AGRICULTURE UNIVERSITY, KOTA

Proceedings of 27th Meeting of Academic Council

Date : 16th September,2026

Time : 11:00 AM

Venue : Conference Hall,Agriculture University,Kota

AGRICULTURE UNIVERSITY, KOTA

Proceedings of 27thMeeting of Academic Council

The 27th meeting of Academic Council of Agriculture University, Kota was held on 16th September, 2026 at 11.00AM in the Conference Hall, Agriculture University, Kota under the Chairpersonship of Dr. Vimla Dunkwal, Vice-Chancellor, AU, Kota. The following were present:

S.No.	Name	DESIGNATION	
1.	Dr. Vimla Dunkwal	Vice-Chancellor, AU, Kota	Chairman
2.	Smt. Manisha Tiwari	Registrar, AU, Kota	Member
3.	Dr. M. C. Jain	Director Research, A.U., Kota	Member
4.	Dr. Mahendra Singh	Director Extension Education, A.U., Kota	Member
5.	Dr. Ashutosh Mishra	The Director, LRG, A.U., Kota	Member
6.	Dr. D.K.Singh	Director, HRD, A.U., Kota	Member
7.	Dr. Mukesh Goyal	Director, PM&E, A.U., Kota	Member
8.	Dr. Virendra Singh	Director, Students' Welfare, A.U., Kota	Member
9.	Dr. I.B. Maurya	Dean, College of Horti. & Forestry, Jhalawar	Member
10.	Dr. S.K. Jain	Dean, College of Agriculture, Ummedganj, Kota	Member
11.	Dr. N.L. Meena	Dean, College of Agriculture, Hindoli	Member
12.	Dr. Harish Verma	Controller of Examinations, A.U., Kota	Member
13.	Dr. K.M. Sharma	Prof.& Head, Deptt. of Agronomy	Member
14.	Dr. K.C. Meena	Prof. & Head, Deptt. of Agricultural Extension and Communication	Member
15.	Dr. C.B. Meena	Prof. & Head, Deptt. of Plant Pathology	Member
16.	Dr. Subash Aswal	Professor (Soil Science)	Nominated Member
17.	Dr. M.K. Sharma	Prof. & Head, Deptt. of Soil Science	Member
18.	Dr. Ram Raj Meena	Professor & Head, Deptt. of Horticulture	Member
19.	Dr. N.R. Koli	Prof. & Head, Deptt. of PB&G	Member
20.	Dr. S.B.S. Pandey	Prof., Deptt. of Silv. & Agroforestry	Member
21.	Dr. B.K. Patidar	Prof. & Head, Deptt. of Entomology	Member
22.	Dr. Prahlad V.C.	Assoc. Prof. (Silviculture & Agroforestry)	Nominated member
23.	Dr. Kapil Sihag	Assoc. Prof & Head, Deptt. of FPU	Member
24.	Dr. Praveen Singh	Ex-VC, SKNAU, Jobner	Co-opted member
25.	Dr. Sudesh Kumar	Ex-DEE, SKNAU, Jobner	Co-opted member
26.	Prof. B.K. Sharma	Ex-Director Education, SKNAU, Jobner	Co-opted member
27.	Dr. Jitendra Singh	Director Education, A.U., Kota	Member Secretary

Dr. R.K. Rai**,** Ex-Prof & Head, Division of Agronomy, IARI, New Delhi., Dr. Meghendra Sharma, Pro Vice-Chancellor, Chatrapati Shivaji Maharaj University, Navi Mumbai., Dr. Prerak Bhatnagar, Dr. Kavita A., and Dr. C.K. Arya could not attend the meeting due to some unavoidable circumstances.

The meeting began with the National song followed by University Kulgeet. Dr. Jitendra Singh; the Member Secretary delivered welcome address in the meeting. At this occasion, Hon'ble Vice-Chancellor presented bouquet to the guest members presented in the meeting.

At the outset, the Hon'ble Vice-Chancellor and Chairperson in her opening remarks emphasized on the significance of such meeting towards smooth functioning of the university by upscaling the rules/regulations required time to time

The Director of Education presented agenda. After thorough discussions on each, the following resolutions were passed:

Agenda Item No.	Particulars
AUK/AC-27/2026 03/01	**Confirmation of the Minutes of the 25th Academic Council Meeting held on 24.02.2026** It was resolved to confirm the minutes of 25th meeting of Academic Council held on 24.02.2026.
AUK/AC-27/2026-03/02	**Confirmation of the Minutes of the 26th Academic Council Meeting held on 22.04.2026** It was resolved to confirm the minutes of 26th meeting of Academic Council held on 22.04.2026.
AUK/AC-27/2026-03/03	**Action Taken Report on the Proceedings of the 25th & 26th Meeting of the Academic Council** It was resolved to approve Action Taken Report on the proceedings of 25th and 26th meeting of Academic Council held on 24.02.2026 and 22.04.2026, respectively.
AUK/AC-27/2026-03/04	**Rescheduling of incentives for applicants of Research Paper/Project Sanction, Best Teacher, Extension Educationist, and Research Scientist Awards.** It was resolved to forward the matter to the finance committee AU, Kota for further course of action in this matter **Action: DHRD, AU, Kota**
AUK/AC-27/2026-03/05	**Approval of course title, course codes, credit load and semester wise distribution of various courses for "Ph.D. Agricultural Extension Education" programme to be offered by Department of Agricultural Extension and Communication in the Faculty of Agriculture** The council approved the course title, course codes, credit load and semester wise distribution (as Annexed in Annexure I) of various courses for "Ph.D. Agricultural Extension Education" programme to be offered by Department of Agricultural Extension and Communication in the Faculty of Agriculture. **Action: Dean, CoA, Kota**
AUK/AC-27/2026-03/06	**Approval of course title, course codes, credit load and semester wise distribution of various courses for "M.Sc. (Agri.) Entomology" programme to be offered by Department of Entomology in the Faculty of Agriculture** The council approved course title, course codes, credit load and semester wise distribution (as Annexed in Annexure II) of various courses for "M.Sc. (Agri.) Entomology" programme to be offered by Department of Entomology in the Faculty of Agriculture. **Action: Dean, CoA, Kota**
AUK/AC-27/2026-03/07	**To initiate the B.Sc. Ag. (Hons.) Natural Farming degree programme in the university from Academic session 2027-28** It was resolved to constitue a committee under the chairmanship of Director Education to decide modus oprendi to initiate the B.Sc. Ag. (Hons.) Natural Farming (as Annexed in Annexure III) **Action: Registrar, AU, Kota**

AUK/AC-27/2026-03/08	**Approval for Deduction of Alumni Association Membership Fee from the Caution Money of Students at the Time of Leaving the College for Strengthening the Alumni Association** The council approved to get the consent of student in prescribed format for the sake of deduction of Alumni Association Membership Fee from the Caution Money of the student at the Time of Leaving the College with effect from the session 2026-27. It shall be applicable to all the constituent colleges of university. **Action: DSW, AU, Kota**
AUK/AC-27/2026-03/09	**Framing guidelines for providing a Scribe to students with temporary disabilities during university examinations** The council approved to frame the guidelines in alinment with the guidelines for providing a Scribe to students with permanent disabilities for final theory/practical examination **Action: CoE, AU, Kota**
AUK/AC-27/2026-03/10	**Approval of subject combinations for admission to UG programmes in the Faculties of Agriculture, Horticulture and Forestry** It was approved to adopt the four subject combinations (ABC or PCM or PCB or PCA) as the eligibility criteria for admission to undergraduate programmes in the Faculties of Agriculture, Horticulture and Forestry for ICAR students. Candidates who appeared in subjects different from those studied and passed/appeared in the 10+2 examination shall not be considered eligible for admission, and their candidature shall be rejected. **Action: Registrar, AU, Kota**
AUK/AC-27/2026-03/11	**Consideration of eligibility of Subject Matter Specialists (Pay Level-10; GP 5400) for direct recruitment to of Associate Professor (Pay Level-13A: GP 9000).** The house decided to forward the matter to VC coordination committee constituted at state level for necessary consideration in the matter **Action: DEE, AU, Kota**
AUK/AC-27/2026-03/12	**Transfer of students from one constituent college to another constituent college of the University** It was decided to constitue a committee under the chairmanship of DE, AU Kota, to consider such cases considering equal opportunity to all students seeking transfer from one constituent college to another constituent college of the university based on merit. Further the committee should consider such cases from the students after completion of second year and aviailbility of seat in constituent college on special payment basis as decided by the university time to time **Action: Registrar, AU, Kota**
AUK/AC-27/2026-03/13	**Finalization of disciplines need based for the posts of SMS to be filled through direct recruitment in the KVKs of AU, Kota**

	The house consented for the following deciplines for the post of subject matter specialist to be filled through direct recruitment in the KVKs of Agriculture University, Kota **Action: Registrar, AU, Kota**
Table Agenda–1	**Conversion or creation of one post of Assistant Professor (livestock management) at ARS, Kota.** It was concented to creat/convert two posts of Assistant professor Livestock Management from existing post of genetics and plant breeding (non plan) ARS. Kota **Action: Registrar, AU, Kota**

