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003

PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1 (For Social Science)

PRACTICAL

Use of R / SPSS / equivalent for Frequency distribution, Summarization and tabulation of data, F test, Correlation, Pearson Correlation, Spearman Correlation, ANOVA, ANCOVA

Use of R / SPSS / equivalent for Regression: Simple, Multiple Linear regression, Estimation of regression by OLS & MLE method, Logit, Probit, Stepwise regression, Coefficient of determination

Use of R / SPSS / equivalent for Kolmogorov-Smirnov test, Wilcoxon signed rank test, Mann-Whitney U, Kruskal-Wallis, McNemar's test

Use of R / SPSS / equivalent for Discriminant analysis - fitting of discriminant functions, identification of important variables, Factor analysis. Principal component analysis - obtaining principal component.

Use of R / SPSS / equivalent for Analysis of time series data - AR, MA, ARIMA models

SUGGESTED READING

- 1. Anderson CW & Loynes RM. 1987. The Teaching of Practical Statistics. John Wiley.
- 2. Atkinson AC. 1985. Plots Transformations and Regression. Oxford University Press.
- 3. Chambers JM, Cleveland WS, Kleiner B & Tukey PA. 1983. Graphical Methods for Data Analysis. Wadsworth, Belmount, California.
- 4. Chatfield C & Collins AJ. 1980. Introduction to Multivariate Analysis. Chapman & Hall.
- 5. Chatfield C. 1983. Statistics for Technology. 3 rd Ed. Chapman & Hall.
- 6. Chatfield C. 1995. Problem Solving: A Statistician's Guide. Chapman & Hall.
- 7. Cleveland WS. 1985. The Elements of Graphing Data. Wadsworth, Belmont, California.
- 8. Ehrenberg ASC. 1982. A Primer in Data Reduction. John Wiley.
- 9. Erickson BH & Nosanchuk TA. 1992. Understanding Data. 2 nd Ed. Open University Press, Milton Keynes.
- 10. Snell EJ & Simpson HR. 1991. Applied Statistics: A Handbook of GENSTAT Analyses. Chapman & Hall
- 11. Sprent P. 1993. Applied Non-parametric Statistical Methods. 2 nd Ed. Chapman & Hall.
- 12. Tufte ER. 1983. The Visual Display of Quantitative Information. Graphics Press, Cheshire, Conn.
- 13. Velleman PF & Hoaglin DC. 1981. Application, Basics and Computing of Exploratory Data Analysis. Duxbury Press.
- 14. Weisberg S. 1985. Applied Linear Regression. John Wiley.
- 15. Wetherill GB. 1982. Elementary Statistical Methods. Chapman & Hall.
- 16. Wetherill GB.1986. Regression Analysis with Applications. Chapman & Hall.
- 17. Learning Statistics: http://freestatistics.altervista.org/en/learning.php.
- 18. Free Statistical Soft wares: http://freestatistics.altervista.org/en/stat.php.
- **19.** Statistics Glossary http://www.cas.lancs.ac.uk/glossary_v1.1/main.html

PGS 504

BASIC CONCEPTS IN LABORATORY TECHNIQUES (For Plant Sciences)

AIM OF THE COURSE

To acquaint the students about the basics of commonly used techniques in laboratory.

PRACTICAL

Unit I

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separator funnel, condensers, micropipettes and vaccupets. Ashing, drying and sterilization of glassware; Drying of solvents/chemicals.

Unit II

Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions. Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values.

Unit III

Preparation of different agro-chemical doses in field and pot applications. Principles and handling techniques of Chromatography.

Unit IV

Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath. Preparation of media and methods of sterilization.

Unit V

Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy. Specific methodologies concerning each discipline

PRACTICAL SCHEDULE

- 1. Safety measures while in Lab; Handling of chemical substances
- 2. Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micro pipettes and vaccupets
- 3. Washing, drying and sterilization of glassware
- 4. Drying of solvents/chemicals
- 5. Weighingandpreparationofsolutionsofdifferentstrengthsandtheirdilution
- 6. Handling techniques of solution; Preparation and neutralisation of acid and bases
- 7. Preparation of buffers of different strengths and pH values

8. Mid semester examination

9. Preparationofdifferentagro-chemicaldosesinfieldandpotapplications (Herbicides and Fertilizers)

- 10. Preparationof different agro-chemical doses infield and pot applications (Pesticides)
- 11. Principles and Handling techniques of Chromatography.
- 12. Use and handling of microscope, laminar flow, vacuum pumps viscometer, thermometer, magnetic stirrer, micro-ovens, incubator, sand bath, water bath, oil bath etc.
- 13. Preparation of media and methods of sterilization
- 14. Seed viability testing, testing of pollen viability
- 15. Tissue culture of crop plants. Description of flowering plants in botanical term sin relation to taxonomy
- 16. Specific methodologies of each discipline concerned.
- 17. Final Practical Examination

SUGGESTED READING

- 1. FurrAK.2000.CRC Hand Book of Laboratory Safety. CRC Press.
- Gabb MH and Latchem WE.1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL 1+0 DEVELOPMENT PROGRAMMES

AIM OF THE COURSE

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

THEORY

Unit I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions.

Unit II

Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centers (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

Unit III

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

Unit IV

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme.

Unit V

Integrated Rural Development Programme (IRDP) Panchayat Raj Institutions, Cooperatives, Voluntary Agencies/Non-Governmental Organizations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

LECTURE SCHEDULE

- 1. History of agriculture in brief; Global agricultural research system: need, scope, opportunities
- 2. Role in promoting food security, reducing poverty and protecting the environment
- 3. National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions
- 4. Consultative Group on International Agricultural Research (CGIAR); International Agricultural Research Centres (IARC)
- 5. Partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels
- 6. International fellowships for scientific mobility.
- 7. Research ethics: research integrity, research safety in laboratories
- 8. Welfare of animals used in research, computer ethics, standards and problems in research ethics.

9. Mid semester examination

- 10. Social trends on research ethics, adequate codes of conduct to regulate researchactivity
- 11. Concept and connotations of rural development, rural development policies and strategies.
- 12. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme
- 13. Special group Area Specific Programme
- 14. Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Cooperatives, Voluntary Agencies/ Non-Governmental Organisations.
- 15. Critical evaluation of rural development policies and programmes
- 16. Constraints in implementation of rural policies and programmes
- 17. Final Examination.

SUGGESTED READING

1. Bhalla GS and Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publication. Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

- 2. Rao BSV. 2007. Rural Development Strategies and Role of Institutions Issues, Innovations and Initiatives. Mittal Publication.
- 3. Singh K. 1998. Rural Development Principles, Policies and Management. Sage Publication.

SUPPORTING COURSES

SI No.	Course Code	Course Title	Credits
1	COM 501	R and Python Programming	2+1
2	MAT 501	Mathematics For Agricultural Economics	2+1
3	STA 501	Statistical Methods for Applied Sciences	2+1
4	STA 502	Design of Experiments	2+1

COM 501 R AND PYTHON PROGRAMMING 2+1

WHY THIS COURSE?

This course is all about R which is mainly used for statistical analysis while Python provides a more general approach to data science. R and Python are state of the art in terms of programming language oriented towards data science. Learning both of them gives an idea for handling agricultural data.

AIM OF THE COURSE

The objective of the course is partly to give an introduction to python and software R and how to handle data analysis using R.

THEORY

Unit I

Introduction to Python – Identifiers, Keywords, Statements and Expressions, Variables, Operators, Precedence and Associativity, Data Types, Reading Input, Print Output, Type Conversions - Control Flow Statements, Looping Statements, Functions - Built-In Functions, Commonly Used Modules, Packages - Strings and Lists – Iterators.

Unit II

Regular Expression - pattern matching and searching using regex - validations using regular expressions - Exception handling - Python Database Interaction - SQL Database connection using python - Creating, Reading, storing and searching information on tables.

Unit III

R Console; R Data types; R Vector creation using c (); R Assignment operators = <- ; R Arithmetic Operators; R Logical Operators; R Relational Operators;

Unit IV

R Matrix- Create, Print, Add Column using cbind (), Add Row using rbind (), Slice using [,]; R Data Frame - Create using data.frame (), Edit using edit (), Append using cbind (), rbind (), select (), subset (), sort using order (); List in R - Create using list (), Select; Data

Importing and Exporting in R Using read. table () and write. table (); install. packages (), library

Unit V

R script If, Else, Else If statements in R; For Loop and While Loop in R; Scatter Plot, Bar Chart and Histogram in R; Data Visualization with R ggplot2; Publishing Data Visualizations with R Shiny;

PRACTICALS

Implementation of Control Flow Statements, Looping Statements, Functions, Regular Expression, pattern matching and searching using regex. Validations using regular expressions. Python Database Interaction - SQL Database connection using python. Creating, Reading, storing and searching information on tables. R Console; R Vector creation using c(); R Assignment operators = <- ; R Matrix- Create, Print, Add Column using cbind(), Add Row using rbind(), Slice using [,]; R Data Frame - Create using data.frame(), Edit using edit(), Append using cbind(), rbind(), select(), subset(), sort using order(); List in R - Create using list(), Select; Data Importing and Exporting in R Using read.table() and write.table(); install.packages(), library(); Rscript, If, Else, Else If statements in R; For Loop and While Loop in R; Scatter Plot, Bar Chart and Histogram in R; Data Visualization with R ggplot2; Publishing Data Visualizations with R Shiny;

LECTURE SCHEDULE

Unit I

- 1 Introduction to Python Identifiers, Keywords, Statements and Expressions
- 2 Operators, Precedence and Associativity, Data Types
- 3 Reading Input, Print Output, Type Conversions
- 4 Control Flow Statements, Looping Statements
- 5 Functions Built-In Functions, Commonly Used Modules, Packages
- 6 Strings and Lists
- 7 Iterators

Unit II

- 8 Regular Expression
- 9 Pattern matching and searching using regex
- 10 Validations using regular expressions
- 11 Exception handling
- 12 Python Database Interaction SQL Database connection using python
- 13 Creating, Reading, storing and searching information on tables.

Unit III

- 14 R Console; R Data types; R Vector creation using c();
- 15 R Assignment operators = <- ;
- 16 R Arithmetic Operators;
- 17 Mid semester examination

- 18 R Logical Operators;
- 19 R Relational Operators;

Unit IV

- 20 R Matrix- Create, Print,
- Add Column using cbind(), Add Row using rbind(), Slice using [,];
- 22 R Data Frame Create using data.frame (), Edit using edit(), Append using cbind (), rbind(),
- 23 Select (), subset(), sort using order();
- 24 List in R Create using list(), Select;
- 25 Data Importing and Exporting in R Using read.table() and write.table();
- 26 install. packages(), library();

Unit V

- 27 Rscript
- 28 If, Else in R
- 29 Else If statements in R;
- 30 For Loop in R;
- 31 While Loop in R;
- 32 Scatter Plot, Bar Chart and Histogram in R;
- 33 Data Visualization with R ggplot2
- 34 Publishing Data Visualizations with R Shiny;

PRACTICAL SCHEDULE

- 1 Implementation of Control Flow Statements, Looping Statements, Functions
- 2 Regular Expression
- 3 Pattern matching and searching using regex
- 4 Validations using regular expressions
- 5 Python Database Interaction SQL Database connection using python
- 6 Creating, Reading, storing and searching information on tables
- 7 R Console; R Vector creation using c(); R Assignment operators = <- ;
- 8 R Matrix- Create, Print, Add Column using cbind (), Add Row using rbind (), Slice using [,];
- 9 R Data Frame Create using data. frame (), Edit using edit(), Append using cbind (), rbind (), select (), subset (), sort using order();
- 10 List in R Create using list(), Select; Data Importing and Exporting in R Using read.table () and write. Table ();
- 11 Install. packages(), library(); Rscript,
- 12 If, Else, Else If statements in R;
- 13 For Loop in R; While Loop in R;
- 14 Scatter Plot, Bar Chart and Histogram in R;
- 15 Data Visualization with R ggplot2;
- 16 Publishing Data Visualizations with R Shiny;
- 17 Final practical examination

LEARNING OUTCOME

This course will impart knowledge on how to interpret and analyze data using R and Python programming.

SUGGESTED READING

- 1 Michael J. Crawley (2013). The R Book. 2nd Edition. John Wiley.
- 2 Robert Gentleman (2008). R Programming For Bioinformatics. Chapman and Hall/CRC
- 3 Brian S. Everitt and Torsten Hothorn (2009). A Handbook of Statistical Analyses Using R. Second Edition. Chapman and Hall/CRC
- 4 Bassi, S. (2017). Python for bioinformatics. Chapman and Hall/CRC.

SUGGESTED WEBSITES

- 1 https://www.python.org/doc/
- 2 https://www.r-project.org/other-docs.html
- 3 https://www.r-exercises.com/
- 4 RStudio.com Shiny Tutorial https://shiny.rstudio.com/tutorial/ https:// shiny. rstudio.com /articles/

MAT 501 MATHEMATICS FOR AGRICULTURAL ECONOMICS 2+1

WHY THIS COURSE?

