COMMON TO ALL PH.D. DEGREE PROGRAMMES (BY COURSE WORK)

(FULL-TIME / PART-TIME / EXTERNAL PROGRAMME)

(2019-2020)

REGULATIONS AND SYLLABUS

REGULATIONS

1.SYSTEM OF EDUCATION

1.1These rules and regulations shall govern the Ph.D.Programmes leading to the award of Degree of Doctor of Philosophy in the concerned subject in the Faculty of Agriculture, Annamalai University. They shall come into force with effect from the academic year 2019-2020.

1.2The semester system shall be followed for all the Ph.D. degree programmes.

1.3The duration of doctoral programmes is three (6 semesters) academic years. The first year of study shall be the first and second semesters following student's admission. The second year of study shall be the third and fourth semesters and third year means the fifth and sixth semesters. Every enrolled student will be required to undergo a specified load of course work in the chosen subject of specialization (Major, Minor and supporting courses) and complete seminars, research credits and submit thesis.

2.DEFINITIONS

2.1 An "Academic year" shall consists of two semesters.

2.2 "Semester" means an academic term consisting of 105 instructional days excluding final theory examinations.

2.3"Course" means a unit of instruction to be covered in a semester having specific No., title and credits.

2.4"Credit hour" means, one hour lecture plus two hours of library or home work or two and half hours of library/field practicals per week in a semester.

2.5 'Credit load' of a student during a semester is the total number of credits registered by that student during that particular semester.

2.6 'Grade Point' of a course means the value obtained by dividing the percentage of marks earned in a course by 10 and the Grade Point is expressed on a 10 point scale and rounded off to two decimal places.

2.7 'Credit Point' means the grade point multiplied by corresponding credit hours.

2.8'Grade Point Average'(GPA) means the quotient of the total credit points obtained by a student in various courses at the end of each semester, divided by the total credit hours taken by the student in that semester. The grading is done on a 10 scale and the GPA has to be corrected to two decimals.

2.9'Overall Grade Point Average'(OGPA) means the quotient of cumulative credit points obtained by a student in all the courses taken from the beginning of the first semester of the year divided by the total credit hours of all the subjects which he / she had completed up to the end of a specified semester and determines the overall performance of a student in all subjects during the period covering more than one semester. The OGPA has to be arrived at the second decimal place.

3.PROGRAMMES OFFERED

The details of various Ph.D.programmes offered in the Faculty of Agriculture are as follows:

Agrl. Business Management
Agrl. Economics
Agrl. Entomology
Agrl. Extension
Agrl. Microbiology
Agronomy
Genetics and Plant Breeding
Horticulture
Plant Pathology
Seed Science & Technology
Soil Science and Agrl. Chemistry

4. ELIGIBILITY FOR ADMISSION

Candidates seeking admission to Ph.D. programme should satisfy the following requirements.

4.1 Candidates with two year master degree programmes from Universities recognized by Annamalai University are eligible to apply for Ph.D.programmes of the university.

4.2 Candidates who have undergone the programme under conventional system should possess not less than a second class Master degree. The candidates under trimester system should possess a minimum OGPA of 3.00 out of 4.00. For those under semester system 6.50 out of 10.00 is required for various Doctoral programmes. However, this will not apply to SC/ ST candidates, nominees of State Government / AnnamalaiUniversity / ICAR / and Government of India for whom a pass in the concerned degree is sufficient.

Table – 1: Eligibility Criteria

Doctoral Degree Programmes	Eligibility
1. Agrl. Business Management	MBA in Agribusiness
2. Agrl. Economics	M.Sc.(Ag.) in Agrl. Economics/ Agrl. Marketing Management.
3. Agrl. Entomology	M.Sc.(Ag.) inEntomology
4. Agrl. Extension	M.Sc.(Ag.) in Agrl. Extension
5. Agrl. Microbiology	M.Sc.(Ag.) in Agrl. Microbiology
6. Agronomy	M.Sc.(Ag.) in Agronomy
7. Genetics and Plant Breeding	M.Sc.(Ag.) in Genetics and Plant Breeding
8. Horticulture	M.Sc (Ag.) Hort. / M.Sc. (Hort.)
9. Plant Pathology	M.Sc.(Ag.) in Plant Pathology
10. Seed Science & Technology	M.Sc.(Ag.) in Seed Science & Technology
11. Soil Science and Agrl. Chemistry	M.Sc.(Ag.) in Soil Science and Agrl. Chemistry

5. SELECTION PROCEDURE

A candidate who wishes to undertake Ph.D. programme of this University either full time or part time or external registration should apply in the prescribed form on or before the due date.

Applications which fulfil the above conditions (mentioned in the Prospectus) will be scrutinized by a Departmental Research Committee consisting of the Head of the

Department and three or four senior staff members (not more than five).The selection of the candidates shall be based on marks obtained in the qualifying degree, a written test and an interview. The weightage for Qualifying Degree Examination will be given for 50 marks. The written test shall comprise objective type questions and examine research aptitude, grasp of the subject, intellectual ability and general knowledge of the prospective candidates. The question paper for the written test shall be prepared for one hour duration. Question papers will be set and evaluated by the DRC for 25 marks. The interview will be conducted for 25 marks. The cut off marks for the selection shall be fixed as 50%. NET qualified candidates are exempted from the entrance test, but they have to appear for the interview. The minutes of the DRC together with the recommendation will be placed before the Vice-Chancellor who in consultation with the Dean of the Faculty and Head of the Department will select and admit the applicant to work under the guide proposed.

5.1 Full time programme:

All full time research scholars shall undergo course work for two semesters as prescribed by the Department. Duration of the programme will be for three years.

5.2 Part Time Programme:

The part time programme will be offered to the in-service candidates / Research Scholars of projects of AnnamalaiUniversity. The candidates of this University should route their application through HOD and Dean, Faculty of Agriculture. The duration of the programme will be of 4 years. The in-service candidates / Research Scholars of projectsof AnnamalaiUniversitywill be permitted to register the Ph.D.programme by course work and they have to undergo one year course work by utilizing any eligible leave for that period.

5.3. External Registration

Eligibility : Same as for regular candidates. In addition to that, the following are the additional conditions for registration for a Ph.D. programme under external category

1. The candidates must register under a guide who is a member of the Teaching Faculty of this University
2. The candidate should be working as Asst. Professor/Associate Professor/Professor or in equivalent positions on permanent basis in a recognized college where facilities for carrying out research work are available and have post graduate departments for Agrl. subjects or working as research assistants in private or government institutions having research and development facilities and who fulfill the eligibility conditions.
3. However such colleges/ research institutes should be recognized by AnnamalaiUniversity for this purpose. The colleges/ research institutes/ organization should apply for recognition to the University in the prescribed format with recognition fee as specified by the University in the relevant subjects or department from which they wish to depute candidates for the Ph.D. programme. At the discretion of the Vice chancellor, a committee may be appointed to visit the college/Institution to inspect the infrastructure facilities available for pursuing Ph.D. research. Based on the recommendations of the committee, the university may permit a candidate from the department to be sponsored by the institution. This clause is not

applicable to those institutions/ organizations that have been recognized already for external registration.

4. The candidate should have a recognized co-guide in parent department of the organization. The co-guides may be from other colleges / organization located from the same place if such persons are not available in the parental organizations.
5. Other regulations relating to Ph.D research in the University shall be applicable to these candidates also, except the clause relating to the period of residence.
6. The candidate shall take up 2 papers for the methodology theory examination after completing one year. He / She shall carryout the research at his / her parental organization for the entire of period of the programme.
7. i. NOC (No Objection Certificate) is to be produced from the employer of the institution / Organization where he / she is working and attached along with the application.

   ii. Co-guide acceptance letter should be also be enclosed with the applicationform.

6. CREDIT GRADE POINT REQUIREMENTS

6.1. A student enrolled for Doctoral program to become eligible for the degree is required to complete 75 credits inclusive of 45 credits of research as detailed below

Sl.No.	Details	Credit Hours
1.	Major-Courses	15
2.	Minor-Courses	8
3.	Supporting-Courses	5
4.	Seminar	2
5.	Research	45
	Total	75

6.2. In a semester, a full time Ph.D. student can register a maximum of 15 credits excluding research. However, the research credits registered should not exceed 12 per semester. The Ph.D. students (FT/PT/EXT) should complete their course work within two semesters in the first year.

6.3. Requirements for Ph.D. programme shall also include successful completion of thesisresearch in the major field of study and submission of thesis thereon.

7.ATTENDANCE REQUIREMENT

7.1. “One hundred percent attendance is expected from each scholar. A student who fails to secure 80 per cent ofattendance in each subject separately for theory and practical,shall not be permitted to appear for the final examination in that subject and shall be awarded ‘E’ (incomplete) and will be required to repeat the subject when ever offered.

7.2. In respect of the student who has absented himself / herself for classes with or without valid reasons, that period will be treated as absence only and not as leave. Also, no attendance will be given for writing make up tests.

7.3In case of new admission, for calculating 80% attendance in the first semester, the number of working days will be calculated from the date of joining of the students

who are permitted to join late due to administrative reasons. However, for genuine reasons, condonation of attendance deficiency may be considered by the Vice - chancellor on the recommendation of the RAC, HOD and Dean, Faculty of Agriculture on payment of condonation fee prescribed by the university.

7.4Students absenting from the classes with prior permission of the HOD on official University business shall be given due consideration in computing attendance.

7.5. In respect of students who had absented for the mid-semester examination on University business with prior permission of the HOD and Dean, Faculty of Agriculture, the make up mid-semester examination should be conducted ordinarily within 15 working days from the date of conduct of the mid-semester examination.

7.6. The students who absent himself/herself for mid-semester examination in a subject on genuine reasons shall be permitted on the recommendation of the course teacher / Chairman and Head of the Department concerned. Missing examination should be completed within 15 working days from the date of respective examination on payment of missing examination fee prescribed by the university.

7.7 An employee of the University admitted to the programme leading to the Ph.D. Degree as a part-time internal candidate in accordance with these ordinances shall be required to work for a minimum period of 30 days per annum during the period of research. They shall carry out research work without affecting their regular duty.

7.8 External scholars are required to mark attendance maintained by the supervisor/co-supervisor for a minimum compulsory period of 30 days per annum during their period of research.

7.9 External scholars are required to visit Annamalai University campus at the end of every year on a specified date to appear before the Research Advisory Committee (RAC) for review of the progress of their research work.

7.10 The attendance certificate signed by the Research Supervisor/Co-Supervisor shall be sent to the Controller of Examinations through the respective Head of the Department and the Dean at the time of submission of the Synopsis.

8.RESEARCH ADVISORY COMMITTEE (RAC)

8.1.Each Ph.D. scholar shall have an RAC to guide the student in carrying out his/her programme. A Research Advisory Committee shall be constituted with the approval of the University for each candidate (full-time, part-time and external) separately, immediately after his/her admission. The purpose of the RAC is to provide expert opinion on frontline research. The Research Advisory Committee shall consist of the Head of the Department or a Professor nominated by the Vice-Chancellor as the Chairperson, the Research Supervisor as the Convener, and two members who are experts in the field nominated by the Vice-Chancellor (one member from the same Department, and the other member from another related Department of our University/another University in Tamil Nadu/other states.

8.1.1. Research Supervisor

Every student shall have a research supervisor (among the recognized guides), who will be appointed by the Vice-Chancellor on the recommendation of the Head of the Department and the Dean, Faculty of Agriculture. The approved research supervisor only can be the guide for the students.A teacher

having Ph.D with 5 years service and PG teaching is eligible for teaching and guiding Ph.Dprogramme.A teacher should have a minimum of three years of service before retirement for allotment of doctoral candidates.The Research supervisor in consultation with the HOD will nominate the other two members.In the event of the research supervisor being away on other duty/leave for a period upto one year, the member of the advisory committee from the same department will officiate as the research supervisor.For external candidate, a Co-Guidefrom his/her parental organization will be the Co-Chairman of the Advisory Committee.

8.1.2. Functions of the RAC

The Research Advisory Committee shall have the following functions:

1. Discuss, advice and recommend on all matters connected with the candidate's research from admission till the submission of the thesis.
2. Approve the topic of research and the synopsis.
3. Assess and approve the progress reports of Ph.D. students in the prescribed format and to report to the University on the fitness or otherwise of the candidate to proceed with his/her research work for the Ph.D.
4. If necessary, recommend and approve change of title of dissertation/Thesis, change of Supervisor and status of Researcher (full time to part time and vice-versa)
5. Conduct and supervise the presentation by the candidate of the final draft of his/her proposed thesis for approval before the submission of synopsis of the thesis to the University and to give a certificate to this effect to be submitted along with the synopsis.