This course provides a strong quantitative basis for the students to understand various Micro and Macroeconomic concepts

AIM OF THE COURSE

This course exposure student of Agricultural Economics to calculus and its applications in Agricultural Economics. It covers applications of Differential calculus, Integral calculus and Differential equations. This course provides a strong quantitative basis for the students to understand various Micro and Macro economic concepts.

THEORY

Unit I

Matrices – types - algebra of matrices. Determinants – properties - solution of simultaneous equations. Inverse of a matrix. Caylay Hamilton theorem- Eigen values and Eigen vectors.

Unit II

Definition and examples of variables and functions- basic theorems on limits and continuity (without proof). Revision of methods of differentiation. Maxima and minima of single. Application of differentiation - Elasticity of demand in terms of differentiation.

Average and marginal functions. Cost and Revenue curves- relationship. Conditions for profit maximization, Effects of taxation and subsidy.

Unit III

Revision of Partial differentiation - Maxima and minima of several variables with and without constraints -Marginal demands, partial elasticitics and utility analysis. Theory of consumer behavior- Rate of commodity substitution, Maximization of utility – slut sky equation (Income and substitution effects). Production functions and their mathematical properties- Isoquants and Ridge lines- Least cost combination – Constrained profit Maximization- Properties of linear homogenous functions- Euler's theorem.

Unit IV

Definite integrals, methods of integration definite integral; - Capital formation. Present value of continuous equal income stream. Consumer's and producer's surplus.

Unit V

Differential equations-meaning-types of differential equations-order and degree of the differential equations-formation and solution of first order and first degree linear differential equations. Solution of linear homogeneous equations. Applications in Micro economics – Utility and Demand analysis- Cost functions, Market equilibrium Harood Domor model, basic neo classic models, Solow models Domar debit models and some further applications.

PRACTICALS

Problems in algebra of matrices and determinants, simultaneous equation, eigen values and eigen vectors, simple differentiation, maxima and minima for single variables. Application of differentiation in Agricultural Economics. Simple problems in partial differentiation & Maxima and minima for several variables, Maxima and minima for several variables with constraints-Lagrange's method, Application of partial differentiation in agricultural economics, simple integral, calculation of consumer's and producer's surplus, formation of differential equation, solution of first order and first degree linear differential, solution of linear homogeneous equations.

LECTURE SCHEDULE

Unit I

- 1 Matrices types of matrices, Algebra of matrices and determinant
- 2 Inverse of a matrix, Solution of simultaneous linear equations
- 3 Caylay Hamilton theorem
- 4 Eigen Values and Eigen Vector

Unit II

- 5 Definition and examples of variables and functions
- 6 Basic theorems on limits and continuity (without proof).
- 7 Revision and Simple Problems in differentiation

- 8 Maxima and minima of function of single with out constraints
- 9 Definitions of Elasticity, Total average and Marginal cost curve relations
- 10 Total average and Marginal Revenue curves Conditions for profit maximization

Unit III

- 11 Revision and Simple Problems in partial differentiation.
- 12 Maxima and minima of function of several variables without constraints
- 13 Maxima and minima of function of several variables with constraints -Lagrange's Multiplier's method
- 14 Partial elasticties and utility Analysis Theory of consumer behavior
- 15 Rate of commodity substitution
- 16 Mid semester examination
- 17 Maximization of utility
- 18 Slutsky equation (Income and substitution effects).
- 19 Production functions and their mathematical properties
- 20 Isoquants and Ridge lines
- 21 Least cost combination Constrained profit Maximization
- 22 Properties of linear homogeneous functions Euler's theorem

Unit IV

- 23 Definite integrals and their geometrical applications
- 24 Capital formation Capital growth equation
- 25 Present value of continuous equal income stream
- 26 Calculations of consumer's and producer's surplus

Unit V

- 27 Solution of first order differential equations and Homogeneous
- 28 Linear differential equation with constant coefficients
- 29 Applications in Micro economics Utility and Demand analysis
- 30 Applications in Micro economics Cost functions, , Market equilibrium
- 31 Applications in Macro growth economics Dynamic multiplier models
- 32 Applications in Macro growth economics Harood Domor model
- 33 Applications in Macro growth economics Basic neo classic models
- 34 Applications in Macro growth economics Solow models Domar debit models

PRACTICAL SCHEDULE

- 1 Simple Problems in Matrices, Inverse Matrix
- 2 Problems in Solution of simultaneous linear equations
- 3 Problems in cayley Hamilton
- 4 Problems in Eigen value and Eigen verctor
- 5 Simple Problems in Differentiation
- 6 Maximum and minimum of function of single variables without constraints
- 7 Problems in Elasticity, Total average and Marginal cost/Revenue curves

- 8 Problems in Marginal demands, Partial elasticties and utility Analysis.
- 9 Simple Problems in partial differentiation
- 10 Maximum and minimum of function of several variables without constraints
- 11 Maximum and minimum of function of several variables with constraints
- 12 Problems in Maximization of utility and slut sky equation (Income and substitution effects) and Constrained profit Maximization
- 13 Homogeneous functions and Euler's theorem on homogenous functions
- 14 Problems in Definite integrals geometrical applications
- 15 Calculations of consumer's and producer's surplus
- 16 Problems in Homogeneous, Linear differential equations
- 17 Final practical examination

LEARNING OUTCOME

Students can get exposure in basic knowledge in set theory, cost curve, supply curves and asticity with the applications in Agricultural Economics. Students can know to solve macro and micro economic models. Also this course provides a strong quantitative basis for the students to understand various Micro and Macro economic concepts

SUGGESTED READING

- 1 Metha, B.C. and Madani, G.M.K. (Reprint2008) Mathematics for Economists, Sultan Chand & Sons Educational Publishers, New Delhi.
- 2 ArumugamS. And Thangapandi Isaac (2002), Advanced Calculus, New Gamma Publishing house, Chennai.

SUGGESTED WEBSITES

- 1 http://en.wikipedia.org/wiki/Set_theory mathworld.wolfram.com /Newtons Divided Difference Interpolation Formula.html
- 2 http://en.wikipedia.org/wiki/Taylor_series

STA 501STATISTICAL METHODS FOR APPLIED SCIENCES2+1

WHY THIS COURSE?

- This course will help the students
- To study the exploratory data analysis
- To understand the various probability distributions and their application in their respective fields
- To perform the parametric and non-parametric tests based on the data
- To learn the relationship of the variables using correlation and regression techniques

AIM OF THE COURSE

The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, parametric and non-parametric tests, selection of sampling techniques and correlation, regression and ANOVA techniques.

THEORY

Unit I

Descriptive Statistics: Measure of Central Tendency, Measure of Dispersion, Skewness and Kurtosis for raw data only. Graphical and Diagrammatical representation: Bar Chart, Pie Chart, Frequency curve, Box Plot. Theory of Probability: axioms and properties, Addition and Multiplication Theorems on probability, Random Variable and Mathematical Expectation.

Unit II

Discrete and continuous probability distribution: Binomial, Poisson, Normal Distribution. Sampling theory: Population, parameter, sample and statistics; Sampling, need for sampling; Probability sampling: Simple random sampling (SRS), stratified random sampling, systematic sampling, cluster sampling; Non Probability sampling: Purposive and judgment sampling.

Unit III

Sampling distribution: Standard error and its uses, chi-square, t and F distributions. Theory of Estimation: Point Estimation, properties of good estimators; Properties of good estimators – unbiasedness, consistency, efficiency and sufficiency. Interval estimation: confidence limit, confidence interval. Test of significance based on Normal, t, F and Chisquare distributions.

Unit IV

Correlation and Regression: Correlation, types of correlation, pearson's correlation, testing the significance of correlation coefficient, rank correlation. Simple linear regression: assumption and fitting of simple linear regression, testing and interpretation of regression coefficient, coefficient of determination. Multiple linear regression and testing of coefficients.

Unit V

Introduction to ANOVA: One Way and Two way ANOVA. Non-parametric test: Sign test, Wilcoxon Test, Mann-Whitney U-test, Run test for the randomness of the sequence, Median test, Kruskalwallis test, Friedman's test.

PRACTICAL

Descriptive Statistics: Measure of central tendency, Measure of dispersion, Skewness and Kurtosis for raw data. Graphical and diagrammatical representation, Problems on Binomial, Poisson, Normal Distribution. Confidence interval estimation, Large sample test – testing mean and proportion, t-Test for single mean and two means, F-test for two variance, Test based on chi-square distributions. Correlation and Regression analysis. One Way ANOVA and Two way ANOVA. Non Parametric test: Wilcoxon Test, Mann-Whitney U-test, Run test for the randomness of the sequence, Median test, Kruskalwallis test, Friedman's test

LECTURE SCHEDULE

Unit I

- 1 Descriptive Statistics: Measure of central tendency for raw data
- 2 Descriptive Statistics: Measure of dispersion for raw data
- 3 Skewness and Kurtosis for raw data
- 4 Graphical and diagrammatical representation Bar Chart, Pie Chart, frequency curve, Box Plot
- 5 Theory of Probability: axioms and properties, Addition and Multiplication Theorems on probability
- 6 Random Variable and Mathematical Expectation

Unit II

- 7 Discrete distribution: Binomial distribution
- 8 Discrete distribution: Poisson distribution
- 9 Continuous probability distribution: Normal Distribution
- 10 Sampling theory: Population, parameter, sample and statistics; Sampling, need for sampling
- 11 Probability sampling: Simple random sampling (SRS) with and without replacement
- 12 Probability sampling: stratified random sampling and its method of allocation, Systematic sampling, cluster sampling
- 13 Non Probability sampling: Purposive and judgment sampling

Unit III

- 14 Sampling distribution: Standard error and its uses, chi-square, t and F distributions
- 15 Theory of Estimation: Point Estimation, Properties of good estimators: unbiasedness, consistency, efficiency and sufficiency
- 16 Interval estimation: confidence limit, confidence interval for single and two sample mean (t and Z)
- 17 Mid Semester Examination
- 18 Test of significance based on Normal distribution
- 19 Test of significance based on t distribution
- 20 Test of significance based on F distribution
21 Test of significance based on chi-square distributions

Unit IV

- 22 Correlation, Types of correlation, Pearson's correlation and its properties
- 23 Rank correlation
- 24 Simple linear regression: assumption and fitting of simple linear regression
- 25 Testing and interpretation of regression coefficient, coefficient of determination
- 26 Multiple linear regression model Matrix approach and
- 27 Testingthe significance of correlation coefficient and regression coefficients, coefficient of determination

Unit V

- 28 Introduction to ANOVA: One Way ANOVA
- 29 Two way ANOVA
- 30 Introduction to Non-parametric test: Sign test
- 31 Wilcoxon Test, Mann-Whitney U-test
- 32 Run test for the randomness of the sequence, Median test
- 33 Kruskalwallis test
- 34 Friedman's test

PRACTICAL SCHEDULE

- 1 Descriptive Statistics: Measure of central tendency, Measure of dispersion, Skewness and Kurtosis for raw data.
- 2 Graphical and diagrammatical representation Bar Chart, Pie Chart, frequency curve, Box Plot
- 3 Problems on Binomial distribution, Poisson distribution
- 4 Problems on Normal Distribution
- 5 Confidence interval estimation for single and two sample mean (t and Z)
- 6 Large sample test testing mean and proportion of single and two sample
- 7 t-Test for single mean, two means (paired t-test)
- 8 t-Test for two means (independent t-test), F-test for two variance
- 9 Test of significance based on chi-square distributions
- 10 Correlation and testing of correlation coefficient
- 11 Regression analysis and testing the significance of regression coefficient
- 12 One Way ANOVA and Two way ANOVA
- 13 Wilcoxon Test, Mann-Whitney U-test
- 14 Run test for the randomness of the sequence, Median test
- 15 Kruskalwallis test
- 16 Friedman's test
- 17 Practical Examination

LEARNING OUTCOME

After successful completion of the course the students will be able to understand the exploratory data analysis, sampling and probability distribution, perform parametric and non parametric tests, well versed with regression and correlation analysis.

SUGGESTED READING

- Goon A M, Gupta MK and Das Gupta B. 1983. Fundamentals of Statistics. Vol.
 I. The World Press.
- 2 Hoel PG. 1971. Introduction to Mathematical Statistics. John Wiley
- 3 Hogg RV and Craig TT. 1978. Introduction to Mathematical Statistics. Macmillan
- 4 Robert V. Hogg, Joseph W. McKean, Allen T. Craig (2012). Introduction to Mathematical Statistics (7th Edition)
- 5 Siegel S, Johan N and Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. John Wiley
- 6 Gupta. S.P, 2005, Statistical Methods, Sultan Chand & Sons, New Delhi
- 7 Rangaswamy, R, 2009, A text book of Agricultural Statistics, New Age International (P) Ltd., New Delhi.
- 8 K.P. Dhamu and K. Ramamoorthy, 2007, Statistical Methods, Agrobios (India), Jodhpur.
- 9 R. GangaiSelvi and C. Kailasam, 2017, Applied Statistics, Kalyani Publishers, New Delhi.

SUGGESTED WEBSITES

- 1 https://online.stat.psu.edu/statprogram/statistical%20methods
- 2 https://home.iitk.ac.in/~kundu/Statistical-Methods.pdf
- 3 https://www.nature.com/subjects/statistical-methods
- 4 https://sccn.ucsd.edu/~arno/mypapers/statistics.pdf
- 5 https://www.sciencedirect.com/book/9780123749703/statistical-methods

STA 502DESIGN OF EXPEREIEMNTS2+1

AIM OF THE COURSE

Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to various Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

THEORY

Unit I

Need for designing of experiments, Characteristics of good design. Basic principles of designs- randomization, replication and local control. Uniformity trails, size and shape of plots and blocks – determination of optimum plot size.

Unit II

Analysis of Variance, Data Transformation – Logrithmic, angular and square root transformation. Multiple comparison procedures – Least significant difference and Duncan's multiple range test. Completely randomized design, randomized block design and Latin square design.

Unit III

Factorial Experiments: 2ⁿ and 3ⁿ factorial experiments, analysis using regular method, Yates algorithm (2ⁿ, upto three factors), Asymmetric factorial experiments (upto three factors). orthogonality and partitioning of degrees of freedom. Concept of confounding in symmetric factorial experiments, complete and partial confounding. Split plot and strip plot designs.

Unit IV

Missing plot techniques in randomized block design and Latin square designs. Analysis of covariance.

Unit V

Balanced Incomplete Block Design (BIBD), Partially Balanced Incomplete Block Design (PBIBD), Lattice design, alpha design: concept, randomization procedure, analysis and interpretation. Introduction to resolvable designs and their applications. Combined analysis. Response surface design.

PRACTICAL

Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law, Analysis of data obtained from CRD, RBD, LSD; Analysis of factorial experiments; Analysis of covariance; Analysis with missing data; Data transformation - Split plot and strip plot designs - Analysis of data obtained from BIBD, PBIBD.

LECTURE SCHEDULE

Unit I

- 1. Introduction to principles of Experimental designs; need for designing of experiments
- 2. Characteristics of good design
- 3. Basic principles of designs- randomization, replication and local control.
- 4. Uniformity trails, size and shape of plots and blocks determination of optimum plot size

Unit II

- 5. Analysis of Variance
- 6. Data Transformation Logrithmic and angular transformation
- 7. Square root transformation
- 8. Multiple comparison procedures Least significant difference and Duncan's multiple range test

- 9. Completely randomized design: Layout, randomization, analysis, advantage and disadvantage
- 10. Randomized block design: Layout, randomization, analysis, advantage and disadvantage
- 11. Latin square design: Layout, randomization, analysis, advantage and disadvantage
- 12. Introduction to Factorial Experiments and its type

Unit III

- 13. 2ⁿ factorial experiments using regular method (up to three factors)
- 14. 3ⁿ factorial experiments using regular method (up to three factors)
- 15. Yates algorithm: 2ⁿ factorial experiments (up to three factors)
- 16. Asymmetric factorial experiments (up to three factors)

17. Mid Semester Examination

- 18. Orthogonality : orthogonal Latin squares, Mutually orthogonal Latin squares (MOLS)
- 19. Partitioning of degrees of freedom
- 20. Concept of confounding in symmetric factorial experiments (in 2³ factorial), advantage and disadvantage
- 21. Complete and Partial confounding (in 2³ factorial)
- 22. Split plot designs: Layout, Randomization, Analysis, Advantage, Disadvantage.
- 23. Strip plot designs: Layout, Randomization, Analysis, Advantage, Disadvantage

Unit IV

- 24. Missing plot techniques in randomized block design one and two missing observation
- 25. Missing plot techniques in Latin square designs. one missing observation
- 26. Analysis of covariance (with one covariate)

Unit V

- 27. Balanced Incomplete Block Design (BIBD) concept, randomization procedure
- 28. Balanced Incomplete Block Design (BIBD) analysis and interpretation
- 29. Partially Balanced Incomplete Block Design (PBIBD): concept, randomization procedure, analysis and interpretation.
- 30. Introduction to Lattice design: Square lattice design, randomization, analysis and their application
- 31. Introduction to Alpha design: concept, randomization procedure, analysis and interpretation.
- 32. Introduction to resolvable designs and their applications.
- 33. Concepts of Combined analysis.
- 34. Response surface design and application: second order response surface design

PRACTICAL SCHEDULE

- 1. Uniformity trial data analysis
- 2. Formation of plots and blocks
- 3. Fairfield Smith Law

- 4. Analysis of data obtained from CRD
- 5. Analysis of data obtained from RBD
- 6. Analysis of data obtained from LSD
- 7. Data transformation: logarithmic, angular transformation
- 8. Square root transformations
- 9. Analysis with missing data (RBD one missing value only)
- 10. Analysis of factorial experiments symmetrical
- 11. Analysis of factorial experiments symmetrical
- 12. Split plot design
- 13. Strip plot design
- 14. Analysis of covariance in case of RBD
- 15. Analysis of data generated from a BIB design
- 16. Analysis of data generated from a PBIB design
- 17. Final practical examination

SUGGESTED READING

- 1. Cochran WG and Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
- 2. Dean AM and Voss D. 1999. Design and Analysis of Experiments. Springer.
- 3. Douglas C. Montgomery (2012). Design and Analysis of Experiments, 8th Ed. John Wiley.
- 4. Federer WT. 1985. Experimental Designs. MacMillan.
- 5. Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
- 6. Nigam AK and Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.
- 7. Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley
- 8. Gomez, K.A. and Gomez, A.A., 1993, Statistical Procedures for Agricultural Research, John Wiley & Sons, New Delhi.
- 9. Rangaswamy, R, 2009, A text book of Agricultural Statistics, New Age International (P) Ltd., New Delhi.
- 10. K.P. Dhamu and K. Ramamoorthy, 2007, Statistical Methods, Agrobios (India), Jodhpur.

SUGGESTED WEBSITES

- 1. www.drs.icar.gov.in
- 2. https://www.moresteam.com/toolbox/design-of-experiments.cfm
- 3. https://www.coursera.org/specializations/design-experiments
- 4. https://online.stat.psu.edu/statprogram/stat503
- 5. https://www.labmanager.com/laboratory-technology/online-resources-for-experim ental-design-21103

M.Sc. (Hort.) Vegetable Science

SI No.	Course Code	Course Title	Cr Hr
Major courses			
1.	VSC 501*	Production of Cool Season Vegetable Crops	2+1
2.	VSC 502*	Production of Warm Season Vegetable Crops	2+1
3.	VSC 503*	Growth and Development of Vegetable Crops	2+1
4.	VSC 504*	Principles of Vegetable Breeding	3+0
5.	VSC 505	Breeding of Self Pollinated Vegetable Crops	2+1
6.	VSC 506	Breeding of Cross Pollinated Vegetable Crops	2+1
7.	VSC 507	Protected Cultivation of Vegetable Crops	1+1
8.	VSC 508	Seed Production of Vegetable Crops	2+1
9.	VSC 509	Production of Underutilized Vegetable Crops	2+1
10.	VSC 510	Systematics of Vegetable Crops	1+1
11.	VSC 511	Organic Vegetable Production	1+1
12.	VSC 512	Production of Spice Crops	2+1
13.	VSC 513	Processing of Vegetable	1+1
14.	VSC 514	Postharvest Management of Vegetable Crops	2+1
Seminar a	nd Research		
1.	VSC 591	Seminar	0+1
2.	VSC 599	Research	0+30

M.Sc. (Hort.) Vegetable Science

* Courses to be compulsorily registered

SEMESTER WISE DISTRIBUTION OF COURSES

SEMESTSER I

SI.No.	Course No.	Course Title	Credits
١.	Major Courses	9	
11.	Minor Courses to be registered 6		
111.	Supporting Course		
1	STA 501	Statistical Methods for Applied Sciences	2+1
IV.	Common Courses		
1	PGS 501	Library and Information Services	0+1
2	PGS 503	Intellectual Property and its Management in Agriculture	1+0
3	PGS 504	Basic Concepts in Laboratory Techniques	0+1

SEMESTSER II

SI.No.	Course No.	Course Title	Credits	
Ι.	Major Courses to be registered		8	
11.	Minor Courses to be registered		5 or 6	
111.	Supporting Course			
1	STA 502	Design of Experiments	2+1	
IV.	V. Common Courses			
1	PGS 502	Technical Writing and Communication Skill	0+1	
2	PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0	

SEMESTER III

SI.No.	Course No.	Course Title	Credits
1	VSC 591	Master's Seminar	0+1
2	VSC 599	Master's Research	0+15

SEMESTER IV

SI.No.	Course No.	Course Title	Credits
1	VSC 599	Master's Research	0+15

VSC 501 PRODUCTION TECHNOLOGY OF COOL SEASON 2+1 VEGETABLE CROPS

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.

AIM OF THE COURSE

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

THEORY

Unit I

Area, production and productivity of cool season vegetable crops, Scope and importance of cool season vegetable crops, production technology of Potato, garlic and leek

Unit II

Production technology of Cabbage, cauliflower, kohlrabi, broccoli, Brussels sprouts, kale and chow chow.

Unit III

Production technology of Carrot, radish, turnip and beetroot.

Unit -IV

Production technology of Peas and beans—Garden pea, French bean, broad bean, lettuce and palak

Unit V

Production technology of spinach, asparagus, globe artichoke and other minor cool season vegetables; protected cultivation and precision farming in cool season vegetables

LECTURE SCHEDULE

Unit I

1. Area, production and productivity of cool season vegetable crops

- 2. Scope and importance of cool season vegetable crops
- Potato 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, cropping system.
- 4. Potato 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.
- 5. Garlic- 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, cropping system.
- 6. Garlic- 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.
- 7. Leek -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, 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 - II

- Cabbage 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, cropping system.
- Cabbage –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.

- 10. Cauliflower-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, cropping system.
- 11. Cauliflower–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.
- 12. Knol Khol –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, 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.
- 13. Broccoli 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, 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.
- 14. Brussels sprout 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, 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.
- 15. Kale 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, 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.

16. Chow Chow - 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, 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 III

17. Mid semester examination

- 18. Carrot –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, cropping system.
- 19. Carrot –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.
- 20. Radish –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, 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.
- 21. Turnip –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, 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.

- 22. Beetroot –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, cropping system.
- 23. Beetroot –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 IV

- 24. Garden pea 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, 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.
- 25. French beans 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, 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.
- 26. Broad beans 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, 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.

- 27. Lettuce 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, 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.
- 28. Palak 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, 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 V

- 29. Spinach 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, 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.
- 30. Asparagus 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, 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.
- 31. Globe Artichoke 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, 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.

- 32. Other minor cool season vegetables 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, 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.
- 33. Protected cultivation of cool season vegetables
- 34. Precision farming techniques in cool season vegetable crops

PRACTICAL SCHEDULE

- 01. Nursery practices for direct sown/ specially propagated vegetable crops
- 02. Nursery practices for transplanted vegetable crops
- 03. Description of species and varieties of cole crops, leafy vegetables
- 04. Description of species and varieties of tuber, bulb, peas and beans, root crops
- 05. Intercultural operations in cool season vegetable crops
- 06. Nutrient and irrigation management in cool season vegetable crops
- 07. Role of PGR in cool season vegetable crops
- 08. Studies on system of hydroponics, aeroponics and other soil less culture in cool season vegetables
- 09. Preparation of cropping scheme for commercial farms
- 10. Identification of important pest and diseases and nematodes of cool season vegetable crops
- 11. Physiological and nutritional disorder in cool season vegetable crops
- 12. Maturity and harvesting techniques in cool season vegetable crops
- 13. Postharvest management in cool season vegetable crops
- 14. Seed production techniques in cool season vegetable crops
- 15. Working out of cost benefit ratio
- 16. Visit to commercial vegetable farms, greenhouse poly house and shade nut house

17. Final Practical Examination

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

SUGGESTED READING

- 1. Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. Vegetable crops. Vols. I-III. Naya udyog.
- 2. Bose TK, Som MG and Kabir J. (Eds.). 1993. Vegetable crops. Naya prokash.
- **3.** Chadha KL and Kalloo G. (Eds.). 1993-94. Advances in horticulture Vols. V-X. Malhotra publ. house.
- 4. Chadha KL. (Ed.). 2002. Hand book of horticulture. ICAR.
- 5. Chauhan DVS. (Ed.). 1986. Vegetable production in India. Ram prasad and sons.
- 6. Fageria MS, Choudhary BR and Dhaka RS. 2000. Vegetable crops: production technology. Vol.II, Kalyani publishers.
- 7. Gopalakrishanan TR. 2007. Vegetable crops. New India publ. agency.
- 8. Hazra P and Banerjee MK and Chattopadhyay A. 2012. Varieties of vegetable crops in India, (Second edition), Kalyani publishers, Ludhiana, 199 p.
- 9. Hazra P. 2016. Vegetable Science. 2nd edn, Kalyani publishers, Ludhiana.
- 10. Hazra P. 2019. Vegetable production and technology. New India publishing agency, New Delhi.
- 11. Hazra P, Chattopadhyay A, Karmakar K and Dutta S. 2011. Modern technology for vegetable production, New India publishing agency, New Delhi, 413p
- 12. Rana MK. 2008. Olericulture in India. Kalyani publishers, New Delhi.
- **13.** Rana MK. 2008. Scientific cultivation of vegetables. Kalyani publishers, New Delhi. Rana MK. 2014. Technology for vegetable production. Kalyani publishers, New Delhi.
- 14. Rubatzky VE and Yamaguchi M. (Eds.). 1997. World vegetables: principles, production and nutritive values. Chapman and Hall.
- 15. Saini GS. 2001. A text book of oleri and flori culture. Aman publishing house.
- **16.** Salunkhe DK and Kadam SS. (Ed.). **1998.** Hand book of vegetable science and technology: production, composition, storage and processing. Marcel dekker.
- 17. Shanmugavelu KG. 1989. Production technology of vegetable crops. Oxford and IBH.
- 18. Singh DK. 2007. Modern vegetable varieties and production technology. International book distributing Co.
- 19. Singh SP. (Ed.). 1989. Production technology of vegetable crops. Agril. comm. res. centre.
- 20. Thamburaj S and Singh N. (Eds.), 2004. Vegetables, tuber crops and spices. ICAR.
- 21. Thompson HC and Kelly WC. (Eds.). 1978. Vegetable crops. Tata McGraw-Hill.