8.1.3. The Research Advisory Committee will meet once in six months:

- to scrutinize the research proposal submitted by the candidate
- to assess the conduct of experiments/field work, peruse laboratory notebooks, data recording and analysis, and publication
- to review and endorse the annual progress report of the candidate.
- to approve the synopsis of the thesis.

The convener will convene the Research Advisory Committee meetings with intimation to the Controller of Examinations.

8.2. Changes in RAC

The proposals for changes in the RAC is to be sent to theController of Examinations, through HOD and Dean for approval, if it is keenly felt that such changes are absolutely necessary.

8.3. Change of Research Supervisor

8.3.1 Change of research supervisor shall not be permitted as a routine. In exceptional cases, such change may be permitted, if valid reasons are provided by the candidates. The Committee headed by the Vice-Chancellor shall look into the request of the petitioner, if there is any conflict between the scholar and the research supervisor. The research supervisor under whom the scholar has originally registered shall give a "No Objection Certificate" and the new proposed Research Supervisor should give a "Certificate of Willingness" to guide the candidate. The final decision will rest with the University. However, the Vice-Chancellor, on the recommendation of the RAC and Dean's Committee, has the right to assign a new research supervisor to the research scholar.

8.3.2 When the change of Research Supervisor is approved, the candidate shall work for a minimum of one year with the new Research Supervisor if the topic of

his/her research is different under the new supervisor, provided he/she fulfils the attendance requirements.

8.3.3 The research supervisors who wish to avail leave/lien/deputation beyond a period of six months shall propose a Co-supervisor in the concerned subject for the candidates registered with them and it may be intimated to the University well in advance. The final approval of the proposal rests with the Vice-Chancellor.

8.4 Change of Topic of Research

8.4.1 Change of the specific area of research may be permitted within one year from the date of admission and request must be submitted with the recommendations of the RAC. In such cases, the minutes of the RAC meeting must include whether the course work undertaken by the candidate is relevant to the new research area and the competence of the research supervisor in this field.

8.4.2 If the RAC is of the view that there is a major change in the specific area of research and is not relevant to the course work undertaken, the candidates will have to go through the process of fresh examination pertaining to the area of research.

8.5. Absence of member during qualifying / final Viva-Voce examination

Under extra-ordinary circumstances if the qualifying/ final viva-voce examination to Ph.D. student has to be conducted in the absence of one or two RAC members, permission to conduct the examination by co-opting another member in such contingencies should be obtained from the Controller of Examinations in advance.

9. EVALUATION OF STUDENT'S PERFORMANCE

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.

9.1.Examinations

There will be two examinations viz. mid semester and final examination. Wherever the course has practical, there will be a final practical examination also.

9.2. Grading

- The duration of mid semester examinationwill be of one hour and final examinationsin theory and practical will be conducted for three hours each.
- The mid semester examinations will be conducted by course teachers during the ninth week of the semester as per the scheme drawn by HOD, evaluate and send the marks obtained by the students to the Controller of Examinations through HOD within seven working days.
- There will be final examination separately for theory and practical which will be conducted by the University. Each final theory and practical examinations will be evaluated by two examiners (one will be the course teacher and another will be the senior faculty of the Department).
- The distribution of marks will be as indicated below:

S.No	Examination	Course with practical	Course withoutpractical	Course without theory
1	Mid-semester	30	30	30
2	Final theory	40	70	-
3	Final practical	30	-	70
	Total	**100**	**100**	**100**

The question paper model and distribution of marks for mid semester and final theory examinations are as follows.

Mid semester :

1	Objective Type	10 out of 12	(10 x 0.5)	5 marks
2	Definitions/concepts	5 out of 7	(5 x 1)	5 marks
3.	Short notes	5 out of 7	(5 x 2)	10 marks
4	Essay type	2 out of 3	(2x5)	10 marks

Final Theory:

Courses without practicals (70 marks)

1.	Short notes	5 out of 7	(5 x 4)	20 marks
2	Essay type	5 out of 7	(5 x 10)	50 marks

Courses with practicals (40 marks)

1.	Short notes	5 out of 7	(5 x2)	10 marks
2	Essay type	5 out of 7	(5 x 6)	30 marks

9.3.Minimum Marks for Pass

a) The student should secure a minimum of 60 per cent marks separately in the theory and practical and an aggregate of70% to securea pass in the subject .

b) Each subject shall carry a maximum of 100 marks for purpose of grading. The grading will be done as grade point. i.e., the percentage of marks earned in a subject is divided by 10. The grade point is expressed on a 10 point scale upto two decimals.

c) Students who secure marks below 70 per cent in a subject will be awarded 'F' grade and students withouthaving the required minimum attendance of 80 per cent will not be allowed to write the final examination and they will be awarded 'E' grade. Students who secure 'F' grade should appear for re-examination in the subsequent semester.

d) If a student secured 'E' grade, he/she has to re-register and attend the course again during the next academic year.

9.4.Minimum GPA Requirement

A Ph.D student to continue his/her studies in the University, shouldmaintain certain minimum Average Grade Point prescribed here under:

a) Earn a Grade Point of 7.00 for a pass in each subject.

b) For purpose of continuing as a student in the university, a candidate is required to earn an Overall Grade Point Average of not less than 7.50 at the end of each semester

c) A Ph.D. student may repeat the course(s) in which he/she gets a Grade point below 7.50 and above 7.0 to improve the OGPA.

9.5. Re-Examination

Re-examination is permitted only for the final theory and practical examinations.The students who secure 'F' grade are permitted to write the re-examinations as and when conducted with the permission of university.The re-examination fee as prescribed by university per course is to be paid on or before the prescribed date. A student is permitted to write the final theory and practical examinations only two times during the course period of three years excluding the regular final examination.In the event of a student who fails to

secure a pass in the two re-examinations permitted, he/she has to re-register for the course along with juniors.The marks secured in mid semester examination will be retained and the student should produce the practical record during re-examination.The registration for the re-examination shall be done after mid-semester examination on the date specified by the Controller of Examinations. Each registration is considered as an attempt even if the student absents for the examination.

9.6. Return Of Valued Answer Papers

The valued 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. The answer paper should be retained with the course teacher for six months and then disposed off. Evaluated final theory papers have to be retained up to six months by the Controller of Examinations after the conduct of examination and then disposed off. The same is applicable to improvement/re-examination also.

10.CREDIT SEMINAR

Seminar is compulsory for all students and each student should register and present two seminars each with 0+1 credits. A student can register only one seminar in a semester and only after successful completion of the first seminar the student is permitted to register for the second seminar.

10.1. Credit Seminar Topic

10.1.1The seminar topic should be only from the major field and should not be related to the area of thesis research.

10.1.2The seminar topics are to be assigned to the students by the research supervisor in consultation with HOD within three weeks after commencement of the semester.

10.1.3. Under the guidance and supervision of the research supervisor of the RAC,the student should prepare a seminar paper containing not less than 50 typed and printed pages with a minimum number of 75 references covering the recent 10 years time after reviewing all the available literature and present the seminar after completion of 80% attendance in the semester inthe presence of the HOD, RAC, staff and post-graduate students of the concerned department.

10.1.4.The circular on the presentation of the seminars may be sent to other Departments to enable those interested to attend the same.

10.1.5.The research supervisor will monitor the progress of the preparation of the seminar and correct the manuscript. The student will submit 2 copies of the corrected manuscript to the HOD through chairman before presentation.

The student will incorporate the suggestions and carry out corrections made during the presentation and resubmit three fair copies to the HOD (one to Dept. library, the second to the research supervisorand the third for student) within 15 days after presentation.

10.1.6.The performance of the student in the credit seminar will be evaluated and grade point awarded by the HOD along with the RAC for 100 marks. Grade Point may be given based on the following norms:

Details	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

11. QUALIFYING EXAMINATION

Only those students who successfully complete the qualifying examination will be admitted to candidacy of the degree. The qualifying examination consists of writtenand oral examination.

11.1. Minimum requirement for Qualifying Examination

The students who have completed all the courses and earned a grade point average of not less than 7.5 will be permitted to appear for the qualifying examination. Students who do not satisfy these requirements shall not be permitted to take up the qualifying examination. The qualifying examination will be conducted after the completion of course work.

11.2. Selection of Examiner

A panel of five external examiners for qualifying examinations shall be given by the RAC in consultation with HOD before three months of the date of completion of the student's course work to the Controller of Examinations. One of them will be appointed as external examiner.

11.3. Written Examination

The written examination consists of two papers covering major and minor subjects only.The Controller of Examinations will conduct the examination by obtaining the question paper from Head of Department to be prepared in consultation with the course teachers concerned.

The question paper for the written examination will be of 3 hours duration and each question (Essay type) need not be restricted to any particular topic in a course but it should be a comprehensive covering of each unit of the syllabus of each course. The written examinations will be conducted at the same time in all disciplines.The external examiner will evaluate the answer papers during his/her visit to conduct the viva-voce examination.

Qualifying marks for passing the examination will be 60.

11.4. Qualifying viva-voce Examination

The RAC shall conduct the qualifying viva-voce examination with one external member who shall be a specialist in the subject from outside the university

11.5.The Heads of Departments will monitor and coordinate the conduct of the qualifying viva.The performance of the candidate will be graded as Satisfactory / Unsatisfactory.

11.6. Communication of Results of Qualifying Examination

The research supervisor shall act as chairman for the examination committee and shall be responsible for communicating the results of the examination to the Controller of Examination through HOD in the prescribed format.

11.7.Failure /Absence in Qualifying Examination

When a student fails or absents for the qualifying examination, he/she may apply again for permission to appear for re-examination to the Controller of Examination with the recommendation of the chairperson of the RAC/Head of the Department. A student, who applies for re-examination should attend written examination and viva-voce.Re-examination shall not take place earlier than three months after the first examination and it will be conducted by the RAC as previously indicated. If a student fails in the re-examination, furtherre-examination will be considered on the recommendation of the RAC, HOD and Dean, Faculty of Agriculture.

If the students fail in the qualifying examination, he / she is not permitted to register for further research credits.

12. THESIS RESEARCH

12.1.Selection of Topic

The thesis research for the Ph.D. degree should be of the nature of a definite contribution to the subject and the results should be of sufficient importance to merit publication. The findings should have some practical utility or should lead to theoretical contribution. 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. A certificate to this effect duly endorsed by the Research supervisor shall accompany the thesis.

12.2. Research Proposal

The research scholars shall present their broad area of research and submit a proposal to the Research Advisory Committee at the end of the first semester.The research proposal has to be presented by the student in a meeting organized by the Head of the Department to get the opinion / suggestion of the scientists of the Department for improving it. Three copies of the research proposal in the prescribed format should be sent to the Director (CARE) through the Head of the Department for approval

The distribution of research credit will be as follows:

Semester	Credit Hours
ISemester	0+1
IISemester	0+2
IIISemester	0+12
IVSemester	0+12
VSemester	0+9
VISemester	0+9
Total	0+45

12.3. Evaluation of Thesis Research

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. After scrutiny and approval, a copy of the programme has to be given to the student for carrying out the work during the semester.

12.3.1.Attendance register must be maintained in the Department by HOD for all thestudents to monitor whether the student has 80% of attendance in research.

12.3.2.The student has to submit his/her research observation note book to the research supervisor whowill scrutinize the progress and sign the note book with remarks as frequently as possible. This note book will form the basis for evaluation of research progress.

12.3.3.After completion of 80% attendance for research and on or before the last day of the semester, the research scholars, both full time and part time, shall submit Progress Reports in the prescribed format (Annexure-1) duly endorsed by the Research Advisory Committee once in six months to the Controller of Examinations until they submit their synopsis.

12.3.4 Failure to submit the progress reports shall entail automatic cancellation of registration.

12.3.5 The minutes of the meeting of the Research Advisory Committee along with enclosures will be sent to the Controller of Examinations.

12.3.6 The review meetings of the RAC may also be conducted through video conferencing or internet chat if the candidate or the Research Supervisor is in a foreign country.

12.3.7 Candidates who are recipients of fellowships such as JRF/SRF directly from any of the funding agencies/ shall send the progress reports and the utilization certificates in the format prescribed by the respective funding agency through proper channel.

12.3.8.The procedure of evaluating research credits under different situations are explained hereunder.