VSC 502 PRODUCTION OF WARM SEASON VEGETABLE CROPS 2+1

WHY THIS COURSE?

Unlike cool-season vegetables, warm-season vegetable crops require higher soil and air temperature, thus, they are always planted after the last frost date ranging from late spring after the last frost date to late summer. Daytime temperature 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.

AIM OF THE COURSE

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

THEORY

Unit I

Tomato, brinjal, hot pepper and sweet pepper

Unit II

Okra, Indian bean (Sem), cluster bean and cowpea.

Unit III

Cucumber, ash gourd, bottle gourd, ridge gourd, snake gourd, bitter gourd and water melon

Unit IV

Musk melon, pumpkin, squashes, coccinea and sweet potato

Unit V

Elephant foot yam, taro, tapioca, yam, amaranth and drumstick

LECTURE SCHEDULE

Unit I

- Tomato 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 and irrigation requirements.
- Tomato 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.

- 3. Brinjal -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 and irrigation requirements.
- 4. Brinjal- 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.
- 5. Hot pepper -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 and irrigation requirements.
- 6. Hot pepper- 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.
- 7. Sweet pepper -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 and irrigation requirements.
- 8. Sweet pepper- 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.

Unit II

- 9. Okra -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 and irrigation requirements.
- 10. Okra- 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.

- 11. Indian bean -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 and irrigation requirements.
- 12. Indian bean- 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.
- 13. Cluster bean -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 and irrigation requirements.
- 14. Cluster bean -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.
- 15. Cowpea -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 and irrigation requirements.
- 16. Cowpea -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.

Unit III

17. Mid semester exam

- 18. Cucumber -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 and irrigation requirements.
- 19. Cucumber -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.

- 20. Ash gourd -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 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.
- 21. Bottle gourd and Ridge gourd-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 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.
- 22. Bitter gourd 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 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.
- 23. Snake gourd 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 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.
- 24. Water melon 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 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.

Unit IV

- 25. Musk melon 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 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.
- 26. Pumpkin 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 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.
- 27. Squashes 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 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.
- 28. Coccinea 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 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.

29. Sweet potato - 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 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.

Unit V

- 30. Elephant Foot Yam and Taro 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 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, postharvest management (grading, packaging and marking), pest and disease management.
- 31. Tapioca 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 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.
- 32. Yam 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 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.

- 33. Amaranth 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 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.
- 34. Drumstick 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 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.

PRACTICAL SCHEDULE

- 1. Scientific raising of nursery and seed treatment
- 2. Sowing, transplanting and vegetable grafting
- 3. Description of commercial varieties and hybrids
- 4. Demonstration on methods of irrigation, fertilizers and micronutrients application
- 5. Mulching practices, weed management
- 6. Use of plant growth substances in Solanaceous crops
- 7. Use of plant growth substances in Cucurbits
- 8. Study of nutritional and physiological disorders in Solanaceous crops
- 9. Study of nutritional and physiological disorders in Cucurbits
- 10. Studies on hydroponics, aeroponics and other soilless culture in tomato
- 11. Studies on hydroponics, aeroponics and other soilless culture in melons
- 12. Identification of important pest and their control measures
- 13. Identification of important diseases and their control measures
- 14. Preparation of cropping scheme for commercial farms
- 15. Visit to commercial farm, greenhouse/ polyhouses
- 16. Analysis of benefit to cost ratio

17. Practical Examination

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

- 1. Bose, T.K., J.Kabir, T.K. Maity, V.A.Parthasarathy and M.G. Som. 2003. *Vegetable crops*. Vols. I-III.Naya Udyog.
- 2. Bose, T.K., M.G. Som and J.Kabir (Eds.). 1993. Vegetable crops. Naya Prakash.
- 3. Chadha, K.L and G. Kalloo (Eds.). 1993-94. *Advances in horticulture* Vols. V-X. Malhotra Publ. house.
- 4. Chadha, K.L. (Ed.). 2002. Hand book of horticulture. ICAR.
- 5. Fageria, M.S, B.R. Choudhary and R.S. Dhaka. 2000. *Vegetable crops: Production technology*. Vol. II. Kalyani.
- 6. Gopalakrishnan, T.R. 2007. Vegetable crops. New India Publ. agency.
- 7. Hazra, P and M.K. Banerjee and A. Chattopadhyay. 2012. *Varieties of vegetable crops in India*, (Second edition), Kalyani publishers, Ludhiana, 199 p.
- 8. Hazra, P. 2016. Vegetable science. 2nd Edn, Kalyani Publishers, Ludhiana.
- 9. Hazra, P. 2019. *Vegetable production and technology*. New India Publishing Agency, New Delhi.
- 10. Hazra, P., A.Chattopadhyay, K.Karmakar and S.Dutta. 2011. *Modern technology for vegetable production*, New India Publishing Agency, New Delhi, 413p
- 11. Rana, M.K. 2008. Scientific cultivation of vegetables. Kalyani Publishers, New Delhi.
- 12. Singh, D.K. 2007. *Modern vegetable varieties and production technology*. International Book Distributing Co.
- 13. Thamburaj, S and N. Singh (Eds.). 2004. Vegetables, tuber crops and spices. ICAR.

VSC 503 GROWTH AND DEVELOPMENT OF VEGETABLE CROPS 2+1

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 itslife 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.

AIM OF THE COURSE

To teach the physiology of growth and development of vegetable crops

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; Physiology of dormancy and germination—Physiology of dormancy and germination of vegetable seeds, tubers and bulbs

Unit II

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, anti-transpirants, 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

Phototropism, Fruit physiology—Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; Parthenocarpy in vegetable crops;

Unit V

Ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening, Morphogenesis and tissue culture—Morphogenesis and tissue culture techniques in vegetable crops; Grafting techniques in different vegetable crops.

LECTURE SCHEDULE

Unit I

- 1. Growth and development Definition, importance and growth pattern in plants
- 2. Cellular structure and their functions
- 3. Steps in cell growth and development cell division, cell enlargement and differentiation
- 4. Growth factors, growth correlation and growth kinetics in crop plants
- 5. Growth analysis in vegetable crops
- 6. Phyto hormones Definition, importance, classification and application methods in vegetable crops
- 7. Physiology and biochemistry of seed dormancy and germination
- 8. Physiology of dormancy in tuber and bulb vegetables

Unit II

- 9. Auxin biosynthesis, translocation. mode of action and major functions in vegetable crops
- 10. Gibberellin and Cytokinin biosynthesis, translocation. mode of action and major functions in vegetable crops
- 11. Ethylene and Abscisic acid biosynthesis, translocation. mode of action and major functions in vegetable crops
- 12. Role and mode of function of brassinosteroids, morphactins and other growth retardants / inhibitors in vegetable crops
- 13. Use of PGR in vegetable crop production
- 14. Physiology of bud dormancy
- 15. Antitranspirants and ripening retardants definition, classification, mode of action and their application in vegetable crops
- 16. Bio-stimulants and their role in vegetable crop production

Unit III

17. Mid semester examination

- 18. Role of light in photosynthetic productivity and light compensation point
- 19. Effect of temperature, gas composition and assimilate translocation on photosynthetic productivity of crop plants
- 20. Importance of leaf and leaf arrangement, LAI in vegetable crop production
- 21. Apical dominance in plants, meristem type and functions
- 22. Flowering and flowering stimulus in plants

Unit IV

- 23. Photoperiodism and thermoperiodism in relation to flowering in vegetable crop plants
- 24. Sex expression in vegetable crop plants
- 25. Physiology of plants response to stressful environment
- 26. Plant adaptation to changing environment
- 27. Physiology of fruit set and fruit development
- 28. Parthenocarpy in vegetable crops

Unit V

- 29. Ripening physiology and changes associated with ripening
- 30. Physiology of senescence and abscission in crop plants
- 31. Ethylene inhibitor role and application method in vegetable crops
- 32. Canopy management in relation to vegetable crop production
- 33. Morphogenesis and tissue culture techniques in vegetable crops
- 34. Vegetable grafting importance, status and techniques

PRACTICAL SCHEDULE

- 1. Plant growth substances forms and preparations
- 2. Studies on types of seed germination

- 3. Dormancy mechanism in seeds, tubers and bulbs of vegetable crops
- 4. Role of plant growth substances on germination and seedling vigour in vegetable crops
- 5. Effect of bio stimulants on germination and seedling growth
- 6. Experiment on induction of dormancy in vegetable crops
- 7. Experiments on breaking seed dormancy in vegetable crops
- 8. Studies on leaf area index
- 9. Experiments on use of plant growth substances for control of flower and fruit drop in vegetable crops
- 10. Experiments on use of plant growth substances for sex modification in vegetable crops
- 11. Growth Analysis in Vegetable Crops
- 12. Study of growth and development pattern under different environments
- 13. Studies on induction of fruit ripening
- 14. Stress impact on growth and development of vegetable crop
- 15. Studies on physiological / biochemical changes associated with fruit ripening
- 16. Vegetable grafting techniques
- 17. Final practical examination

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

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.
- 2. 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.
- 3. Leopold AC and Kriedemann PE. 1981. Plant growth and development, Tata McGraw-Hill, New Delhi.
- 4. 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.
- 6. Saini *et al.* (Eds.). 2001. Laboratory manual of analytical techniques in horticulture. Agrobios, Jodhpur.

PRINCIPLES OF VEGETABLE BREEDING

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. Nevertheless, 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.

AIM OF THE COURSE

To teach basic principles and practices of vegetable breeding

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.

LECTURE SCHEDULE

Unit I

- 1. Importance and history of vegetable breeding
- 2. Evolutionary aspects of vegetable breeding
- 3. Difference between vegetable breeding and cereal crop breeding
- 4. & 5. Different methods of selection breeding / procedure and achievements
- 6. Solanaceae
- 7. Cucurbitaceae

Unit II

- 8. Brassicaceae
- 9. Apiaceae
- 10. Alliaceae
- 11. Euphorbiaceae
- 12. Malvaceae
- 13. Leguminosae
- 14. Heterosis concepts and different methods

Unit III

- 15. Solanaceae
- 16. Cucurbitaceae
- 17. Mid-Semester Examination
- 18. Brassicaceae
- 19. Apiaceae
- 20. Alliaceae
- 21. Euphorbiaceae
- 22. Malvaceae

Unit IV

- 23. Mutation breeding concepts and types
- 24. Mutation breeding achievements in vegetable crops
- 25. Ploidy breeding concepts and methods
- 26. Ploidy breeding achievements in vegetable crops
- 27. Difference between traditional breeding and ideotype breeding
- 28. Main point of ideotype and steps in ideotype breeding

Unit V

- 29. Selection of ideal plant type
- 30. Features of ideotype
- 31. General plant ideotype concepts in leguminosae

- 32. Merits and demerits of ideotype breeding
- 33. Ideotype breeding in Brassicaceae
- 34. Ideotype breeding in root crops

PRACTICAL SCHEDULE

- 1. Floral biology and pollination behaviour of different vegetable crops
- 2. Techniques of selfing and crossing of Cole crops
- 3. Techniques of selfing and crossing of okra
- 4. Techniques of selfing and crossing of Cucurbits
- 5. Techniques of selfing and crossing of tomato
- 6. Techniques of selfing and crossing of eggplant
- 7. Techniques of selfing and crossing of hot pepper
- 8. Techniques of selfing and crossing of potato
- 9. Techniques of selfing and crossing of peas and beans
- 10. Male sterility and self-incompatibility systems in vegetable crops
- 11. Calculation of Heterosis, Heterobeltios is and Standard Heterosis in vegetable crops
- 12. Breeding for biotic stress and abiotic stress resistance in vegetable crops
- 13. Application of In-vitro and molecular techniques in vegetable improvement
- 14. Breeding system and handling of filial generations of different vegetables
- 15. Exposure to biotechnological lab practices
- 16. Visit to breeding farms
- 17. Practical Examination

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 ofvegetable crops
- Understand how the basic principles are important to start breeding of vegetablecrops

SUGGESTED READING

- 1. Allard RW. 1960. Principle of plant breeding. John Willey and Sons, USA.
- 2. Kalloo G. 1988. Vegetable breeding (Vol. I, II, III). CRC Press, Fl, USA.
- 3. Kole CR. 2007. *Genome mapping and molecular breeding in plants-vegetables*. Springer, USA.
- 4. Peter KVand Pradeep Kumar T. 1998. Genetics and breeding of vegetables. ICAR, New Delhi, p.488.
- 5. Prohens J and Nuez F. 2007. *Handbook of plant breeding-vegetables* (Vol I and II). Springer, USA.
- Singh BD. 2007. Plant breeding- principles and methods (8thedn.). Kalyani Publishers, New Delhi.