SITUATION – I

The student, has completed the research credits as per the approved programme and awarded 'Marks' by the RAC. Under the said situation the student can be permitted to register for fresh research credits in the subsequent semester.If the student is not successful, he/she has to re-register the same block of research credits.

SITUATION – II

The student who has not secured the minimum attendance of 80 percent(i.e. absent for more than 21 working days) shall be awarded grade E. The student has to re-register the same block of research credits for which 'E' grade was awarded earlier in the following semester with prior permission. Until the completion of reregistered credits, the student should not be allowed to register for fresh (first time) research credits.

SITUATION – III

The student could not complete the research as per the approved programme of work for reasons beyond his/her control such as,

a) Failure of crop
b) Non-incidence of pests or disease or lack of such necessary experimental conditions.
c) Non-availability of treatment materials like planting materials chemicals, etc.
d) Any other impeding / unfavourable situation for satisfying the advisory committee.

Under the said situations Grade 'EE' should be awarded.

In the mark list, it should be mentioned that 'E" grade or 'EE' grade was awarded due to 'lack of attendance' or 'want for favourable experimental conditions'.

SITUATION – IV

When the student failed to complete the work even in the 'second time' registration, the student will be awarded EE and in the mark list the 'second time' should be mentioned.

For the registration of research credits for the third time, permission has to be obtained from the Dean based on the recommendation of the RAC, and HOD. Permission for registration for the fourth time shall be given only by University based on the recommendation of the RAC, HOD and Dean, Faculty of Agriculture.

13.SUBMISSION OF THESIS

The research credits registered in the last semester should be evaluated only at the time of the submission of thesis, by the RAC. Students can submit the thesis at the end of the final semester. If a student has completed the thesis before the closure of the final semester, the research supervisor can convene the RAC meeting and take decision on the submission of the thesis provided the student satisfies 80 per cent attendance requirement.The candidate shall be allowed to submit his/her thesis after the completion of stipulated period. A grace period of 30 days may be allowed to submit the thesis after the prescribed duration. If the thesis is not submitted even after the grace period, the student shall pay the tuition fee for the year.

If a student is not able to submit the thesis within the grace period, the student has to re-register for the credits in the forthcoming semester.The student who re-registers the credits after availing of the grace period will not be permitted to avail of grace period for the second time. The Head 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

Five copies of the thesis (in the approved format) shall be submitted together with the submission of the synopsis. No dues certificates from the Department and Central Libraries, Hostel, Stores, etc. must be submitted with the thesis copies. The Research Supervisor shall forward the thesis copies with the enclosures to the Controller of Examinations through the HOD and the Dean. A soft copy of the thesis in PDF format as prescribed by Shodhganga, shall also be submitted.

The Ph.D scholars admitted have to publish a minimum of two research papers in Scopus / Web of Science indexed journals. The synopsis will be accepted for processing only after showing evidences for publications of 2 such articles.

The soft copy of the thesis shall be checked for plagiarism using Turnitin software. Beyond the percentage of reproduction prescribed by UGC will not be accepted for evaluation.

13.1 Pre-submission Presentation

1. The pre-submission presentation of the thesis is a requirement to enrich the scholar and to fine tune his/her research presentation
2. This presentation shall be conducted before the submission of the synopsis in the presence of the RAC, Supervisor/Co-Supervisor, Faculty members, Research Scholars, M.Phil., and /or P.G. Students.
3. The scholar is expected to present the first draft of the research work or explain the findings/problems faced.

4. The gathering may suggest ideas/references to be consulted/suggestions to improve the work and so on.
5. A report on this event along with an attendance sheet shall be forwarded by the Research Supervisor with the endorsement of the RAC and HOD to the Controller of Examinations.

13.2 Submission of Synopsis

1. The submission of synopsis may be permitted 3 months before the completion of required duration on successful completion of course work
2. The Research Scholar shall submit 3 copies of the synopsis approved by the Research Advisory Committee alone with a soft copy to the Controller of Examinations through the Research Supervisor, the HOD and Dean of the respective Faculty. Guidelines for the preparation of the synopsis are appended in Annexure -2
3. Name of the candidate and name of the supervisor shall not be mentioned anywhere in the synopsis; enrolment number of the candidate alone shall be given. A model cover page for a synopsis is given in Annexure – 3

13.3 Guidelines for Preparation of Thesis

1. The thesis shall not exceed 250 pages excluding the Bibliography, Appendices, etc. If it exceeds the specified number of pages, the Research Supervisor should write to University with the reasons and get prior approval from the University. The candidate shall pay a penalty for the excess number of pages as decided by the Deans Committee. The thesis should be in A4 size. The specification for the preparation of the thesis are given in Annexure-4. A model cover page for a thesis is given in Annexure -5.
2. The thesis shall be typed on both sides of the page in order to save paper and postage
3. The thesis shall contain a Certificate from the guide (Annexure-6) specifying that the thesis submitted is a record of research work done by the candidate during the period of study under him/her and that the thesis has not previously formed the basis for the award of any Degree, Diploma, Associateship, Fellowship or similar title. A statement from the guide indicating the extent to which the thesis represents independent work on the part of the candidate should also be made.
4. The thesis shall also contain a Declaration by the candidate (Annexure -7) that the work reported in the thesis has been carried out by the candidate himself/herself and that the material from other sources, if any, is duly acknowledged and no part of the thesis is plagiarized.

14. VALUATION OF THE THESIS

The thesis submitted in partial fulfillment of the Ph.D. degree shall be evaluated by two external experts one from within the country and the other from outside the country appointed by the Vice-Chancellor on the recommendation of the research supervisor of the RAC, HOD and Dean. They shall be chosen from a panel of at least five names of specialists separately from within the country and outside the country in the particular field, suggested by the research supervisor. The external experts shall send their evaluation reports of the thesis directly to the Controller of Examinations

along with the copy of the evaluated thesis. The Controller of Examinations on receipt of the reports from the two examiners will send them to the concerned guide who is the convener of viva-voce board. The guide will send the consolidated report with his remarks to the Controller of Examinations through the Head of the Department. On the satisfactory reports of the evaluation, viva-voce examination will be arranged.

After a student's thesis for Ph.D. degree is evaluated as indicated above, the thesis shall be finally accepted for the award only after the student satisfactorily completes a final viva-voce examination. The Viva-Voce board comprises the student's RAC with the addition of the external examiner who valued the thesis, and the HOD. If the HOD happens to be the guide, the Dean, Faculty of Agriculture will nominate a senior member of the staff of the concerned Department as a member. In case of external candidates, the co-guide will also serve as a member of the viva-voce board. The candidate is expected to defend the thesis at the viva-voce examination. The degree shall be awarded on the unanimous recommendation of the examining committeeas satisfactorywith regard to the thesis and the performance of the student in the final oral examination. The recommendation of the committee shall be forwarded to the Controller of Examinations by the research supervisor through HOD and Dean which shall be signed by all members of the committee and the external examiner.

14.2.Revision and Resubmission of Thesis

i. If an examiner recommends change / further work, the thesis will be referred to the same examiner after compliance for his opinion. In case of rejection by any one of the examiners, the thesis will be sent to another examiner and his / her recommendation will be final.

ii. If the thesis is recommended to be revised by one or both examiners, the points of revision will be indicated clearly in the report. The necessary correction should be carried out, and the revised version should be sent to the concerned examiner(s). If the examiner(s) is / are still not satisfied with the revised version, the thesis will be rejected. If the thesis is accepted by the examiners (Evaluation), Viva–Voce examination will be conducted by the viva-voce board.

iii. A candidate who is not successful (unsatisfactory) at the viva –voce examination will be permitted to undergo the viva voce examination again within a period of three months.

14.3.Re-registration and Submission of Thesis

The minimum of 80% 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 of 3 years (6 semesters) and completed the credit requirements with 80% attendance.

14.4.Extension of Time

1. Research scholars who do not submit the thesis within the stipulated period as per full-time/part-time/external mode should apply for extension of time three months before the completion of five years.Extension of time and the fees to be paid will be considered by the Deans Committee, if the extension is duly recommended by the RAC, Head of the Department, and the Dean of the Faculty, such candidates will be eligible for extension of time for a maximum period of three years.
2. The scholar will have to enroll as fresh candidates if he/she fails to submit the thesis within the maximum extension period of three years when granted.

3. If a scholar requires a few more months after the expiry of the maximum extension period of three years for the submission of the thesis as per the evaluation of the RAC, duly recommended by the Head of the Department and the Dean of the Faculty, as an exceptional case, the Deans committee may consider for re-registration to enable the scholar to submit the thesis. In any case, the time granted shall not exceed six/ twelve months.

14.5.Number of Chances

A candidate will not be permitted to submit a thesis for the degree on more than two occasions.However, it will be open to the syndicate, if the Board of Examiners so recommend, to permit the candidate to submit a thesis on a third occasion.Also, he/she will not be permitted to appear for the viva-voce examination on more than two occasions.

15.DISCONTINUANCE AND READMISSION

15.1.Students admitted to the PhD degree who discontinuetheir studies before completing the degree with written permission from the University may be re-admitted to the degree programme, provided that the student should have completed the course work before such discontinuance. However the period of such discontinuance should not exceed five years for Ph.D. Degree from date of admission.

15.2.After completion of course work and qualifying examination, a student iseligible to discontinue temporarily his research program only once within 5 years for PhD program.If the discontinuation period exceeds two semesters, the student has to forego the research credits already registered and register afresh with revised program. In the case of field experiments or laboratory experiments in which continuity is essential forresearch and if a student temporarily discontinues in the middle without completing the experiments, then the entire experimentshould be repeated even if the discontinuation period does not exceed two semesters.

15.3.A student joining the studies, after discontinuation should pay the fees of the existing semester.

16. PUBLICATION OF THE THESIS

The thesis, whether approved or not, should not be published in full or abridged form without the permission of the Syndicate, which may grant permission for the publication under such conditions as it may impose.

17. Each Department should maintain a list of theses produced so far with the abstract of the same.

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DEPARTMENT OF AGRONOMY

Ph.D. AGRONOMY (BY COURSE WORK)
(FULL TIME COURSE WORK)
(2019-2020)

Course No.	Course Title	Credit Hours
MAJOR COURSES (three and two from I and II sem. respectively)		
GAGR 811	Advances in crop growth and productivity	2+1
GAGR 812	Current trends in Agronomy	3+0
GAGR 813	Advances in weed management	2+1
GAGR 814	Advances in soil conservation and watershed management	2+1
GAGR 821	Farming Systems and Sustainable Agriculture	3+0
GAGR 822	Current trends in irrigation Agronomy	2+1
GAGR 823	Stress Crop Production	2+1
GAGR 824	Advances in crop ecology	2+1
	Total	10+ 5 = 15
MINOR COURSES		
GAGR 815	Environmental protection and pollution management	2+1
GAGR 825	Principles and practices of organic management	2+1
GAGR 826	MOOC COURSE	2+0
	Total	6 + 2 =8
SUPPORTING COURSES		
GCOM 811	Advances in Computing Application	0+1
GLIS 812	Advances in agricultural information retrieval	0+1
GSTA 821	Advances in Design of Experiments	2+1
	Total	2+3 =5
GAGR 081	Seminar	0 + 1
GAGR 082	Seminar	0 + 1
	Total	0 + 2=2
GAGR801-806	Research	0 + 45=45
	Total	18 + 57 =75

PROGRAM OUTCOMES:

- Students will demonstrate knowledge on environment impacting agriculture practices in understanding and appreciation for the importance of the impact of globalization and diversity in modern agriculture
- Students will demonstrate an ability to engage in critical thinking by analyzing situations and constructing and selecting viable solutions to solve problems by analyzing the current events and issues that are occurring in agriculture and how they affect the future of agriculture.
- Students will be able to recognize and examine the relationships between inputs and outputs in their agricultural field to make effective and profitable decisions for use by scientists, marketers, and producers.
- Students will comprehend to interpret and solve soil and crop production problems and implement decision-making at various levels to enhance the success of an agricultural enterprise.
- Students will be able to demonstrate critical thinking and problem solving skills as they apply to a variety of animal and or plant production systems.

GAGR 811: ADVANCES IN CROP GROWTH AND PRODUCTIVITY (2+1)

Learning Objectives

- Students will understand the advances in crop growth and productivity.
- Students will undertake basic, applied and adaptive research to address current and future challenges of farming systems.
- Students will evaluate management options relevant to the prevailing agro-climatic and socioeconomic situations.
- Students will generate appropriate technologies to support sustainable growth of agricultural crop production.
- Students will develop and analyze crop growth under different ecosystems for enhanced and sustainable agricultural production.

Theory

Unit I – Plant Density and Crop Productivity:

Environmental factors, affecting crop yield, distribution, strategies for maximizing solar energy utilization; leaf area; interception of solar radiation and crop growth. Photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; physiological limitations to crop yield; solar radiation concept and agro-techniques for harvesting solar radiation.

Unit II - Growth Analysis:

Concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and Limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship.

Unit III – Cropping Systems:

Principals involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.

Unit IV - Competitive Relationship and Competition Functions:

Biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial measures; heat unit concept of crop maturity: concept and types of heat units.

Unit V - Concept of plant ideotypes:

Crop physiological and new ideotypes; characteristics of ideotype for wheat, rice, maize, etc.; concept and types of growth hormones; their role in field crop production; efficient use of resources.

Practical

- Field measurement of root-shoot relationship in crops at different growth stages
- Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI, ATER, CR, EMAI etc., at different stages of crop growth.
- Computation of harvest index of various crops
- Assessment of crop yield on the basis of yield attributing characters
- Construction of crop growth curves based on growth analysis data
- Computation of competition functions, viz. LER, IER, aggressivity, competition Index etc.
- Senescence and abscission indices
- Analysis of productivity trend in un-irrigated areas
- Analysis of productivity trend in irrigated areas

Lecture Schedule

1. Crop productivity – Soil fertility – plant density – definition – concepts
2. Agronomic significance of plant density and crop productivity
3. Factors and constraints involved in soil and crop productivity for sustainable Production.
4. Importance of radiation energy-solar constant-Dispassion of solar energy net radiation balance
5. Radiation laws such as Planck law, wavelength and frequency relationship, Wein's law etc.
6. Radiation distribution in a plant and in a plant community – Monteith's equations.
7. Photosynthesis a big business – interaction between radiant energy and matter action & absorption spectra – importance – quantum yield.
8. C_3, C_4 and CAM Plants and its importance in crop productivity
9. Crop management practices for higher photosynthesis
10. Growth analysis concepts CGR, RGR & NAR for higher productivity.
11. Growth analysis concepts – LAI, LAD and LAR for higher productivity
12. Growth expressions using growth curves – sigmoid, polynomial and asymptotic
13. Root - shoot relationships
14. Resource utilization in irrigated cropping

15. Resource utilization in rainfed cropping
16. Criteria for assessing yield advantages
17. Assessment of competition and yield advantages
18. **Mid semester examinations**
19. Interaction in mixed crop communities
20. Competition for solar radiation & carbon dioxide
21. Competition for soil & other factors
22. Role of plant population & geometry for maximum yield under inter cropping
23. Role of sowing time & genotype selection for maximum yield under inter cropping
24. Problems of crop production in dry farming
25. Moisture stress - Development of moisture stress & effects of moisture stress.
26. Crop adaptations & water harvesting in dry areas.
27. Soil & moisture conservation measurers
28. Definition and concept of plant ideotypes
29. Factors responsible for successful cultivation of new plant types.
30. Recent approaches towards reconstructing new plant types.
31. Ideotype for advance agronomy
32. Characters of ideotype for wheat & maize
33. Characters of ideotype for rice
34. Role of growth hormones and crop production

Practical Schedule

1. Beer's law – calculation resulting
2. Seed rate & yield from vegetative as well as from reproductive growth usage of experimental data & discussing.
3. Growth analysis – Determination of CGR & RGR – experimental data from cereals & millets interpretation.
4. Growth analysis estimation LAI, NAR experimental data from cereals & millets interpretation.
5. Working out & mapping rainfall types in dry farming tracts in Tamil Nadu, India & world.
6. Working out drought indices.
7. Rainfall prediction – rainfall analysis & formulation of cropping system
8. Working out rainfall use efficiency and solar use efficiency.
9. Working out yield sustainability indices
10. Working out yield stability indices.
11. Indices for evaluation of intercropping system.
12. Working out economics of inter cropping system in dry lands
13. Working out watershed models for alfisol and vertisols
14. Visit to dry farming research stations for studying improved dry land technology
15. Crop response to growth regulators.
16. Determination of photosynthetic efficiency in crop plants
17. Estimation of soluble protein in crops to assess the photosynthetic rate.

Course Outcomes

- To describe the role of environmental factors on plant density and crop productivity.
- To comprehend different growth rates on development of a crop.
- To understand the impact of latest cropping systems practices on crop resource use efficiency.
- To undertake sampling of plants and soils to interpret results of research on crop growth and development, radiation interception and radiation use efficiency, crop water use and water use efficiency.
- To evaluate the ideal plant type on crop production.

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	-	-	-
CO2	3	3	3	-	3
CO3	3	3	-	3	3
CO4	-	-	2	-	-
CO5	2	-	-	2	3

Suggested readings

1. Chopra, V.L. and Paroda, R.S. 1984. *Approaches for Incorporation of Drought and*
2. *Salinity Resistance in Crop Plants*. Oxford & IBH
3. Evans, L.T. 1975. *Crop Physiology.* Cambridge Univ. Press
4. Evans, L. T. 1996. *Crop Evolution, Adaptation and yield.* Cambridge Univ. Press Gupta, U.S. (ed.).1995. *Production and Improvement of Crops for Drylands.* Oxford & IBH
5. Gupta, U.S. 1988. *Progress in Crop Physiology*. Oxford & IBH
6. Kramer P. J. and Boyer . J. S. 1995. *Water Relations of Plants and Soils.* Academic Press
7. Mukherjee, S. and Ghosh. 1996. *Plant Physiology*. Tata McGraw Hill
8. NarwalS.S ,Politycka B. and Goswami, C.L. 2007. *Plant Physiology: ResearchMethods.* Scientific Publishers
9. Noggle, G. R. and Fritz, G. J. 1983. *Introductory Plant Physiology.* Prentice-Hall of India.
10. Nanda Kumar Fagria, Zhenli He and Virupax C. Baligar 2017. Phosphorus management in crop production CRC press.
11. RaltanLal and B.A. Stewart, 2016. Soil water and agronomic productivity. CRC. Press.

e- Resource

1. www.el.doccentre.info/eldoc1/k33_/intercropping-principles.pdf
2. agriinfo.in/default.aspx?page=topic&superid=3&topicid=2122
3. eagri.org/eagri50/PPHY261/lec19.pdf
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2613695/
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5227689/
6. http://www.wamis.org/agm/pubs/agm8/Paper-13.pdf
7. http://www.fao.org/3/a-i7339e.pdf
8. https://academic.oup.com/jxb/article/63/1/13/553113

GAGR 812: CURRENT TRENDS IN AGRONOMY (3+0)

Learning Objectives

- Students will gain knowledge on recent advances in Agricultural production.
- Students will acquire knowledge on globalization Agriculture, Marketing and export potential of organic products.
- Students will gain knowledge on GIS based Crop management, precision agriculture.
- Students will comprehend the use of crop residues and weed management options in different agro ecosystems.
- Students will understand and execute high tech production of crops with agro-technologies in a holistic approach.

Theory

Unit–I

Agro-physiological basis of variation in yield, recent advances in soil plant - water relationship.

Unit–II

Globalization of agriculture and WTO, precision agriculture, contract farming, organic farming, marketing and export potential of organic products, certification, labeling and accreditation procedures.

Unit–III

Crop residue management in multiple cropping systems; latest developments in plant management, weed management, cropping systems, grassland management, agro-forestry, allelopathy.

Unit–IV

GIS, GPS and remote sensing for crop management, Drone technology global warming, GM crops, climate resilient farming climate ready crops.

Unit–V

Concepts of system agriculture; holistic approach of farming systems, dryland farming, sustainable agriculture. Cost; effective agro techniques high tech production technologies in crop production, Nanotechnology Information technology in Agriculture research and Biotechnology.

Lecture Schedule

1. Physiological factors limiting crop yields
2. Microclimate and crop production
3. Potential yield – actual yield – reducing the gap between potential yield and actual yield
4. Growth analysis – tools, crop production in different eco-system
5. Recent advances in soil, water &plant relationship
6. Conventions adopted in soil and plant water relationship
7. Active and passive absorption – soil plant atmosphere continuum
8. Water resources in India and Tamilnadu
9. Water resources present status and future needs
10. Water and its role in plants

11. Globalization in agriculture
12. Impact of WTO in Agriculture sector
13. Crop modeling, information techniques and WTO issues in agriculture
14. Precision Agriculture – concept, approach and relevance to Indian agriculture
15. Precision agriculture and cropping system
16. Soil and land information for precision agriculture
17. Organic farming – definition, concepts, prospects, opportunities
18. Current status of organic farming in India and Tamilnadu
19. Marketing and export potential of organic product
20. Certification standards, procedure and regularity mechanism
21. Organic certification – standards and agencies – marketing and export avenues
22. Organic product – labeling and accreditation
23. Crop residues in crop association
24. Farm wastes utilization in agriculture - Organic manures and their dynamics
25. **Midsemester examination**
26. Crop residue management – its importance in soil and crop productivity
27. Organic manures in relation to soil fertility
28. Latest development in plant management
29. New developments in weed management
30. Latest developments in Cropping system
31. Latest development in grassland management and agroforestry
32. Allelopathy and interaction among crop communities
33. GIS, GPS – Introduction – History – basic concept
34. Techniques, procedure and terminology of geography information systems
35. Application of GPS in agricultural and natural resource management
36. GPS and Drone technology.
37. Scope of remote sensing in agriculture – sensors and platforms, data availability for agricultural remote sensing
38. Differentiation and identification of soils and soil resource mapping and remote sensing
39. Crop mapping – vegetation dynamics, crop stress evaluation and differentiation
40. Research prioritization and selection of research problem, designing research program for field experimentation
41. Definition and concept of climatic, crop stress evaluation and differentiation
42. Genetic engineering and crop improvement – steps and techniques involved and application
43. GM crops and traits – prospects of transgenic crops
44. Climate resilient farming and climate ready crops
45. Concept of system agriculture
46. Holistic approaches of farming system
47. Dry farming – dry land research – past and present scenario
48. Dry climates – dry farming regions in India and Tamil Nadu
49. Nanotechnology and its application in agriculture.
50. Cost effective techniques in crop production.

51. Information technology in Agriculture research.
52. Biotechnology in agriculture development.

Course Outcomes

- To understand the latest knowledge on recent advances in soil-plant-water relationship.
- To gain knowledge enriching on principles and components of organic farming, resource conservation technologic, contact farming GIS and tender information on marketing.
- To recognize the importance of crop residue management, weed management, grass land management, agro forestry and allelopathy in the agro ecosystem.
- To synthesize remote sensing for crop management and analyze the effect of global warming and climate resilent farming.
- Demonstrate the holistic approach on the information and nano technology on farming and dry land farming systems.

Suggested readings

1. Govardhan V. 2000. *Remote Sensing and Water Management in Command Areas: AgroecologicalProspectives*. IBDC.
2. ICAR. 2006. *Hand Book of Agriculture*. ICAR.
3. Jamie Hanks. 2015. Current progress in Agronomy volume 11. Elsevier.
4. Jitendra Kumar, AditayaPratap and Shir Kumar. 2015. Phenomics in crop plants: Trebds, options and Limitations. Springer.
5. Narasaiah ML. 2004. *World Trade Organization and Agriculture*. Sonali Publ.
6. Palaniappan SP&Annadurai K. 2006. *Organic Farming - Theory and Practice*.Scientific Publ.
7. Sen S & Ghosh N. 1999. *Seed Science and Technology*. Kalyani.
8. Tarafdar JC, Tripathi KP & Mahesh Kumar 2007. *Organic Agriculture*. Scientific Publ.