7. Singh Ram J. 2007. *Genetic resources, chromosome engineering, and crop improvement-vegetable crops* (Vol. 3). CRC Press, Fl, USA.

VSC 505 BREEDING OF SELF-POLLINATED VEGETABLE CROPS 2+1

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 selfpollinated vegetable crops.

AIM OF THE COURSE

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

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.

LECTURE SCHEDULE

Unit I

- 1. Origin, botany, taxonomy and wild relatives of potato
- 2. Cytogenetics and genetics, types of pollination, fertilization mechanism and sterility in potato
- 3. Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy) of potato
- 4. Varieties and varietal characterization of potato
- 5. Breeding for biotic and abiotic stresses resistance in potato

Unit II

- 6. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility in tomato
- Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in tomato
- 8. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility in eggplant
- 9. Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in eggplant
- 10. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in hot pepper
- 11. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in sweet pepper
- 12. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility in okra
- 13. Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in okra

Unit III

- 14. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility in garden pea
- 15. Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy) of garden pea
- **16.** Varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in garden pea

17. Mid Semester Examination

- **18.** Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility in cowpea
- 19. Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in cowpea

Unit IV

- 20. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility in French bean
- 21. Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in French bean
- 22. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility in Indian bean
- 23. Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in Indian bean
- 24. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility in cluster bean
- 25. Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in cluster bean
- 26. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in broad bean

Unit V

- 27. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility in lettuce
- 28. Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in lettuce
- 29. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of

pollination, fertilization mechanism and sterility in fenugreek.

- 30. Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in fenugreek.
- 31. Breeding for protected environment in self pollinated vegetable crops
- 32. Breeding for quality improvement in self pollinated vegetable crops
- 33. Molecular markers and marker's assisted breeding in self pollinated vegetable crops
- 34. QTLs, PPV and FR Act in self pollinated vegetable crops

PRACTICAL SCHEDULE

- 1. Floral mechanisms favouring self and often cross pollination
- 2. Progeny testing and development of inbred lines in self pollinated vegetable crops
- Selection of desirable plants from breeding population, observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations
- 4. Palynological studies, selfing and crossing techniques in potato
- 5. Palynological studies, selfing and crossing techniques in tomato and eggplant
- 6. Palynological studies, selfing and crossing techniques in hot pepper and sweet pepper
- 7. Palynological studies, selfing and crossing techniques in Leguminous vegetables
- 8. Palynological studies, selfing and crossing techniques in leafy vegetables
- 9. Hybrid seed production of potato
- 10. Hybrid seed production of tomato and eggplant
- 11. Hybrid seed production of hot pepper and sweet pepper
- 12. Hybrid seed production of Leguminous vegetables
- 13. Hybrid seed production of leafy vegetables
- 14. Screening techniques for biotic and abiotic stress resistance in self pollinated vegetable crops
- 15. Molecular marker techniques to identify useful traits in the self pollinated vegetable crops and special breeding techniques
- 16. Visit to breeding farms

17. Final practical examination

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

SUGGESTED READING

- 1. Allard RW. 1999. Principles of plant breeding. John Wiley and Sons.
- 2. Basset MJ. (Ed.). 1986. Breeding vegetable crops. AVI Publ.

- 3. Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005, Plant genetic resources: horticultural crops. Narosa Publ. House.
- 4. Fageria MS, Arya PS and Choudhary AK. 2000, Vegetable crops: Breeding and seed production. Vol. I. Kalyani.
- 5. Gardner EJ. 1975. Principles of genetics. John Wiley and Sons.
- 6. Hayes HK, Immer FR and Smith DC. 1955. Methods of plant breeding. McGraw-Hill.
- 7. Hayward MD, Bosemark NO and Romagosa I. (Eds.). 1993. Plant Breeding-principles and prospects. Chapman and Hall.
- 8. Hazra P and Som MG. 2015. Vegetable science (Second revised edition), Kalyani publishers, Ludhiana, 598 p.
- 9. Hazra P and Som MG. 2016. Vegetable seed production and hybrid technology (Second revised edition), Kalyani Publishers, Ludhiana, 459 p
- 10. 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.
- 12. Paroda RS and Kalloo G. (Eds.). 1995. Vegetable research with special reference to hybrid technology in Asia-Pacific Region. FAO.
- Peter KV and Pradeepkumar T. 2008. Genetics and breeding of vegetables. Revised, ICAR. Peter KV and Hazra P. (Eds). 2012. Hand book of vegetables. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.
- 14. Peter KV and Hazra P (Eds). 2015. Hand book of vegetables Volume II.Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509 p.
- 15. Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume III.Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 634 p.
- 16. Rai N and Rai M. 2006. Heterosis breeding in vegetable crops. New India Publ. Agency.
- Ram HH. 1998. Vegetable breeding: principles and practices. Kalyani Publishers, New Delhi. Simmonds NW. 1978. Principles of crop improvement. Longman. Singh BD. 1983. Plant Breeding. Kalyani Publishers, New Delhi.
- 18. Singh PK, Dasgupta SK and Tripathi SK. 2004. Hybrid vegetable development. International Book Distributing Co.
- 19. Swarup V. 1976. Breeding procedure for cross-pollinated vegetable crops. ICAR.

VSC 506 BREEDING OF CROSS POLLINATED VEGETABLE CROPS *762+1

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

varieties. Since cross-pollinated vegetable crops are naturally hybrid (heterozygous) 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.

AIM OF THE COURSE

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

THEORY

Origin, botany, 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.

LECTURE SCHEDULE

Unit I

- 1. Origin, botany, taxonomy and wild relatives, cytogenetics, genetics, types of pollination, fertilization mechanism and sterility and incompatibility in gourds
- 2. Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy) in gourds
- 3. Varieties, varietal characterization and breeding for biotic and abiotic stresses resistance in gourds
- 4. Origin, botany, taxonomy and wild relatives, cytogenetics, genetics, types of pollination, fertilization mechanism and sterility and incompatibility in melons
- Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties, varietal characterization and biotic and abiotic stresses resistance in melons
- 6. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding
methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in cucumber

- 7. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in pumpkin
- 8. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in squashes

Unit II

- 9. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility in cauliflower
- 10. Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in cauliflower
- 11. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility in cabbage
- 12. Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in cabbage
- 13. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in kholrabi
- 14. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in Broccoli
- 15. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in Brussels sprout

Unit III

16. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of

pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in carrot

17. Mid semester examination

- 18. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in radish
- 19. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in turnip
- 20. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in beetroot
- 21. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility in small and bellary onion
- 22. Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in small and bellary onion

Unit IV

- 23. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility in sweet potato
- 24. Breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in sweet potato
- 25. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in tapioca
- 26. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in taro

27. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in yam

Unit V

- 28. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in beet leaf
- 29. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in spinach
- 30. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in amaranth
- 31. Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination, fertilization mechanism and sterility, breeding objectives and breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, breeding for biotic and abiotic stresses resistance in coriander
- 32. Breeding for quality improvement in cross pollinated vegetable crops
- 33. Molecular markers and marker's assisted breeding in cross pollinated vegetable crops
- 34. QTLs, PPV and FR Act in cross pollinated vegetable crops

PRACTICAL SCHEDULE

- 1. Floral mechanisms for favouring cross pollination
- 2. Progeny testing and development of inbred lines in cross pollinated vegetable crops
- Selection of desirable plants from breeding population, observations and analysis of various qualitative and quantitative traits in germplasm of cross pollinated vegetable crops
- 4. Analysis of various qualitative and quantitative traits in hybrids (heterosis) and segregating generations of cross pollinated vegetable crops
- 5. Palynological studies and crossing techniques in cucurbitaceous vegetables
- 6. Palynological studies and crossing techniques in cole crops

- 7. Palynological studies and crossing techniques in root, bulb and tuberous vegetables
- 8. Palynological studies and crossing techniques in leafy vegetables (beet leaf, spinach, amaranth and coriander)
- 9. Hybrid seed production of cucurbitaceous vegetables
- 10. Hybrid seed production of cole crops
- 11. Hybrid seed production of root and bulb vegetables
- 12. Hybrid seed production of leafy vegetables
- **13.** Screening techniques for biotic and abiotic stress resistance in cross pollinated vegetable crops
- 14. Demonstration of sib-mating and mixed population in cross pollinated vegetable crops
- 15. Molecular marker techniques to identify useful traits in the cross pollinated vegetable crops and special breeding techniques
- 16. Visit to breeding blocks

17. Final practical examination

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

SUGGESTED READING

- 1. Allard RW. 1999. *Principles of plant breeding*. John Wiley and Sons.
- 2. Basset MJ. (Ed.). 1986. *Breeding vegetable crops*. AVI Publ.
- 3. Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005. *Plant genetic resources: horticultural crops*. Narosa publ. house.
- 4. Fageria MS, Arya PS and Choudhary AK. 2000. *Vegetable crops: breeding and seed production*.Vol. I. Kalyani.
- 5. Gardner EJ. 1975. *Principles of genetics*. John Wiley and Sons.
- 6. Hayes HK, Immer FR and Smith DC. 1955. *Methods of plant breeding*. McGraw-Hill.
- 7. Hayward MD, Bosemark NO and Romagosa I. (Eds.), 1993. *Plant breeding-principles and prospects*. Chapman and Hall.
- 8. Hazra P and Som MG. 2015. *Vegetable science* (Second revised edition), Kalyani publishers, Ludhiana, 598 p.
- 9. Hazra P and Som MG. 2016. *Vegetable seed production and hybrid technology* (Second revised edition), Kalyani Publishers, Ludhiana, 459 p
- 10. Kalloo G. 1988. Vegetable breeding. Vols. I-III. CRC Press.
- 11. Kalloo G. 1998. *Vegetable breeding*. Vols. I-III (Combined Ed.). Panima Edu. Book Agency.
- 12. Kumar JC and Dhaliwal MS. 1990. *Techniques of developing hybrids in vegetable crops*. Agro botanical publ.

- 13. Paroda RS and Kalloo G. (Eds.). 1995. Vegetable research with special reference to hybrid technology in Asia-Pacific region. FAO.
- 14. Peter KV and Pradeepkumar T. 2008. *Genetics and breeding of vegetables.* Revised, ICAR.
- 15. Peter KV and Hazra P. (Eds). 2012. *Hand book of vegetables*. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.
- 16. Peter KV and Hazra P. (Eds). 2015. *Hand book of vegetables* Volume II and III. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509 p.
- 17. Prohens J and Nuez F. 2007. *Handbook of Plant Breeding- Vegetables* (Vol I and II), Springer, USA.
- 18. Rai N and Rai M. 2006. *Heterosis breeding in vegetable crops*. New India Publ. Agency.
- 19. Ram HH. 1998. *Vegetable breeding: principles and practices*. Kalyani Publishers, New Delhi.
- 20. Simmonds NW. 1978. Principles of crop improvement. Longman.
- 21. Singh BD. 1983. Plant breeding. Kalyani Publishers, New Delhi.
- 22. Singh PK, Dasgupta SK and Tripathi SK. 2004. *Hybrid vegetable development*. International book distributing Co.
- 23. Swarup V. 1976. Breeding procedure for cross-pollinated vegetable crops. ICAR.

VSC 507 PROTECTED CULTIVATION OF VEGETABLE CROPS 2+1

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 environmentto 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.

AIM OF THE COURSE

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

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/ green house structures and Classification of protected structures.