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1. https://nptel.ac.in/courses/105105110/pdf/m3l02.pdf
2. https://pdfs.semanticscholar.org/d8a7/68c720c2dc01030a4ee654558d9240465d89.pdf
3. www.hillagric.ac.in/edu/coa/.../lect/.../Lecture-2-Concepts-of-Organic-Agriculture.pdf
4. https://en.wikipedia.org/wiki/Genetically_modified_crops
5. https://www.asti.cgiar.org/pdf/India-Note.pdf
6. https://bigdata.cgiar.org/blog-old/crop-modeling/
7. http://www.fao.org/3/a-i6583e.pdf
8. https://www.slideshare.net/FAOoftheUN/the-future-of-food-and-agriculture-trends and-challenges

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	3	3
CO 2	2	3	3	3	-
CO 3	3	3	3	2	3
CO 4	-	-	-	3	2
CO 5	3	2	2	-	3

GAGR 813: ADVANCES IN WEED MANAGEMENT (2+1)

Learning Objectives

- Students will learn about the changing weed flora under varied ecosystem
- Students will acquire knowledge on concepts and principles of weed management
- Students will know new herbicides, their resistance, toxicity, antidotes and residue management under different cropping systems
- Students will acquire skills on herbicide spraying techniques and bioassay
- Students will understand transgenic herbicide resistant crops and study the relationship of herbicides with other inputs in agriculture.

Theory

Unit I – Weed Biology and Ecology:

Ecological and physiological characteristics of weeds, crop-weed association and competition in different agro-eco systems, weed shift, weed migration, changes in weed flora, various causes and effects.

Unit II – Chemistry of Herbicides:

Physiological and biological aspects of herbicides, their absorption, translocation, metabolism and mode of action; selectivity of herbicides and factors affecting them.

Unit III – Herbicide Physiology:

Climatic factors and phytotoxicity of herbicides; fate of herbicides in soil and factors affecting them, residue management of herbicides, adjuvants.

Unit IV – Herbicide interaction with other Chemicals:

Advances in herbicide application techniques; herbicide resistance; antidotes and crop protection compatibility of herbicides of different groups; compatibility of herbicides with other pesticides.

Unit V – Herbicide Resistance:

Development of transgenic herbicide resistant crops; nano technological applications herbicide development, registration procedures. Relationship of herbicides with tillage, fertilizer and irrigation; bioherbicides and herbicide bioassays.

Practical

- Study on the biology of lowland, garden and dryland weeds.
- Phenological study of aquatic weeds.
- Weed indices.
- Classification of herbicides.
- Herbicide application techniques.
- Weed control experiments: lab and field.
- Herbicide phytotoxicity on crop and weed.

- Bioassay technique for analysis of herbicide residues

Lecture schedule

1. Definition – Characters of weed – Survival mechanism of weeds – Economic uses of weeds
2. Crop weed association and competition –Allelopathy- Allelochemicals
3. Impact of weeds on different crops
4. Behavior of weeds in different agro-eco system
5. Ecological role of weeds in agro-ecosystems of crop manipulations.
6. Weed migration – Dormancy and Germination
7. Herbicides – definition – classification and it's characteristics
8. Inorganic herbicides - un classified groups -descriptions
9. Absorption, translocation of herbicides - Mode of action of herbicides
10. Selectivity of herbicides in plants
11. Factors influencing the selectivity of herbicides
12. uptake and translocation of foliage & soil applied herbicides
13. Persistence of herbicides as influenced by climatic factors
14. Degradation of herbicides as influenced by climatic factors
15. Herbicide toxicity to crop & weeds – symptoms
16. Degradation mechanism of herbicides in plant
17. Fate of herbicides in soil – volatilization & leaching
18. **Midsemester examination**
19. Chemical decomposition – adsorption, photo decomposition & plant uptake
20. Herbicide persistence & residue & residue management
21. Advance techniques in herbicide application &equipments
22. Principles of herbicide resistance
23. Nature and characteristics of herbicide resistance in crops & associated weeds
24. Reasons for development of herbicide resistance & its significance
25. New herbicides – herbicide protectants & antidotes
26. Compatibility of herbicides with agrochemicals
27. Compatibility of herbicides with fertilizers
28. Bio-technological approaches – Development of herbicide resistance in crops
29. Development of herbicide resistance in crops – Genetic & other methods
30. Herbicide development
31. Herbicide relationship with – Tillage and irrigation
32. Herbicide registration & regulation – Decision support system
33. Bio-herbicides – development- Natural products & bio-technology in weed management- nano technological applications
34. Bio-Assays of herbicide residues

Practical schedule:

1. Identification, characterization and classification of terrestrial weeds
2. Identification, characterization and classification of aquatic weeds
3. Identification, characterization and classification of problem and parasitic weeds

4. Phytosociological survey of weeds
5. Assesment of weed seed bank and seed production potential of weeds
6. Working out herbicides and spray fluid requirements
7. Herbicide application techniques and equipments
8. Use of herbicides with different formulation
9. Working out weed control efficiencies of different weed management practices
10. Study on the influence of herbicides on soil micro flora
11. Study on complimentary weed control through cultural practices like mulching, and intercropping.
12. Identification and use of bio agents for weed control
13. Identification and use of natural products for weed control
14. Methodology for weed research- competition studies and control
15. Scoring for phyto-toxic injury of herbicides and bio –assay of herbicide residues
16. Economic analysis of different weed management methods
17. Weed management for different farming systems and crops.

Course outcomes

- To acquire knowledge on phytosociological weed survey and weed mapping under varied ecosystem
- To gain knowledge on interrelationship between crop and weed and management of weeds
- To understand the herbicide application techniques
- To gained information on methodology of weed research-competition, control, herbicide residue and bio-assay studies

Suggested readings

1. Aldrich RJ & Kramer R.J. 1997. *Principles in Weed Management*. Panama Publ.
2. Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed. Wiley-Inter Science.
3. Chauhan, Bhagirath, S. Mahajan and Gulshan. 2014. Recent advances in weed management. Springer.
4. Gupta OP. 2000 *Weed Management – Principles and Practices*. Agrobios.
5. Kalyani. Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic Press.
6. Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ.
7. Rao VS. 2007. *Principles of Weed Science*. Oxford & IBH.
8. Subramanian SAM & Kumar R.J. 1997. *All About Weed Control*.
9. Tomlin, C.D.S. 2006. *The Pesticide Manual*. 14th Edition, BCPC Publications, Hampshire, UK.
10. Xu, Zhenghao, Zhou and Guoning 2017. Identification and control and common weeds Vol, 2&3. Springer

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2. http://www.agrisk.umn.edu/cache/ARL02964.htm
3. hhtp://www.eolss.net/sample-chapters/c10/E1-05A-31-00.pdf
4. http://www.fao.org/docrep/006/y5031e/y5031e00.htm#Contents
5. http://www.fao.org/docrep//006/y5031e/y5031e0j.htm
6. http://www.omafra.gov.on.ca/english/crops/pub811/12crop.htm
7. https://icar.org.in/NRM-2016/7%20AICRP%20on%20Weed%20Management_4-2-2016.pdf
8. https://aicrp.icar.gov.in/wm/
9. http://dwr.org.in/PDF%20Document/Training-Brochure-final.pdf

	PO1	PO2	PO3	PO4	PO5
Course Outcome 1	**2**	**2**	**3**	**2**	**2**
CO 2	**2**	**2**	**3**	**2**	**2**
CO 3	**3**	**2**	**2**	**3**	**2**
CO 4	**2**	**3**	**3**	**2**	**1**

GAGR 814: ADVANCES IN SOIL CONSERVATION AND WATERSHED MANAGEMENT (2+1)

Learning Objectives:

- Students will gain knowledge on various aspects of soil conservation practices
- Students will be given larger exposure on areas affected by soil degradation in India and remedial measures to overcome those constraints
- Students will be put in the right track in understanding the common problems that act as a stumbling block in agriculture production
- Students will be imparted mastery on watershed management and its design & development for enhancing the overall livelihood.

Theory

Unit I -Soil erosion

definition, nature and extent of erosion; types of erosion, factors affecting erosion.

Unit II - Soil conservation

definition, methods of soil conservation; agronomic measures - contour cultivation, strip cropping, cover crops; vegetative barriers; improved dry farming practices; mechanical measures - bunding, gully control, bench terracing; role of grasses and pastures in soil conservation; wind breaks and shelter belts.

Unit III - Watershed management

definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas.

Unit IV - Land use capability

classification, alternate land use systems; agro-forestry; ley farming; *jhum*management - basic concepts, socio-ethnic aspects, its layout.

Unit V - Drainage

considerations and agronomic management; rehabilitation of abandoned *jhum*lands and measures to prevent soil erosion.

Practical

- Study of different types of erosion
- Field studies of different soil conservation measures
- Run-off and soil loss measurements
- Laying out run-off plot and deciding treatments
- Identification of different grasses and trees for soil conservation
- Visit to a soil conservation research centre, demonstration and training centre

Lecture Schedule

1. Soil erosion – Definition – Agents of erosion – Forms of erosion – soil and nutrient loss – land degradation.
2. Erosion – Extent of soil erosion – types – Geological – Accelerated erosion –
3. Water erosion – Process of water erosion – forms of water erosion – sheet erosion – rill erosion – Gully erosion – ravines – landslides – stream bank erosion.
4. Factors affecting water erosion – rainfall – soils – topography – soil surface cover – biotic interference.
5. Wind erosion – mechanism of wind erosion – saltation – suspension – surface crop.
6. Factors affecting wind erosion – soil cloudiness – surface crust – wind and soil moisture – vegetative cover – organic matter – Topography – soil.
7. Estimation of soil loss – losses due to water erosion – wind erosion – Erosion control factors – Agronomic measures forestry measures.
8. Soil conservation – Definition – soil conservation research in India – soil moisture constraints and their management.
9. Methods of soil and water conservation – Insitu conservation - Agronomic measures – contour cultivation - contour ploughing – summer ploughing - mulching – strip cropping – cover crops – Inter cropping.
10. Mechanical measures – Broad bed furrows – Dead furrow – contour bunding – compartmental bunding – Graded bunding –Terracing.
11. Biological measures – pastures – strip cropping with grasses – Ley farming – vegetative barriers.
12. Control of water losses – Evaporation control – shelter belts – wind breaks – Transpiration control – antitranspirants – Growth retardants – windbreaks – shelter belts.
13. Soil conservation programmes in rice valleys – national conservation strategy – Initiatives to control environmental pollution – new policy initiatives.
14. Degraded eco-system and conservation of biodiversity – India's efforts for biodiversity conservation – Insitu, Exsitu conservation – conventional methods of situ conservation by seeds.
15. Watershed management micro and macro watershed – definition – Principles of watershed management – need and advantages.

16. Concepts – Aim and approaches of watershed management – components of watershed management – water resource improvement – soil and moisture conservation in cultivated lands.
17. Components – soil water conservation and water harvesting – Hardware treatments – water ways – bunds - graded bunds – Terracing.
18. **Mid semester examination**
19. Medium Software treatments – key line bunds – strip leveling – line buds - vegetative barriers – software treatments – contour farming – Tillage.
20. Water harvesting measures - minor irrigation tanks - Farm ponds – percolation tanks – stop dams.
21. Watershed development methods – crop management – selection of improved varieties – contingency plan – Integrated farming system.
22. Alternate land use system – action plan for watershed development - socio economic problems – cost benefit analysis of watersheds.
23. Classification of land – land use Pattern before independence – land use pattern in India – types of land use – land use planning.
24. Steps in land use planning – change in land use pattern – optimal land use pattern – cropping pattern - Area under food grains and non food grains.
25. Alternate land use systems for marginal and degraded lands – pastures and grasslands lands – silvi culture – multipurpose tree species.
26. Agroforesty – Definition - Importance – components.
27. Agro forestry systems – based on structure, dominance of components, Temporal arrangement of components and allied components.
28. Agroforesty systems in India – Agri – silviculutre – silvi pastoral – Agri-horticulture – Agri – Silvi pastoral – Agri-horti – silvi culture.
29. Agroforesty Systems –Homestead agroforestry – ley farming – alley cropping – classification of alley cropping.
30. Jhum/shifting cultivation – Jhum cultivation in India – basic concepts.
31. Harmful effects – ecological problems due to Jhum cultivation - Jhum cultivation in modernday – layout of Jhum cultivation.
32. Abolishing shifting cultivation – role of government – drainage considerations and agronomic management.
33. Waste land development – management classification – cultivable and uncultivable wastelands- raverine land – coastal sandy areas.
34. High altitude and steep sloppy areas – salt affected soils. Salt affected soils of India – alkali soils – water logged and marshy lands – Gullied and Ravinous land – sand dune management – afforestation

Practical Schedule

1. Types of erosion and methods to prevent erosion
2. Insitu soil moisture conservation techniques
3. Mulching and its effects
4. Antitranspirants
5. Estimation of run off and soil loss
6. Laying out run-off plot and deciding treatments

7. Working out land use pattern in the world, India and Tamilnadu
8. Preparation and methodology for implementation of water shed projects
9. Preparation of model watershed programme
10. Identification of common tree species
11. Identification of common pasture grasses and legumes
12. Nursery techniques and planting methodology for tree crops.
13. Study of litter fall and biomass deposits
14. Assessment of economic uses of trees
15. Assessment of biomass production under watershed area
16. Visit to an Institute related to Agroforestry / dryland agriculture
17. Visit to watersheds of NWDPRA / CWDP – Input analysis

Course Outcome:

- To understand the major areas of soil degradation in India and application of agro-techniques in conserving the soil
- To develop afforestation and other biological measures to conserve soil and water holding capacity toward improving crop productivity
- To design and develop watershed suitable for the region to save water for agricultural and non-agricultural uses.

Suggested readings

1. Arakeri HR & Roy D. 1984. Principles of Soil Conservation and Water Management. Oxford & IBH.
2. Bimal Chandra Mal. 2012. Introduction to soil and water conservation Engineering. Kalyani publishers.
3. Dhruvanarayana VV. 1993. Soil and Water Conservation Research in India. ICAR.
4. FAO. 2004. Soil and Water Conservation in Semi-Arid Areas. Soils Bull., Paper 57.
5. Frederick RT, Hobbs J, Arthur D & Roy L. 1999. Soil and Water Conservation: Productivity and Environment Protection. 3rd Ed. Prentice Hall.
6. Gurmel Singh, Venkataraman CG, Sastry B & Joshi P. 1990. Manual of Soil and Water Conservation Practices. Oxford & IBH.
7. Gabriela Vazquez. Rodriguez, Liliana and Lizarragamendiola . 2016. Rainwater harvesting and soil water conservation technique .Intelliz press LLC.
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9. PawanJeet and Prem. 2016. Objectives in soil and water conservation engineering. New vishal publications.
10. Rattan and B.A. Stewart. 2012. Soil water and agronomic productivity. CRC press.
11. Tripathi RP & Singh HP. 1993. Soil Erosion and Conservation. Wiley Eastern.
12. Yellamanda Reddy T &Sankara Reddy GH. 1992. Principles of Agronomy.

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3. www.themediaexpress.com/2016/07/16/factors-affecting-the-extent-of-wind-erosion/
4. www.yourarticlelibrary.com/watershed-management/watershed-management.../77309
5. www.envirothon.org/pdf/2012/.../KP4.3land_capability_classification%5B1%5D.pdf
6. www.crida.in/DRM1-Winter%20School/GSR.pdf
7. https://nptel.ac.in/courses/105101010/downloads/Lecture06.pdf
8. http://www.fao.org/docrep/t0321e/t0321e-14.htm

	PO 1	PO 2	PO3	PO 4	PO 5
Course Outcome 1	2	2	2	3	2
CO 2	2	2	3	3	2
CO 3	3	3	2	1	2

SECOND SEMESTER

GAGR 821: FARMING SYSTEMS AND SUSTAINABLE AGRICULTURE (3+0)

Learning Objectives:

- Students will gain knowledge about different farming enterprises suitable for different agro-climatic condition for sustainable agriculture.
- Students will acquire knowledge on holistic approaches of farming system.
- Students will acquire knowledge on objective concepts of cropping system farming system, integrated farming system.

Theory

Unit I - Farming systems:

Farming systems: definition and importance; classification of farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply, enterprises.

Unit II – Natural resources and sustainable farming system:

Concept of sustainability in farming systems; efficient farming systems; natural resources - identification and management.

Unit III - Production potential of components in farming system:

Production potential of different components of farming systems; interaction and mechanism of different production factors; stability in different systems through research; eco- physiological approaches to intercropping.

Unit IV – Farming for environmental conservation:

Systems classification; flow charts, modeling techniques and methods of integration - state, rates and driving variables, feedbacks and relational diagrams.Crop diversification for Sustainability environmental pollutant and farming:

Unit V – Crop modeling:

Crop modeling methods for crop-weather interaction, climate change and variability components. Restoration of degraded and waste land.

Lecture Schedule

1. Concept – Principles of Farming Systems Management
2. Goals of farming systems
3. Farming system definition and importance
4. Farming systems research and development priorities and methodological issues
5. Classifications and approaches to farming systems research
6. Scope and futurology of farming systems.
7. Low input concepts for farming systems
8. Inter related objectives and steps of farming systems research
9. Nutrient and water management in farming systems
10. Weed management in farming systems
11. Factors influencing the choice of component elements
12. Integrated farming systems prospects of constraints
13. Types and intensity of rotations in farming systems
14. On farm nutrient budgeting in farming system
15. Commercialization of value addition in farming systems
16. Enterprises involved in wetland farming systems
17. Enterprises involved in dryland farming systems
18. Enterprises involved in gardenland farming systems
19. Sustainability of farming system and development
20. Resource management through farming systems
21. Crop planning and alternate land use systems
22. Natural resource recycling through farming systems
23. FSR methodology and problem identification
24. Environment conservation and farming
25. **Midsemester examination**
26. Socio economic constraints for farming systems adoption
27. Component technologies of systems approach farming
28. Multidisciplinary approach and prospects in farming systems
29. Components identification and management in farming systems
30. Production potentiality of different components of farming systems
31. Organic recycling and integrated farming systems
32. Interaction and Allocation of farming components
33. Mechanism of different production factors in farming systems
34. Stability and complimentary benefits through farming systems research
35. Allelopathy and plant Interactions in cropping systems
36. Evaluation and socio economic constraints in cropping systems
37. Systems classifications and methodology for institutional research
38. Flow chart for methods in on farm trials
39. Flow chart for problem identification and development of a base
40. Crop diversification for sustainability
41. Environmental conservation, GMO's and farming

42. Bio remediation and bio scavenging
43. Hierarchy and parameters quantifying the prototype evaluation
44. Modeling techniques in farming systems research
45. Driving variables, feed backs and relational modeling in farming systems
46. Tools to evaluate environmental impacts of farming systems
47. Predictions of crop production in relation to climate
48. Computerized farming system simulation model in land use optimization
49. Adaptation of different Agrl. systems to climate change.
50. Crop modeling a tool for Agrl. research
51. Variability and interaction involved in farming systems
52. Integrated approaches to climate crop modeling - Biotic interaction of farming components and crop modeling

Course Outcome:

- To understand the concepts, principles of cropping and advanced farming system management.
- To ascertain the production potentiality of different component of farming system.

Suggested readings

1. Balasubramanian P &Palaniappan SP 2006. *Principles and Practices of Agronomy*. Agrobios.
2. Joshi M &Parbhakarasetty TK. 2005. *Sustainability through Organic Farming*. Kalyani.
3. Kathiresan. RM. 2010. *Components integration in small holders farms* Lambert Acadamic Publishing. AG & Co., Koln, Germany.
4. Mathews RB, Kropff MJ, Bachelet D &VaanLaar HH. (Eds.). 1993. *Modelling the Impact of Climate Change on Rice Production in Asia.* CABI.
5. Panda SC. 2004. *Cropping systems and Farming Systems.* Agribios.
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3. kiran.nic.in/pdf/publications/Nutrient_Recycling.pdf
4. ipclimatechange.trg-learning.com/wp-content/uploads/2013/.../Pitesky2014CSRER.pd...
5. https://www.encyclopedia.com/environment/encyclopedias-almanacs.../organic-waste
6. http://www.agriinfo.in/?page=topiclist&superid=1&catid=42
7. http://agcollegejagtial.weebly.com/uploads/4/6/5/5/46554149/agro303.pdf

8. http://agritech.tnau.ac.in/sustainable_agri/susagri.html
9. http://www.uky.edu/~deberti/test/sust.pdf

	PO 1	PO 2	PO3	PO4	PO 5
Course Outcome 1	2	3	3	2	2
CO 2	3	2	3	3	2

GAGR 822: CURRENT TRENDS IN IRRIGATION AGRONOMY (2+1)

Learning Objectives:

- Students will understand the importance of water in agriculture
- Students will recognize the principles of water holding capacity of different soil and the suitable crops
- Students will know the soil moisture tension at various soil moisture regimes to understand the irrigation requirement of crops
- Students will gain knowledge on estimation of ET for different corps so that it they will advise the irrigation requirement for a larger farming community thereby saving water

Theory

Unit–I

Water resources and importance

Water resources of India, irrigation projects; irrigation needs, atmosphere, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth.

Unit–II

Soil-plant-atmosphere process

Soil-plant-water relationships, Reference evapotranspiration (ETo): (FAO-Penman Monteith approach), Soil physical properties and soil water content: Common expressions of soil water, pressure head, yield response to water under unlimited and limited water supply, Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops.

Unit–III

Irrigation methods and scheduling

Surface irrigation, Sprinkler irrigation, Drip irrigation, Short introduction to water distribution for irrigation by surface and pressurized systems, Performance criteria for irrigation methods: efficiency, uniformity and adequacy, Irrigation scheduling-Deficit irrigation,

Unit–IV

Management of irrigation water quality

Strategies of using limited water supply, Leaching requirement to prevent soil salinity; Distribution, application and project efficiency in irrigation schemes, factors affecting ET, control of ET by mulching and use of anti-transpirants, fertilizer use in relation to

irrigation; optimizing the use of given irrigation supplies.

Unit–V

Land suitability for irrigation

Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation, Agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management.

Practical

- Determination of water infiltration characteristics and water holding capacity of soil profiles
- Moisture extraction pattern of crops
- Computation of the crop evapotranspiration (crop water requirements), and the net and gross irrigation requirement, including the special case of paddy rice
- calculation of the leaching requirement to prevent soil salinity
- irrigation scheduling
- Estimation of wind drift for sprinkler, wetted area and wet bulb for drip and the time-distance graph for furrow irrigation
- Crop planning at the farm and project level
- Agronomic evaluation of irrigation projects, case studies

Lecture Schedule

1. Water resources of India, Tamil Nadu-present status and future needs
2. Irrigation projects in India – Tamil Nadu
3. Irrigation needs – Soil plant and meteorological factors determining irrigation need
4. Water deficits and its influence on crop growth
5. Soil-water-plant relationship: concepts
6. Mass water content, volumetric water content, equivalent depth, Water stored in the root zone; Root zone depletion, Water movement under – Saturated and unsaturated condition
7. Availability of water and absorption by roots- Soil water retention-field capacity, wilting point, total available water, readily available water
8. Study of climatic data such as air temperature, humidity, wind speed, solar radiation, sunshine and evaporation in relation to water needs
9. Significance of transpiration, factors determining the crop coefficient (Kc); Construction of the Kc-curve
10. Physiological process of transpiration and crop productivity
11. Computation of the net and gross irrigation,
12. Infiltration – Factors affecting infiltration rate – Measurement of infiltration rate.
13. Irrigation efficiency – Management practices for improving water use efficiency of crops.

14. Soil moisture conservation practices for improving water use efficiency of crops.
15. Operation of furrow and rice basins, estimation of advance time and needed infiltration time for furrow irrigation, Underground pipeline irrigation.
16. Different types and operation of sprinkler systems and estimation of wind drift losses, uniformity, impact of nozzle size and pressure on distribution of water
17. Operation, components of the drip system and estimation of the wetbulb.
18. Irrigation management for different agro ecosystem
19. **Mid-Semester exam**
20. Water requirement of major crops.
21. Strategies of using unlimited water supply.
22. Crop water requirements and gains of water by rainfall and capillary rise
23. Irrigation scheduling when water supply is not limiting and under conditions of water scarcity (e.g. deficit irrigation);
24. Crop plant adoption to moisture stress / excess and crop growth.
25. Factors affecting Evapotranspiration.
26. Control of ET by mulching and anti-transpirants
27. Fertilizer use in relation to irrigation – fertigation.
28. Optimizing the use of water / Effective utilizing of irrigation
29. Agronomic considerations in the design
30. Land suitability for irrigation land irrigability classification
31. Institutions of water management and IWM in command area
32. Farmers participation in command area
33. Characteristics of irrigation and farming systems affecting irrigation management.
34. Irrigation legislation in India

Practical Schedule

1. Estimation of soil moisture and constants by different methods
2. Measurement of evapotranspiration
3. Moisture extraction pattern of different crops
4. Computation of water requirement of crops using Penman-Montieth equation
5. Net and Gross irrigation requirement
6. Determination of infiltration rate and hydraulic conductivity
7. Designing and practical demonstration and measurement of sprinkler, drip and furrow irrigation
8. Time-distance graph for furrow irrigation
9. Estimation of wind drift for sprinkler, wetted area and wet bulb for drip
10. Developing fertigation scheduling for various crops, chemigation under micro - irrigation.
11. Working out irrigation efficiencies and crop water demand
12. Water requirement of a given cropping pattern/ variable productivity
13. Exercises on irrigation scheduling
14. Measurement of irrigation water by various devices.
15. Calculation of the leaching requirement to prevent soil salinity
16. Agronomic evaluation of irrigation projects
17. Excursion to a farmer and/or an experimental station where irrigation is used

Course Outcome:

- To understand the water resources of India and Tamil Nadu
- To understand the water requirement of various crops in various climatic and soil conditions
- To estimate the correct water requirement of crops.