Unit II

Types of protected structure- and types of protected structures greenhouse/polyhouses, 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;

Unit III

Soil and soil-less media for bed preparation; Design and installation of drip irrigation and fertigation system. 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 and Cultivation of crops - High tech vegetable nursery raising in protected structures using plugs and portrays, different media for growing nursery under protected cultivation; Nursery problems and management technologies including fertigation- 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 V

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 green house crop production.

LECTURE SCHEDULE

Unit I

1. Concept and scope and importance of protected cultivation of vegetable crops

- 2. Principles, design, orientation of green house structure
- 3. Low cost polyhouses/ greenhouse structures.
- 4. High cost polyhouses/ greenhouse structures
- 5. Classification of protected structures

Unit II

- 6. Types of protected structures green house / polyhouse
- 7. Plastic and non plastic low tunnels, plastic walk in tunnels
- 8. High roof tunnels with ventilation
- 9. Insect proof net houses
- 10. Shade net houses
- 11. Rain shelters, naturally ventilated polyhouses
- 12. Climate control green houses
- 13. Hydroponics and aeroponics

Unit III

- 14. Bed preparation using soil
- 15. Types of media used for bed preparation
- 16. Design and installation of drip irrigation
- 17. Mid semester examination
- 18. Fertigation system in green house
- 19. Effect of environmental factors and manipulation of temperature and light on growth and yield of different vegetables.
- 20. Effect of environmental factors and manipulation of carbon dioxide and humidity on growth and yield of different vegetables

Unit IV

- 21. High tech vegetable nursery using pro-trays
- 22. Different media used nursery under protected cultivation
- 23. Nursery problems and their management technologies
- 24. Regulation of flowering and fruiting in vegetable crops
- 25. Technology for raising tomato in protected structure
- 26. Technology for raising sweet pepper in protected structure
- 27. Technology for raising cucumber in protected structure

Unit - V

- 28. Problems of growing vegetables in protected structures and their remedies
- 29. Physiological disorders in vegetables in protected cultivation
- 30. Insect and disease management in protected cultivation
- 31. Seed production in tomato under protected structure
- 32. Seed production in sweet pepper under protected structure
- 33. Seed production in cucumber under protected structure
- 34. Economics of green house cultivation

PRACTICAL SCHEDULE

1. Study of various types of protected structures

- 2. Nursery management to raise quality seedlings for protected cultivation
- 3. Study of soil sterilization in protected structures
- 4. Methods to control temperature and humidity
- 5. Methods to control carbon dioxide and light
- 6. Study of different types of growing media
- 7. Training and pruning systems in tomato under protected structure
- 8. Training and pruning systems in sweet pepper under protected structure
- 9. Training and pruning systems in cucumber under protected structure
- 10. Study of fertigation and nutrient management under protected structures
- 11. Pest and disease management in protected structures
- 12. Use of protected structures in hybrid seed production of tomato
- 13. Use of protected structures in hybrid seed production of sweet pepper
- 14. Use of protected structures in hybrid seed production of cucumber
- 15. Economics of tomato cultivation in green house
- 16. Visit to established green/ polyhouses/ shade net houses in the region
- 17. Practical Examination

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 asentrepreneur

SUGGESTED READING

- 1. Chadha KL and Kalloo G. (Eds.). 1993-94. *Advances in horticulture*. Malhotra Pub. House.
- 2. Chandra S and Som V. 2000. *Cultivating vegetables in green house*. Indian horticulture 45:17-18.
- 3. Kalloo G and Singh K. (Eds.). 2000. *Emerging scenario in vegetable research and development*.Research periodicals and Book publ. house.
- 4. Parvatha RP. 2016. *Sustainable crop protection under protected cultivation*. E-Book Springer.
- 5. Prasad S and Kumar U. 2005. *Greenhouse management for horticultural crops*. 2nd Ed. Agrobios.
- 6. Resh HM. 2012. *Hydroponic food production*. 7thEdn. CRC Press.
- 7. Singh B. 2005. Protected cultivation of vegetable crops. Kalyani publishers, New Delhi
- 8. Singh DK and Peter KV. 2014. *Protected cultivation of horticultural crops* (1st Edition) New India publishing agency, New Delhi.

VSC 508 SEED PRODUCTION OF VEGETABLE CROPS

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 cannot be realized. The use of high quality seed thus, playsa 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.

AIM OF THE COURSE

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

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 varieties, 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, 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

LECTURE SCHEDULE

Unit I-Introduction, history, propagation and reproduction

- 1. Seed Definition characters of good quality seed Significance of quality seeds
- 2. Seed Morphology of different vegetable crops, Apomixis and fertilization
- 3. Pollination Mechanisms and sex forms in vegetable
- 4. Seed development and maturation
- 5. History and current status of vegetable seed production
- 6. Status and share of vegetable seeds in seed industry

Unit II-Agro-climate and methods of seed production

- 7. Climate and its influence on quality seed production
- 8. Varietal deterioration of crops Causes and Maintenance
- 9. Genetic and Agronomic Principles of seed production in vegetable crops
- 10. Factors influencing vegetable seed production Seed Village Concept
- 11. Varietal and Hybrid seed Production in Tomato, Brinjal, chilli and sweet pepper
- 12. Varietal and Hybrid seed Production in bhendi
- 13. Varietal and Hybrid seed Production in cucurbitaceous vegetables
- 14. Varietal and Hybrid seed Production in Cauliflower and cabbage
- 15. Varietal and Hybrid seed Production in Carrot, Beetroot and Radish
- 16. Varietal and Hybrid seed Production in lab lab, Cluster bean, Vegetable cowpea, peas and beans.

17. Mid Semester Examination

- 18. Varietal and Hybrid seed Production in Amaranthus, Palak, Spinach, Lettuce, Black nightshade
- 19. Varietal and Hybrid seed Production in Moring and onion

Unit III- Seed multiplication and its quality maintenance

- 20. Seed Multiplication ratio, Seed replacement rate and Varietal replacement
- 21. Generation system of seed multiplication in supply chain and Seed Renewal period

22. Maintenance and production of nucleus, breeder, foundation, certified/truthful label seeds

Unit IV- Seed harvesting, extraction and its processing

- 23. Maturity indices Seed harvesting and Extraction
- 24. Seed Processing and their importance Seed processing sequence for various crops - Seed treatment and packaging materials
- 25. Seed quality enhancement techniques for major vegetable crops Seed health test and control measurements
- 26. Seed Storage Basic principles and factors affecting seed viability
- 27. Storage Behaviour of Orthodox and Recalcitrant seeds
- 28. Seed dormancy Response of dormant seeds in storage condition

Unit V- Improved agro-techniques, field and seed standards

- 29. True potato seed production and seed plot technique in potato
- 30. Clonal Multiplication Techniques in Potato, Sweet potato, Tapioca, Colocasia and yam
- 31. Field and seed standards for important vegetable crops
- 32. International seed movement and factors affecting seed marketing
- 33. Planning for seed production programme criteria for selection of season, variety and location infrastructure facilities
- 34. Aspects of the Indian vegetable seed industry and future Prospects

PRACTICAL SCHEDULE

- 1. Examine the external and internal structure vegetable seeds
- 2. Study of floral biology and pollination mechanisms in vegetables
- 3. Preparation of nurseries and practicing recommended seed treatment techniques for vegetable seeds
- 4. Use of pollination control mechanisms in hybrid seed production of important vegetables
- 5. Practicing emasculation and pollination methods in major vegetables
- 6. Identification of Genetic contaminants in Vegetable Seed production field
- 7. Visit to commercial seed production farm/areas
- 8. Identification of Maturity indices in vegetable crops
- 9. Practicing wet seed extraction methods Tomato, brinjal, bitter gourd, pumpkin, water melon, musk melon and cucumber
- 10. Practicing dry seed extraction methods chilli, bhendi, ridge gourd and bottle gourd
- 11. Visit to seed processing unit
- 12. Seed sampling and testing
- 13. Visit to seed production plot and seed testing laboratory
- 14. Seed production planning for vegetables
- 15. Economics of varietal and hybrid seed production in vegetables
- 16. Visit to private vegetable seed company
- 17. Final practical examination

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 andpost-extraction processing of vegetable seeds
- Adoption of seed production of vegetable crops as entrepreneur

SUGGESTED READING

- Agarwal, R.L. 2012. Seed Technology. Oxford & IBH Publishing Company Pvt. Ltd., New Delhi.
- Vanangamudi, K., Natarajan, N., Srimathi, P., Natarajan, K., Saravanan, T., Bhaskaran, M., Bharathi, A., Natesan, P. and Malarkodi, K. 2006. Advances in Seed Science and 1333 Technology. Vol. 2. Quality Seed Production in Vegetables. Agro bios, Jodhpur.
- **3.** Maiti, R.K., Sarkar, N.C. and Singh, V.P. 2006. Principles of Post Harvest Seed Physiology and Technology. Agrobios, Jodhpur, Rajasthan
- 4. Singhal, N. C. 2010. Seed Science and Technology. Kalyani Publishers, New Delhi.
- 5. Kulkarni, G. N. 2011. Principles of Seed Technology. Kalyani Publishers, New Delhi.
- 6. McDonald, M.B. and Copeland, L. 1998. Seed Production Principles and Practices. CBS Publishers, New Delhi.

VSC 509 PRODUCTION OF UNDERUTILIZED VEGETABLE CROPS 2+1

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 gualities 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 orrarely 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.

AIM OF THE COURSE

To impart knowledge about production technology of lesser utilized vegetable crops

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 different underutilized vegetable crops

Unit I

Scope and iimportance of underutilized vegetable crops, Asparagus, leek, Chinese chive, red cabbage, Chinese cabbage and kale

Unit II

Lettuce, celery, parsley, endive, chicory and Indian spinach

Unit III

Spinach, chenopods, chekurmani, black nightshade, *solanum tarvum* and sweet gourd.

Unit IV

Spine gourd, teasle gourd, round gourd, and little/ Ivy gourd, athalakai, pointed gourd and kachri,

Unit V

Long melon, snap melon, gherkin, yam bean, lima bean, winged bean and Underutilized yams

LECTURE SCHEDULE

Unit I

- 1. Scope and iimportance of underutilized vegetable crops
- 2. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of Asparagus
- 3. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of Leek
- 4. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of Chinese chive
- 5. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of red cabbage

- 6. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of Chinese cabbage
- 7. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of Kale

Unit II

- 8. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of lettuce
- 9. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of celery
- 10. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of Parsley
- 11. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of endive
- 12. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of chicory
- 13. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of Indian spinach (poi)

Unit III

- 14. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of spinach
- 15. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of chenopods
- 16. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of chekurmanis

17. Mid-semester examination

- 18. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of black night shade
- 19. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest

management and plant protection measures of solanum tarvum

20. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of sweet gourd

Unit IV

- 21. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of spine gourd
- 22. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of teasle gourd
- 23. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of round gourd
- 24. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of little/ lvy gourd
- 25. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of athallakai
- 26. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of pointed gourd
- 27. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of kachri

Unit V

- 28. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of long melon
- 29. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of snap melon
- 30. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of gherkin
- 31. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of yam bean
- 32. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest

management and plant protection measures of lima bean

- 33. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of winged bean
- 34. Botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting, yield, post harvest management and plant protection measures of underutilized yams

PRACTICAL SCHEDULE

- 1. Identification of seeds; botanical description of plants and varieties of underutilized stem vegetables
- 2. Identification of seeds; botanical description of plants and varieties of underutilized bulbous vegetables
- 3. Identification of seeds; botanical description of plants and varieties of underutilized cole crops
- 4. Identification of seeds; botanical description of plants and varieties of underutilized salad vegetables
- 5. Identification of seeds; botanical description of plants and varieties of underutilized leafy vegetables
- 6. Identification of seeds; botanical description of plants and varieties of underutilized gourds
- 7. Identification of seeds; botanical description of plants and varieties of underutilized melons
- 8. Identification of seeds; botanical description of plants and varieties of underutilized yam
- 9. Identification of seeds; botanical description of plants and varieties of underutilized beans
- 10. Identification of seeds; botanical description of plants and varieties of black nightshade and *solanum tarvum*
- 11. Propagation methods followed in different underutilized vegetable crops
- 12. Production, lay out and method of planting followed in major underutilized vegetable crops
- 13. Important cultural operations followed in underutilized vegetable crops
- 14. Identification of important pests and diseases and their control in major underutilized vegetable crops
- 15. Maturity standards and harvesting in major underutilized vegetable crops
- 16. Visit to local farms.

17. Practical examination

LEARNING OUTCOME

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

• Appreciate the scope and scenario of production of underutilized vegetable

cropsin India

- Acquire knowledge about the production technology of underutilized vegetable crops
- Adopting production of lesser utilised crops as entrepreneur

SUGGESTED READING

- 1. Bhat KL. 2001. Minor vegetables-untapped potential. Kalyani publishers, New Delhi.
- 2. Indira P and Peter KV. 1984. Unexploited tropical vegetables. Kerala Agricultural University, Kerala.
- 3. Pandey AK. 2011. Aquatic vegetables. Agrotech publisher academy, New Delhi.
- 4. Peter KV. (Eds.). 2007-08. Underutilized and underexploited horticultural crops. Vol.1-4, New India Publishing Agency, Lucknow.
- 5. Peter KV and Hazra P. (Eds). 2012. Hand book of vegetables. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.
- 6. Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume II and III. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509 p.
- 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
- 8. Rubatzky VE and Yamaguchi M. 1997. World vegetables: vegetable crops. NBPGR, New Delhi.