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Suggested readings

1. Cecilia Tortajada ,Asit K . Biswas and AvinashTyagi 2016. Water
2. Davis Twomey . 2016. Irrigation and water management. Syrawood publishing, Hense.
3. FAO. 1984. Irrigation Practice and Water Management. Oxford & IBH.
4. Guy. J. Levy ,Pinchas Fine and Asher Bar-Tal. 2010. Treated waste water in agriculture. John. Wiley and son Ltd.
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5. https://nptel.ac.in/courses/105105110/pdf/m3l04.pdf
6. https://www.elsevier.com/books/advances-in-irrigation/hillel/978-0-12-024303-7
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	PO 1	PO 2	PO3	PO 4	PO 5
Course Outcome 1	3	2	3	2	2
CO 2	3	2	3	3	1
CO 3	3	2	3	2	1

GAGR 823: STRESS CROP PRODUCTION (2+1)

Learning Objectives

- Students will assess and analyze the symptoms, causes and effects of stress on crop production and implement appropriate stress management techniques.
- Students will monitor effectiveness of stress management techniques and revise to meet current needs.
- Students will gather information on current crop stress management techniques and to evaluate.
- Students will practice specific techniques, track effectiveness in different agro-ecosystem.

Theory

Unit I – Stress Concept in Agriculture:

Definition of stress – Distinction between stress and disturbances – limitation and stress – Crop Response to stress – Physiological and Ecological optimize – How crops cope up with stress – Ecological Dimension of stress science stress Biology.

Unit II - Stress and Strain Terminology:

Temperature stress Nature and stress injury and resistance; causes of stress. Low temperature stress: freezing injury and resistance in plants, measurement of freezing tolerance, chilling injury and resistance in plants, practical ways to overcome the effect of low temperature tress through, soil and crop manipulations. High temperature or heat stress: meaning of heat stress, heat injury and resistance in plants, practical ways to overcome the effect of heat stress through soil and crop manipulations.

Unit III - Water Deficit Stress:

Plant water deficient stress and its effect on growth and development, water deficit injury and resistance, practical ways to overcome effect of water deficit stress through soil and crop, manipulations. Stress at population level – density stress. Phenotypic and Genotypic variation – in population with stress. Excess water or flooding stress: meaning of excess water stress, its kinds and effects on crop plants, excess water stress injury and resistance, practical ways to overcome excess water stress through soil and crop manipulations

Unit IV- Salt stress:

Salt stress and Acid stress effect on crop growth, salt and acid soil stress injury and resistance in plants, practical ways to overcome the effect of salt and acid stress through soil and crop manipulations. Mechanical impedance of soil and its impact on plant growth; measures to overcome soil mechanical impedance.

Unit V – Stress response at cellular level:

Oxidative stress – definition - ROS - Types - ROS under stress and ROS Scavengers – Biological role of ROS Environmental pollution stress air, soil and water pollution, and their effect on crop growth

Practical

- Determination of electrical conductivity of plant cell sap
- Determination of osmotic potential and tissue water potential
- Measurement of transpiration rate

- Measurement of stomatal frequency
- Growing of plants in sand culture under salt stress for biochemical and physiological studies
- Studies on effect of osmotic and ionic stress on seed germination and seedling growth
- Measurement of low temperature injury under field conditions

Lecture Schedule

1. Stress and strain terminology
2. Nature and stress injury in crop plants.
3. Soil salinity and sodicity as particular plant / Crop stress factors.
4. Different causes of stress.
5. High temperature stress – Definition - heat injury
6. Effect of heat – Temperature stress on photosynthetic apparatus.
7. Soil and crop manipulations to overcome the effect of heat stress.
8. Excess water stress through soil and crop manipulations.
9. Water stress – Definition – Plant water deficit stress.
10. Constraints by water stress on plant growth
11. Effect of water deficit stress on growth and development.
12. Nutrient uptake by plants under stress condition.
13. Plant response to water – Deficit condition.
14. Soil and crop manipulation to overcome the effect of water deficit stress.
15. Excess water to crop plant water stress.
16. Water stress and its kinds and effect on crop plants.
17. **Mid-Semester examination**
18. Excess water stress injury and resistance.
19. Soil and crop manipulation to overcome the effect of excess water stress.
20. Salt stress – Definition – Its effect on crop growth.
21. Plants in saline environments.
22. Salt stress injury and resistance in plants.
23. Crop response & management of salt affected soils.
24. Soil manipulation to overcome the effect of salt stress.
25. Crop manipulation to overcome the effect of salt stress.
26. Mechanisms involved in salt tolerance in plants.
27. Mechanical impedance of soil & its impacts on plant growth.
28. Measures to overcome soil mechanical impedance.
29. Definition – Pollution – air pollution effect on crop growth and quality of produce.
30. Soil pollution – Effect on crop growth and quality of produce.
31. Water pollution – Effect on crop growth and quality of produce.
32. Effect of atmospheric pollution with special reference to ozone on plants under normal & saline conditions.
33. Plant response to air pollution & heavy metal stress.
34. Photosynthetic response of crop to environmental changes.

Practical schedule

1. Determination of electrical conductivity of plant cell sap.
2. Determination of osmotic potential.
3. Determination of tissue water potential.
4. Measurement of transipiration rate.
5. Measurement of stomatal frequency.
6. Growing of plants in sand culture under salt stress for biochemical studies.
7. Growing of plants in sand culture under salt stress for physiological studies.
8. Studies on effect of osmotic stress on seed germination.
9. Students on ironic stress on seed germination.
10. Studies on effect of osmotic stress on seedling growth.
11. Students on effect of ironic stress on seedling growth.
12. Measurement of low temperature injury under field condition.
13. Measurement of high temperature under controlled condition.
14. Studies on Air, water and soil pollution.
15. Studies on effect of different types of pollution on crop growth and quality of produce.
16. Studies on the effect of excess water or flooding stress on crop growth and development.
17. Measures to prevent different environmental pollution.

Course Outcomes

- To describe in detail the crop stress physiology.
- To discuss the concepts of assimilate translocation and partitioning in a crop plant under stress.
- To examine the physiology of crop adaptation to their environment;
- To develop critical thinking and problem-solving skills with respect to crop stress physiology

Suggested readings

1. Baker FWG.1989. Drought Resistance in Cereals. Oxon, UK.
2. Gupta U.S. (Ed.). 1988. Physiological Aspects of Dryland Farming. Oxford & IBH.
3. Kramer PJ.1983. Water Relations of Plants. Academic Press.
4. Levitt J. 1980. Response of Plants to Environmental Stresses. Vols. I, II. Academic Press.
5. Matthew P. Reynolds.2010. Climate change and crop production.CAB Publishing.
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8. Michael AM &Ojha TP.1981. Principles of Agrl. Engineering. Vol II. Jain Bros.
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	PO 1	PO 2	PO3	PO 4	PO 5
Course Outcome 1	3	2	2	3	2
CO 2	2	-	2	3	-
CO 3	2	-	2	2	1
CO 4	3	2	2	1	2

GAGR: 824 ADVANCES IN CROP ECOLOGY (2+1)

Learning Objectives:

- Students will study the various factors that influence the eco system
- Students will understand the adaptation of crops to different eco system

Theory

UNIT I - Concept of crop ecology:

Ecology of agricultural systems, ecology of cropping systems, principles of plant distribution and adaptation, crop and world food supply.

UNIT II – Ecosystems types and function:

Ecosystem characteristics, types and functions, terrestrial ecology, flow of energy in ecosystem, ecosystem productivity, biomass, succession and climax concept.

UNIT III – Physiological Response of crops in Ecosystems :

Physiological response of crop plants to light, temperature, CO2, moisture and solar radiation; influence of climate on photosynthesis and productivity of crops; effect of global climate change on crop production.

UNIT IV – Solar energy in ecosystems:

Exploitation of solar energy in crops; vertical distribution of temperature; efficiency in crop production. Solar corridor accepts in different latitude.

UNIT V – Competition of crop plants in ecosystem:

Competition in crop plants; environmental pollution, ecological basis of environmental management and environment manipulation through agronomic practices; improvement of unproductive lands through crop selection and management.

Practical

- Different growth stages of field crops
- Growth analysis
- Role of climatic factors on crop growth
- Impact of environmental pollution on crop yields
- Waste land development techniques
- Light measurement amidst crop canopy in cropping system

Lecture schedule

1. Introduction – bio diversity – biological and cultural diversity - plant genetic resources-
   Bio sphere – Hot spots – Biotic wealth – its importance – distribution.
2. Genetic diversity – center of plant genetic diversity – in relation to Agriculture - origin of food crops.
3. Ecology definition, concepts and History.
4. Ecological crop geography – definition, concepts.
5. Crop ecology definition - concepts and history.
6. Agricultural systems – definition and hierarchy concepts – Natural social and artificial systems.
7. Agricultural systems – definition - classification and hierarchy – merits and demerits.
8. Cropping systems ecology – principles – diversification of crops and cropping systems.
9. Crop organization and rotation, crop choice.
10. Residue management – nutrient and water management.
11. Eco system – definition – components - characters.
12. Types of ecosystem – structure and its functions.
13. Terrestrial ecology – definition – components – characters.
14. Flow of energy in ecosystem – definition – importance.
15. Cycling energy and nutrients – tropic level – primary producers – role of organisms in energy flow.
16. Food chain – food web – energy pyramids.

17. Crop morphology and development in response to light and temperature.
18. Response of crops to moisture and solar radiation.
19. Crop plant in response to water stress – drought stress.
20. Influence of climate on crop distribution – temperature and photosynthesis.
21. Climatic factors on crop growth production and productivity.
22. Climate change and its effects on crop growth and development.
23. Impact of climate change on global crop production and productivity.
24. Agriculture and resource exploitation.
25. Renewable energy in agriculture – application of solar energy in agriculture.
26. Sustainable agriculture - renewable energy and its application.
27. Vertical temperature – definition – horizontal and vertical distribution of temperature on earth.
28. Horizontal and vertical distribution of temperature on ocean.
29. Effect of seasonal distribution of temperature.
30. Plant competition - definition – types – importance.
31. Crop - crop competition – crop weed competition.
32. Environmental pollution – its effects on crop growth and production.
33. Management of environmental pollution through agronomic practices.
34. Improvement of unproductive lands through crop selection and management.

Practical schedule

1. Basic problems in crop Ecology.
2. Methods of determining frequency.
3. Characters used in community structure.
4. &5. Practice in understanding various plant architecture.
6. &7. Growth analysis.
8. Nutrient use efficiency and studies on source and sink relationship.
9. Calculation of diversity index, dominance index and similarity index.
10. Different growth stages and yield components determination in rice.
11. Different growth stages and yield components determination in maize.
12. Different growth stages and yield components determination in sorghum.
13. Optimum soil temperatures for maximizing yield of important field crops.
14. Yield level, used to explain the conceptual basis for crop losses.
15. Survey about application of ecology in agriculture.
16. &17. Visit to different ecosystem – study the related experiments – data collection – interpretation.

Course Outcomes

- To understand the climatic factors and physiological response of crops to different eco systems
- To gain knowledge on competition of different crop plats in certain eco systems.