VSC 510 SYSTEMATICS OF VEGETABLE CROPS 1+1

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.

AIM OF THE COURSE

To impart knowledge on morphological, cytological and molecularvegetable crops

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, history, evolution and distribution of vegetable crops; Botanical description of genera, species and morphological important key to identify the solanaceae and cucurbitaceae family vegetables

Unit III

Botanical description of genera, species and morphological important key to identify the cruciferaceae, alliaceae, malvaceae, umbelliferae and chenopodiacae family vegetables

Unit IV

Botanical description of genera, species and morphological important key to identify the fabaceae, moringaceae, amaranthaceae, euphorbiaceae and convolvulaceae, araceae, dioscoreaceae and labiatae family vegetables

Unit V

Cytological level of various vegetable crops with descriptive keys; Molecular markers—Importance of molecular markers in evolution of vegetable crops; Molecular markers as an aid in characterization and taxonomy of vegetable crops

LECTURE SCHEDULE

Unit I

- 1. Significance of systematics and crop diversity in vegetable crops
- 2. Principles of classification of vegetables and different methods of classification of vegetables
- 3. Salient features of international code of nomenclature of vegetable crops

Unit II

- 4. Origin, history, evolution and distribution of vegetable crops,
- 5. Botanical description of genera, species and morphological important key to identify the solanaceae family vegetables
- 6. Botanical description of genera, species and morphological important key to identify the cucurbitaceae family vegetables

Unit III

- 7. Botanical description of genera, species and morphological important key to identify the cruciferaceae family vegetables
- 8. Botanical description of genera, species and morphological important key to identify the alliaceae and malvaceae family vegetables

9. Mid-Semester Exam

10. Botanical description of genera, species and morphological important key to identify the umbelliferae and chenopodiacae family

Unit IV

- 11. Botanical description of genera, species and morphological important key to identify the fabaceae family vegetables
- 12. Botanical description of genera, species and morphological important key to identify the moringaceae and amaranthaceae family vegetables
- 13. Botanical description of genera, species and morphological important key to identify the euphorbiaceae and convolvulaceae family vegetables
- 14. Botanical description of genera, species and morphological important key to identify the araceae, dioscoreaceae and labiatae family vegetables

Unit V

- 15. Cytological level of various vegetable crops and descriptive keys for important vegetable crops
- 16. Importance of molecular markers in evolution of vegetable crops
- 17. Molecular markers as an aid in characterization and taxonomy of vegetable crops

PRACTICAL SCHEDULE

- 01. Identification, description, classification and maintenance of vegetable species and varieties of solanaceae family.
- 02. Identification, description, classification and maintenance of vegetable species and varieties of cucurbitaceae family gourds.
- 03. Identification, description, classification and maintenance of vegetable species and varieties of cucurbitaceae family melons.
- 04. Identification, description, classification and maintenance of vegetable species and varieties of alliaceae family.
- 05. Identification, description, classification and maintenance of vegetable species and varieties of cruciferaceae family.
- 06. Identification, description, classification and maintenance of vegetable species and varieties of umbelliferae family.
- 07. Identification, description, classification and maintenance of vegetable species and varieties of chenopodiacae family
- 08. Identification, description, classification and maintenance of vegetable species and varieties of fabaceae family
- 09. Identification, description, classification and maintenance of vegetable species and varieties of moringaceae family
- 10. Identification, description, classification and maintenance of vegetable species and varieties of amaranthaceae family
- 11. Identification, description, classification and maintenance of vegetable species and varieties of malvaceae family
- 12. Identification, description, classification and maintenance of vegetable species and varieties of asteraceae family.
- 13. Identification, description, classification and maintenance of vegetable species and varieties of euphorbiaceae and convolvulaceae families.

- 14. Identification, description, classification and maintenance of vegetable species and varieties of araceae, dioscoreaceae and labiatae families.
- 15. Collection of locally available allied species, genera and preparation of keys to the species and varieties.
- 16. Methods of preparation of herbarium and specimens.

17. Final practical examination

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

SUGGESTED READING

- 1. Chopra GL.1968. Angiosperms Systematics and Life Cycle. S. Nagin 37
- 2. Dutta AC.1986. A Class Book of Botany. Oxford Univ. Press.
- 3. Pandey BP.1999. *Taxonomy of Angiosperm*. S. Chand & Co.
- 4. Peter KV & Pradeepkumar T. 2008. *Genetics and Breeding of Vegetables*. (Revised), ICAR
- 5. Peter KV and Hazra P. (Eds). 2012. Hand book of vegetables. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.
- 6. Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume II. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509p.
- 7. Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume III. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 634p.
- 8. Simmonds NW and Smartt J. 1995. Evolution of crop plants.
- 9. Soule J. 1985. *Glossary for Horticultural Crops*. John Wiley & Sons.
- 10. Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS. 2001. *Minimal Descriptors if Agri-Horticultural Crops*. Part-II: *Vegetable Crops*. NBPGR, New Delhi.
- 11. Vasistha. 1998. Taxonomy of Angiosperm. Kalyani.
- 12. Vincent ER & Yamaguchi M. 1997. World Vegetables. 2nd Ed. Chapman & Hall.
- 13. Wiley-Blackwell. Soule J. 1985. Glossary for Horticultural Crops. John Wiley and Sons.

VSC 511 ORGANIC VEGETABLE PRODUCTION 1+1

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.

AIM OF THE COURSE

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

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 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

LECTURE SCHEDULE

Unit - I

- 1. Organic Farming Definition, concepts and importance
- 2. Trends in organic farming Indian and Global scenario, Prospects and constraints
- 3. Organic vegetable production Principles and Concepts
- 4. Approaches in organic farming, organic agriculture movement and promotion of organic farming in India
- 5. Importance and steps involved in organic transition

Unit - I

- 6. Organic production of Solanaceous vegetables
- 7. Organic production of okra and cucurbitaceous vegetables
- 8. Organic production of cool season vegetables (cole crops / beans)

9. Mid-semester examination

10. Organic production of roots, tubers and bulbous vegetables

Unit III

- 11. Role of bio-fertilisers and composts in organic vegetable production system
- 12. Role of green manures, green leaf manures, concentrated organic manures and liquid manures in organic vegetable production system
- 13. Weed management strategies under organic vegetable production system

Unit IV

- 14. Biodynamic agriculture definition, principle and methods
- 15. Role of ITK's in organic vegetable production
- 16. Pest and disease management strategies in organic vegetable production system

Unit V

17. Organic certification including GAP and GMP. Export opportunities and challenges for organic products

PRACTICAL SCHEDULE

- 1. Composting principles, advantages and techniques
- 2. Recycling farm waste through vermin-composting
- 3. Role of bio-fertilizers and their application methods in vegetable crops
- 4. Seed treatment methods for organic vegetable production
- 5. Soil solarisation for nursery production of vegetable seedlings
- 6. Organic production of vegetable crops
- 7. Role of green manure and green leaf manure in organic vegetable cultivation
- 8. VAM in vegetable crops
- 9. Preparation of panchagavya and jeevamrutham
- 10. Weed management in organic vegetable cultivation
- 11. Biodynamic agriculture
- 12. Preparation and use of botanicals in organic vegetable production
- 13. Non-chemical method of plant protection
- 14. Indigenous technical knowledge
- 15. Organic certification standards and agencies
- 16. Visit to organic farm and organic produces trading centre
- 17. Final practical examination

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 sentrepreneur

SUGGESTED READING

- 1. Dahama AK. 2005. Organic farming for sustainable agriculture. 2nd Ed. Agrobios.
- 2. Gehlot G. 2005. Organic farming; standards, accreditation certification and inspection. Agrobios.
- 3. Palaniappan SP and Annadorai K. 2003. Organic farming, theory and practice. Scientific publ.
- 4. Pradeepkumar T, Suma B, Jyothibhaskar and Satheesan KN. 2008. Management of horticultural crops. New India Publ. Agency.
- 5. Shivashankar K. 1997. Food security in harmony with nature. 3rd IFOAMASIA, ScientificConf. 1- 4 December, UAS, Bangalore.

VSC 512 PRODUCTION OF SPICE CROPS 2+1

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 spicesis 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.

AIM OF THE COURSE

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

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, kernel and bark - Clove, nutmeg and cinnamon

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

LECTURE SCHEDULE

Unit I

- 1. Introduction, importance and classification of spice crops
- 2. Historical accent, present status (national and international), future prospects of spice crops in India
- 3. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, site selection, layout, planting time and methods, training and pruning in black pepper
- 4. Nutritional and irrigation requirement, intercropping, mixed cropping, intercultural operations, weed control, mulching, harvesting, post-harvest management, physiological disorders and plant protection measures in black pepper
- 5. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, site selection, layout, planting time and methods, shade regulation, pruning in small cardamom
- 6. Nutritional and irrigation requirement, intercropping, mixed cropping, intercultural operations (Trashing), weed control, mulching, harvesting, post-harvest management and plant protection measures in small cardamom
- 7. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, site selection, layout, sowing/ planting time and methods, seed rate and seed treatment, nutritional and irrigation requirement, intercropping, mixed cropping, intercultural operations (Trashing) weed control, mulching, harvesting, post-harvest management and plant protection measures in large cardamom
- 8. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, 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, harvesting, post-harvest management and plant protection measures in all spice

Unit II

- Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, site selection, layout, sowing/ planting time and methods, seed rate and seed treatment, nutritional and irrigation requirement, intercropping, mixed cropping in clove
- 10. Intercultural operations, weed control, mulching, harvesting, post-harvest management and plant protection measures in clove
- 11. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, site selection, layout, sowing/ planting time and methods, seed rate and seed treatment, nutritional and irrigation requirement, intercropping, mixed cropping in nutmeg
- 12. Sex problems, Intercultural operations, weed control, mulching, harvesting, postharvest management and plant protection measures in nutmeg
- 13. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, species, propagation, site selection, layout, sowing/ planting time and methods, seed rate and seed treatment, nutritional and irrigation requirement, intercropping, mixed cropping in cinnamon
- 14. Intercultural operations, weed control, mulching, harvesting, post-harvest management and plant protection measures in cinnamon

Unit III

- 15. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, species, propagation, site selection, layout, sowing/ planting time and methods, seed rate and seed treatment, nutritional and irrigation requirement, intercropping, mixed cropping in turmeric
- 16. Intercultural operations, weed control, mulching, harvesting, post-harvest management and plant protection measures in turmeric
- 17. Mid semester Examination
- 18. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, species, propagation, site selection, layout, sowing/ planting time and methods, seed rate and seed treatment, nutritional and irrigation requirement, intercropping, mixed cropping in ginger
- 19. Intercultural operations, weed control, mulching, harvesting, post-harvest management and plant protection measures in ginger
- 20. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, species, propagation, site selection, layout, sowing/ planting time and methods, seed rate and seed treatment, nutritional and irrigation requirement, intercropping, mixed cropping in garlic
- 21. Intercultural operations, weed control, mulching, harvesting, post-harvest management and plant protection measures in garlic

Unit IV

- 22. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, 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, harvesting, post-harvest management and plant protection measures in coriander
- 23. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, 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, harvesting, post-harvest management and plant protection measures in fenugreek
- 24. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, 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, harvesting, post-harvest management and plant protection measures in cumin
- 25. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, 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, harvesting, post-harvest management and plant protection measures in fennel
- 26. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, 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, harvesting, post-harvest management and plant protection measures in ajowain
- 27. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, 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, harvesting, post-harvest management and plant protection measures in dill
- 28. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, 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, harvesting, post-harvest management and plant protection measures in celery

Unit V

29. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, site selection, layout, sowing/ planting time and methods, seed rate and seed treatment, nutritional and irrigation requirement, training, pruning,

intercropping, mixed cropping, intercultural operations, weed control, mulching, harvesting, post-harvest management and plant protection measures in tamarind

- 30. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, 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, harvesting, post-harvest management and plant protection measures in garcinia
- 31. Botany, taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, propagation, site selection, layout, sowing/ planting time and methods, seed rate and seed treatment in vanilla
- 32. Training, pruning, pollination, nutritional, irrigation requirement, intercropping, mixed cropping, intercultural operations, weed control, mulching, harvesting, post-harvest management and plant protection measures in vanilla
- 33. Physiological disorders and value addition in different spice crops
- 34. Quality control and pharmaceutical significance of spice crops

PRACTICAL SCHEDULE

- 1. Identification of seeds and plants of different spice crops
- 2. Botanical description of different spice crops
- 3. Varietal description of fruit and underground spices
- 4. Varietal description of seeds, bark and trees spices
- 5. Preparation of spice herbarium
- 6. Propagation of fruit and underground spices
- 7. Propagation of seeds, bark and trees spices
- 8. Nursery raising for different spice crops
- 9. Field layout and method of planting followed in different spice crops
- 10. Important cultural practices followed in spice crops
- 11. Harvesting in different spice crops
- 12. Processing of fruit and underground spices
- 13. Processing of seeds, bark and trees spices
- 14. Grading, storage and packaging in different spice crops
- 15. Value addition in spice crops
- 16. Short term experiments on spice crops
- 17. Final practical examination

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

SUGGESTED READING

- 1. Agarwal S, Sastry EVD and Sharma RK. 2001. *Seed spices: production, quality, export*. Pointer Publication.
- 2. Arya PS. 2003. Spice crops of India. Kalyani.
- 3. Bhattacharjee SK. 2000. Hand book of aromatic plants. Pointer publications.
- 4. Bose TK, Mitra SK, Farooqi SK and Sadhu MK. (Eds.). 1999. *Tropical horticulture*. Vol. I. Naya Prokash.
- 5. Chadha KL and Rethinam P. (Eds.). 1993. *Advances in horticulture*. Vols. IX-X. *Plantation crops and spices*. Malhotra Publ. House.
- 6. Gupta S. (Ed.). *Hand book of spices and packaging with formulae*. Engineers India research institute, New Delhi.
- 7. Kumar NA, Khader P, Rangaswami and Irulappan I. 2000. *Introduction to spices, plantation crops, medicinal and aromatic plants*. Oxford and IBH.
- 8. Nybe EV, Miniraj N and Peter KV. 2007. Spices. New India Publ. Agency.
- 9. Parthasarthy VA, Kandiannan V and Srinivasan V. 2008. *Organic spices*. New India Publ. Agency.
- 10. Peter KV. 2001. *Hand book of herbs and spices*. Vols. I-III. Woodhead Publ. Co. UK and CRC, USA.
- 11. Pruthi JS. (Ed.). 1998. Spices and condiments. National Book Trust
- 12. Pruthi JS. 2001. *Minor spices and condiments- crop management and post harvest technology*. ICAR.
- 13. Purseglove JW, Brown EG, Green CL and Robbins SRJ. (Eds.). 1981. *Spices*. Vols. I, II. Longman.
- 14. Shanmugavelu KG, Kumar N and Peter KV. 2002. *Production technology of spices and plantation crops*. Agrobios.
- 15. Thamburaj S and Singh N. (Eds.). 2004. Vegetables, tuber crops and spices. ICAR.
- 16. Tiwari RS and Agarwal A. 2004. *Production technology of spices*. International Book Distr. Co.
- 17. Varmudy V. 2001. Marketing of spices. Daya Publ. House.

VSC 513 PROCESSING OF VEGETABLE CROPS 1+1

WHY THIS COURSE?

In India, agriculture is the basis of economy. Agricultural industries and related 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 produces are fed to

the animals or allowed to decay. Even the established vegetable canning industries or small/ medium scale processing centres suffer hugeloss 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.

AIM OF THE COURSE

To educate the students about the principles and practices of processing in vegetablecrops

THEORY

Unit I

Present status— History, Scope and importance of processing; 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 licence; Importance of hygiene; Plant sanitation

Unit IV

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

Unit V

Value addition—Major value-added vegetable products; Utilization of by-products of vegetable processing industry; Management of processing industry waste; Principles and methods of sensory evaluation of fresh and processed vegetables.

LECTURE SCHEDULE

Unit I

- 1. History of processing
- 2. Scope and importance of processing

3. Present status and future prospects of vegetable preservation industry in India

Unit II

- 4. Spoilage of fresh and processed vegetable produce
- 5. Biochemical changes and enzymes associated with spoilage of vegetable produce
- 6. Food poisoning and their control measures
- 7. Role of microorganisms in food preservation

Unit III

8. Raw material for processing; Primary and minimal processing; Processing equipments

9. Mid semester examination

- 10. Layout and establishment of processing industry
- 11. FPO licence; Importance of hygiene; Plant sanitation

Unit IV

- 12. Quality assurance and quality control, TQM, GMP
- 13. Food standards-FPO, PFA
- 14. Food laws and regulations; Food safety- Hazard analysis and critical control points (HACCP)

Unit V

- 15. Major value-added vegetable products
- 16. Utilization and management of by- products of vegetable processing industry
- 17. Principles and methods of sensory evaluation of fresh and processed vegetables.

PRACTICAL SCHEDULE

- 1. Study of machinery and equipment used in processing of vegetable produce
- 2. Chemical analysis for nutritive value of fresh produce
- 3. Chemical analysis for nutritive value of processed produce
- 4. Study of different types of spoilage in fresh produce
- 5. Study of different types of spoilage in processed produce
- 6. Classification and identification of spoilage organisms
- 7. Study of biochemical changes associated with food spoilage
- 8. Study of enzymes associated with food spoilage
- 9. Laboratory examination of fresh vegetable products
- 10. Laboratory examination of processed vegetable products
- 11. Sensory evaluation of fresh produce
- 12. Sensory evaluation of processed produce
- 13. Study of food standards- National
- 14. Study of food standards- International
- 15. Study of Codex Alimentarius Commission
- 16. Visit to processing units to study the layout, hygiene, sanitation and waste management.
- 17. Final practical examination

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

SUGGESTED READING

- 1. Arthey D and Dennis C. 1996. Vegetable processing. Blackie/ Springer-Verlag.
- 2. Chadha DS. 2006. The Prevention of food adulteration act. Confed. of Indian Industry.
- 3. Desrosier NW. 1977. Elements and technology. AVI Publ. Co.
- 4. FAO. 1997. Fruit and Vegetable processing. FAO.
- 5. FAO. CODEX Alimentarius: Joint FAO/ WHO food standards programme. 2nd Ed. Vol. V.
- 6. FAO. Food quality and safety systems- training manual on food hygiene and haccp. FAO.
- 7. Fellow's P. 1988. Food processing technology. Ellis Horwood International.
- 8. Frazier WC and Westhoff DC. 1995. Food microbiology. 4th Ed. Tata McGraw Hill.
- 9. Giridharilal GS Siddappa and Tandon GL. 1986, *Preservation of fruits and vegetables*. ICAR.
- 10. Gisela J. 1985. Sensory evaluation of food- theory and practices. Ellis Horwood.
- 11. Graham HD. 1980. Safety of foods. AVI Publ. Co.
- 12. Hildegrade H and Lawless HT. 1997. Sensory evaluation of food. CBS.
- 13. Joslyn M and Heid Food processing operations. AVI Publ. Co.
- 14. Mahindru SN. 2004. Food safety: concepts and reality. APH Publ. Corp.
- 15. Ranganna S. 1986. *Handbook of analysis and quality control for fruit and vegetable products*.2nd Ed. Tata-McGraw Hill.
- 16. Shapiro R. 1995. Nutrition labeling handbook. Marcel Dekker.
- 17. Srivastava RP and Kumar S. 2003. *Fruit and vegetable preservation: principles and practices*.3rd Ed. International Book Distri. Co.

VSC 514 POST-HARVEST MANAGEMENT OF VEGETABLE CROPS 2+1

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.

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

Unit I

Importance and scope—Importance and scope of post-harvest management of vegetables; Maturity indices and standards for different vegetables; Methods of maturity determination; physiology and biochemistry in vegetables.

Unit II

Biochemistry of maturity and ripening; Enzymatic and textural changes; Ethylene evolution and ethylene management; Respiration and transpiration along with their regulation methods; harvesting tools and methods in major vegetables

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; precooling

Unit IV

Packing house operations—Packing house operations; Commodity pretreatments chemicals, wax coating, 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

LECTURE SCHEDULE

Unit I

- 1. Importance and present scenario of post-harvest management of vegetables in India.
- 2. Chemical and nutritional composition of vegetables.
- 3. Different methods of maturity assessment in vegetables.
- 4. Maturity indices and standards for commercially important vegetable crops.

5. Physiology and biochemistry in vegetables.

Unit II

- 6. Factors influencing respiration (external and internal) in vegetables.
- 7. Physiology of maturity and ripening of vegetables
- 8. Biochemistry of maturity and ripening of vegetables
- 9. Ethylene evolution and ethylene management in vegetables.
- 10. Respiration, transpiration and their regulation methods in vegetables.
- 11. Major causes of post-harvest losses of vegetables.
- 12. Harvesting tools & methods in major vegetables for specific market requirement.

Unit III

- 13. Post-harvest physical and biochemical changes of vegetables.
- 14. Pre-harvest factors affecting in post-harvest quality of vegetables.
- 15. Pre-storage treatments for major vegetables.
- 16. Unit operations in packing house of vegetables importance advantages and disadvantages.

17. Mid Semester Examinations

- 18. Post harvest disinfection in vegetables methods of application advantages and disadvantages
- 19. Wax coating of vegetables types of waxing application methods advantages and disadvantages
- 20. Pre-cooling methods advantages and disadvantages.

Unit IV

- 21. Irradiation techniques of vegetables application methods equipment required advantages and disadvantages.
- 22. Packaging of vegetables importance types of packaging materials advantages and disadvantages.
- 23. Traditional packaging methods for vegetables advantages and disadvantages.
- 24. Modern packaging methods for vegetables advantages and disadvantages
- 25. Post-harvest pest management in vegetables.
- 26. Post-harvest diseases management in vegetables
- 27. Transportation of vegetables methods advantages and disadvantages.

Unit V

- 28. Storage of vegetables primitive -ventilation advantages and disadvantages.
- 29. Storage of vegetables cellar storage and chilling principles equipment required advantages and disadvantages.
- 30. Storage of vegetables ZECC principles advantages and disadvantages.
- 31. Physiological disorder associated with storage chilling injury management.
- 32. Modified atmospheric storage of vegetables principles techniques advantages and disadvantages.
- 33. Controlled atmospheric storage of vegetables principles techniques advantages and disadvantages.

34. Hypobaric storage of vegetables - principles - techniques - advantages and disadvantages.

PRACTICAL SCHEDULE

- 1. Determination of maturity stages of commercially important vegetable crops.
- 2. Studies on harvesting techniques of commercially important vegetable crops.
- 3. Ripening management in vegetable crops.
- 4. Studies on pre-cooling methods for vegetable crops.
- 5. Effects of different pre-treatments on shelf life of vegetables during storage.
- 6. Demonstration of physiological disorders of vegetables during storage at low temperature.
- 7. Studies on different types of packaging materials/containers for shelf life extension of vegetables.
- 8. Experiments on improved packaging techniques for vegetable crops.
- 9. Studies on the effect of chemicals on ripening and enhancing shelf life of vegetables.
- 10. Estimation of physiological loss in weight (PLW) during storage of vegetables.
- 11. Estimation of transpiration, respiration and ethylene release of vegetables during storage.
- 12. Studies on traditional storage methods for vegetables.
- 13. Studies on modern storage methods for vegetables.
- 14. Studies on low cost storage techniques for vegetable.
- 15. Visit to commercial packing house and cold storage units.
- 16. Visit to control atmosphere storage unit.
- **17. Final Practical Examination**

LEARNING OUTCOME

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

- 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

SUGGESTED READING

- 1. Chadha KL and Pareek OP. 1996. Advances in horticulture. Vol. IV. Malhotra Publ. House. Chattopadhyay SK. 2007. Handling, transportation and storage of fruit and vegetables. Gene-Tech books, New Delhi.
- 2. Haid NF and Salunkhe SK. 1997. Postharvest physiology and handling of fruits and vegetables. Grenada Publ.
- 3. Mitra SK. 1997. Postharvest physiology and storage of tropical and sub- tropical fruits. CABI.
- 4. Paliyath G, Murr DP, Handa AK and Lurie S. 2008. Postharvest biology and

technology of Fruits, vegetables and flowers. Wiley-Blackwell, ISBN: 9780813804088.

- 5. Ranganna S. 1997. Handbook of analysis and quality control for fruit and vegetable products. Tata McGraw-Hill.
- 6. Stawley JK. 1998. Postharvest physiology of perishable plant products. CBS publishers.
- 7. Sudheer KP and Indira V. 2007. Postharvest technology of horticultural crops. New India Publ. Agency.
- Verma LR and Joshi VK. 2000. Postharvest technology of fruits and vegetables: handling, processing, fermentation and waste management. Indus Publishing Company, New Delhi, India. ISBN 8173871086.
- 9. Willis R, Mc Glassen WB, Graham D and Joyce D. 1998. Postharvest: An introduction to the physiology and handling of fruits, vegetables and ornamentals. CABI.
- 10. Wills RBH and Golding J. 2016. Postharvest: an introduction to the physiology and handling of fruit and vegetables, CABI Publishing, ISBN 9781786391483.
- 11. Wills RBH and Golding J. 2017. Advances in postharvest fruit and vegetable technology, CRC Press, ISBN 9781138894051.