Suggested Readings

1. Alteri, M. A.1995. *Agroecology; the science of sustainable agriculture*(2nded.) Westview Press, Boulder, Colorado, USA

2. Ambasht RS. 1986. *A Text Book of Plant Ecology* (9th Ed). Students' Friends Chadha KL &Swaminathan MS. 2006. *Environment and Agriculture*. Malhotra Publ. House.
3. Dwivedi P, Dwivedi SK &Kalita MC. 2007. *Biodiversity and EnvironmentalBiotechnology*. Scientific Publ.
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5. productivity and management in Agricultural systems. Cambridge University press.
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7. Hemantarajan A. 2007. *Environmental Physiology*. Scientific Publ.
8. Jen-huchang. 2009. Climate and agriculture: An ecological survey. Routledge publishers.
9. Kumar HD. 1992. *Modern Concepts of Ecology* (7Ed). Vikas.Publ.
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11. Misra KC. 1989. *Manual of Plant Ecology*(3 Ed). Oxford & IBH.
12. Pandey SN & Sinha BK. 1995. *Plant Physiology*. Vikas Publ.
13. Sharma PD. 1998. *Ecology and Environment*. Rastogi Publ.
14. Schulze . E D , Beck .E and muller – Hoherstein . 2005. Plan ecology . Springer.
15. Singh J &Dhillon SS. 1984. *Agricultural Geography*. Tata McGraw Hill.
16. Taiz L &Zeiger E. 1992. *Plant Physiology*. Benjamin/Cummings Publ.

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8. https://www.cimmyt.org/cimmyt-scientist-wins-award-from-crop-science-society-of-america/
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	PO 1	PO 2	PO3	PO 4	PO 5
Course Outcome 1	3	2	3	3	2
CO 2	2	-	3	2	2

MINOR COURSES
(First semester)
GAGR 815 Environmental protection and pollution management (2+1)

Learning Objective:

- Students will understand the impact of environmental agrochemicals in crop productivity
- Students will learn various technologies to mitigate environmental pollution

- Students will recognize various aspect that influence global warming and its impact in crop growth

Theory

UNIT I - Importance of environmental protection:

Environmental protection- importance- Sources of environmental pollution-Types and Impact of pollution-Agricultural pollution-

UNIT II - Agrochemicals and pollution:

Agro chemicals and pollution-pollution from herbicides – Fate of Herbicides in soil – Decomposition: microbial, chemical and photodecomposition, Herbicide persistence – Methods to minimize herbicide residues – placement, herbicide rotation, crop rotation, trap crops, use of bugs for herbicide degradation. PP chemicals and pollution- safe limits in food products and natural resources

UNIT III - Prevention of herbicide toxicity:

Herbicide toxicity problems to living organisms: Mammals, aquatic fauna, microorganisms, shifts in weed flora – herbicide resistance development in weeds – history, reasons and prevention of resistance development. Herbicides in warfare – undesirable effects and health hazards

UNIT IV - Nutrient sources and pollution:

Nutrient sources and pollution – unfavorable effects on soil fertility and soil microbes- Agronomic management of environmental pollution – Agroforestry practices. Use of aquatic weeds for water purification. Siltation and sedimentation of reservoirs and lakes – Eutrophication – reasons and control measures.

UNIT V - Global warming:

Climate change-Global warming- Greenhouse effect- Carbon sequestration- Ozone depletion.

Practical

- Assessment and analysis of ecological degradation and sources of degradation in
- agricultural lands
- Collection water samples and analysis of quality parameters
- Assessment of biodiversity of flora and fauna
- Visit to Pollution Control Board and collection of information related to pollution in Tamil Nadu.
- Visit to Environmental Science Laboratories of reputed Institutes and familiarization of activities.

Lecture schedule

1. Environmental protection and its impact on agriculture, Environmental pollution – sources.
2. Environmental pollution – global warming and impact of pollution on vegetation.
3. Natural depletion of vegetation.
4. Environmental planning and management - concept of environmental management.
5. Agrochemicals and pollution management.
6. Herbicide application and causes.
7. Action of herbicides in soil - Decomposition.

8. Herbicide persistence and residue management.
9. Methods of herbicide application and techniques used to reduce the herbicide residues.
10. Safe limits of herbicide application in crop production.
11. Herbicide toxicity, resistance and shifts in weed flora.
12. Herbicide registration and regulation – Decision support system.
13. Weed shift and invasive alien species and weed Risk assessment.
14. Bio – inoculants resource use in agriculture.
15. Bio scavenging of herbicide spills with GMO's.
16. Bio control of weeds using plant products.
17. Natural resources – definition - prospects.
18. **Mid semester examination**
19. Soil resources and crop productivity.
20. Agronomic measure for management of scarce and costly inputs.
21. Labour resource management – scarce and peak season demand.
22. Cost reduction in crop production.
23. Problem soil and their management.
24. Assessment of resource degradation under different land use system.
25. Resource management under constraint situations.
26. Environmental impact of poor water management.
27. Dealing climate change – causes.
28. Impact of climatic change on agriculture and food security.
29. Climate change mitigation strategies.
30. Climate resilient farming.
31. Bio security in the context of climate change - disaster mitigation.
32. Carbon sequestration strategies – Indigenous Agriculture practices.
33. Opportunity in changing climatic scenario.
34. Integrated approach in climate change adaptation.

Practical schedule

1. Study on environmental impact of poor water quality.
2. Quality assessment of irrigation water in Cuddalore - District.
3. Management of poor-quality water.
4. Study on problem soils.
5. Management of problem soils through reclamation.
6. Study about organic and industrial waste and availability.
7. Impact of organic and industrial wastes to the environment.
8. Awareness and education program modules for invasive alien species.
9. Management of invasive alien species.
10. Bio scavenging in aquatic systems and forestry.
11. Survey of natural resources, availability in Tamil Nadu.
12. Study about genetic resources and their use in modern agriculture.
13. Management of herbicide residues
14. Bio assay techniques for herbicide residues.
15. Scoring for phytotoxic injury of herbicides
16. Visit to pollution control board and data collection.
17. Visit to effluent treatment plant and familiarization of activities.

Course Outcome:

- To understand various agronomic management of environmental pollution
- To identify suitable crops and tree species for remediation of soil and environmental pollution.

Suggested Readings

1. Bhatia.S.C.2008. Hand book of Environmental Biotechnology. Atlantic Publisher.
2. Hodges, L. 1977. *Environmental Pollution*. Holt, Rinehart and Winston, New York
3. Khalid Rehman Hakeem.2015. Crop production and global environmental issues. Springer Nature.
4. Rana, S.V.S. 2005. *Essentials of Ecology and Environmental Science* (2nd ed.) Prentice-Hall of India, New Delhi.
5. Sharma, B.K. 2003. *Environmental Chemistry* (7th ed.). Goel Publishing House, Meerut
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	PO 1	PO 2	PO3	PO 4	PO 5
Course Outcome 1					
CO 2					

SECOND SEMESTER

GAGR 825 Principles and practices of organic management (2+1)

Learning Objectives

- Students will understand the importance organic farming in protecting the environment
- Students will learn the significance of indigenous practices and resource management in organic farming
- Student will know about the procedure for organic certification

Theory

Unit I – Importance of organic farming:

Organic farming for sustainable Agriculture –concept and Definition – Scope and principles – history of organic farming – global scenario-biodiversity-importance and measure to preserve biodiversity pre-requisites for Organic farming.

Unit II – Organic sources:

Organic sources of nutrients – manures and other inputs – on farm and off farm sources – organic waste recycling methods- methods of compost-compost making-*insitu* and *situ*manuring-soil and crop management-intercropping-crop rotation-green manures-cover crops-mulching.

Unit III – Indigenous practices of organic farming:

Indigenous Technical Knowledge (ITK) in organic agriculture. Bio – intensive nutrient management – Nutrient rich organic manures. Biofertilizers- Application of effective microorganism technology– phosphate rich organic manure-indigenous practices of organic farming- Organic Crop Production and Protection methods.

Unit IV – Organic certification:

Organic Certification and labeling – NPOP guidelines – Certification agencies in India – crop production standards – Quality considerations – labeling and accreditation process – marketing and export opportunities – Organic enterprises. Non chemical management methods for weeds, insects and diseases.

Unit V – Resource management :

Resource management LEIA and HEIA concepts And principles- Basic ecological principles of LEISA-Promising LEISA techniques-resource management under constraints situations-Cost reduction strategies in crop production- Non-monetary inputs and low cost technologies-Labour management. Crop residue management. Conservation agriculture and its impact on agriculture.

Practical

- Aerobic and anaerobic methods of making compost
- Making of vermicompost
- Identification and nursery raising of important agro-forestry tress and tress for shelter belts
- Efficient use of biofertilizers, technique of treating legume seeds with Rhizobium cultures, use of Azotobacter, Azospirillum, and PSB cultures in field
- Visit to an organic farm
- Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms

Lecture Schedule

1. Definition-Organic farming-sustainable agriculture-prospects- concepts

2. Scope and principles-history and genesis of organic farming in world and India
3. Present status in world India and Tamilnadu.
4. Pre-requisites and basic steps for organic farming
5. Planning and processes of conservation of organic farming
6. Biodiversity-importance and measure to preserve biodiversity
7. Integration of animal components
8. Sources of organic manures – plant, animal and microbial origin-on-farm resources
9. FYM, green manures, crop residues, poultry manure, sheep and goat manures, biogas slurry.
10. Off-farm resources; coir pith, press mud, oilcakes, fly ash
11. Bio compost, minerals, bone meal, bio fertilizers, traditional preparations.
12. Organic waste recycling- methods and techniques
13. Composting, vermicomposting, in situ composting
14. Intensive cropping system
15. Intercropping-crop rotation
16. Green manuring-cover crops-mulching
17. Nutrient rich organic manures
18. **Mid-semester exam**
19. System approach in crop production
20. Indigenous technical knowledge (ITK) in organic agriculture – importance.
21. Bio intensive nutrient management
22. Organic certification – procedures
23. Certification agencies in India and labeling and accreditation processes.
24. Crop production standards – NPOP guidelines – principles, recommendations and standards and Organic farming
25. Promotional activities; role of government and NGO's – action plan – policy considerations.
26. Quality considerations – assessment methods – premium and export opportunities. Good crop husbandry practices for important field crops
27. Non – chemical weed management methods; preventive, physical, cultural, use of tools and implements and biological measures
28. Organic pests and diseases management practices – bio control agents, bio rational pesticides; minerals, botanicals, soaps, trap crops, bird perches, and traditional preparations – sanitation.
29. Resource management under constraint situation.
30. Cost reduction technologies and non monetary inputs in cropping and farming system.
31. LEIA and HEIA – principles and concepts – Basic ecological principles of LEISA and promising LEISA techniques
32. Labour management in cropping and farming system.
33. Crop residues management (CRM) for sustainable Agriculture
34. Conservation agriculture (CA), scope, advantages and CA technology for sustainable Agriculture.

Practical schedule

1. Resources Inventory of Organic farming.
2. Study on green manuring
3. Raising of green manures (Sunhemp/ Daincha/ Fodder cowpea)
4. Incorporation of green manure
5. Indigenous practices in seed treatment and raising of field crops (Rice, Maize, Cowpea, Cotton, Sugarcane)
6. Quantification of nutrients from organic sources
7. Hands on experience in recycling techniques – composting and vermicomposting
8. Production techniques – grading, packaging and post harvest management
9. Application methods of manures
10. Method of biofertilizer applications
11. Acquiring skills in quality aspects of inputs and products, grading, and packaging.
12. ITK based preparation (Panchakavya, Dasakavya, Amirthakaraisal, fish amino acids)
13. Exposure visit to organic farm market outlets and organic certification agencies.
14. Exposure visit to bio-control agent units
15. Exposure visit to bio fertilizer production units
16. Exposure visit to organic certification agencies/directorate of organic certification
17. Cost of production for organic cultivation of important field crops

Course Outcomes

- To know various input resources for organic farming
- To gain practical knowledge to develop a model organic farming that would help in enhancing their livelihood.

Suggested readings

1. Arunkumar Sharma, 2008. A Hand book of organic farming Agrobios polishers
2. Ann Larkin Hansen.2010. The organic farming method. Storey publishing.
3. Bibek Ghosh. 2007. Crops and livestock farming. Daya Publishing house.
4. Dahama, A.K.2009. Organic farming for sustainable agriculture, Agrobios publishers, Jodhpur
5. DiolipNandvani. 2016. Organic farming for Sustainable Agriculture. Springer International publishing.
6. Gaur, A.C. 1982. *A Manual of Rural Composting*, FAO/UNDP Regional Project Document, FAO.
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8. SP. Palaniappan and K Annadurai. 2008. Organic Farming: Theory and Practice. 2008. Scientific Publishers.
9. Sharma, A. 2002. *Hand Book of Organic Farming*. Agrobios.
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7. https://www.nofany.org/files/USDA_What_is_Organic_Certification.pdf
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	PO 1	PO 2	PO3	PO 4	PO 5
Course Outcome 1					
CO 2					

AGR 826 MOOC COURSE (2 CREDIT)