S.No.	**Subjects of SMS**	**Filled**	**Vacant**	**Proposed need based subjects for the post of SMS to be filled**
1.	Agronomy	1	5	4
2.	Livestock Production	1	5	3
3.	Horticulture	4	2	1
4.	Plant Protection	1	5	4
5.	Home Science (Community Science)	5	0	0
6.	Agriculture Extention	2	4	2
7.	Soil Science	1	-	3
	Total	**15**	**21**	**17**

Towards culmination of the meeting, the co-opted members of the Academic Council expressed satisfaction over undergone healthy discussion in deciding agenda one by one. They conveyed best wishes for the superior progress of the university.

The meeting concluded with a heartfelt vote of thanks to the Chair and all members. At last, National anthem was played in honour of Nation's history.

(Jitendra Singh)
Director Education &
Member Secretary

(Vimla Dunkwal)
Vice-Chancellor, AU, Kota
Chairman

Annexure I

Annexure-1

कृषि महाविद्यालय, उम्मेदगंज–कोटा
COLLEGE OF AGRICULTURE, UMMEDGANJ- KOTA
(कृषि विश्वविद्यालय, कोटा)
(Agriculture University, Kota)
उम्मेदगंज, कैथून रोड, कोटा – 324 001 (राज.)
Ummedganj, Kaithoon Road, Kota- 324 001 (Raj.)

Dr. S.K. Jain
DEAN

Tel:0744-2941655
Email:coak@aukota.org

F.·14 () COA/Kota/2026/ 577-87 **Date :** 02/5/26

NOTIFICATION

In pursuance of the Resolution No. **AUK/AC-25/2026-01/14** of the Academic Council meeting held on 24.02.2026 and the subsequent approval of Board of Management vide Resolution No. BOM-28/2026/05 in its meeting held on 02.04.2026, it is notified to initiate the **Ph.D. Agricultural Extension Education** programme in the Department of Extension Education & Communication, College of Agriculture, Ummedganj, Kota with an intake capacity of **three seats (2 normal + 1 payment)**, from the Academic Session **2026–27**.

Dean and Faculty Chairman

Copy to following for information: -

1. The P.S. to respected Vice-Chancellor, Agriculture University, Kota.
2. The Registrar, Agriculture University, Kota.
3. The Comptroller, Agriculture University, Kota.
4. The Dean COA, Hindoli / CH&F, Jhalawar.
5. The Director, Education/Student Welfare/ Extension Education/ Research/HRD/PM&E, Agriculture University, Kota.
6. The Controller of Examinations, Agriculture University, Kota.
7. Head/ Incharge of all the Departments, Faculty of Agriculture, AU, Kota
8. Academic Incharge (UG/ PG), COA, Kota.
9. O/I, College Website, COA, Kota
10. Nodal Officer, Website, AU, Kota.
11. Guard file.

Dean and Faculty Chairman

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Annexure-2

Nomenclature of Ph.D. Degree programme

S. No.	Discipline/ Departments	English Name	Hindi Name
1	Agricultural Extension Education	Ph.D. Agricultural Extension Education	विद्या वाचस्पति कृषि प्रसार शिक्षा

Detailed Course Programme (Credit Requirement) for Ph.D. Degree Programme
As per BSMA guidelines the Credit Requirements for Ph.D. Degree Programmes

S. No.	Course Structure	Credit Hrs.
1	Major Courses	12*
2	Minor Courses	06
3	Supporting Courses	05
4	Seminar	02
5	Comprehensive Examination	NC
6	Thesis/Research	75
	Total	**100**

Proposed Course Titles, Course Code and Credit Loads

S. No.	Course code as per BSMA	Proposed Course code	Course Title	Credit Hours
Major Courses-12				
1	EXT-601*	EXT-611	Policy Engagement and Extension	3(2+1)
2	EXT-602*	EXT-612*	Methodologies for Social and Behavioural Research	3(2+1)
3	EXT-603*	EXT-621*	Technology Commercialization and Incubation	3(2+1)
4	EXT-604*	EXT-622	Educational Technology and Instructional Design	3(2+1)
Minor Courses-6				
5	EXT-605	EXT-613	Risk Management and Climate Change Adaptation	3(2+1)
6	EXT-606	EXT-614	Livelihood Development	2(1+1)
7	EXT-607	EXT-623	Facilitation for People centric Development	3(2+1)
Supporting Courses-5				
10	STAT	STAT-611	Multivariate Statistical Methods for Extension Research	3(2+1)
11	COM	MCA-613	Multimedia and Applications	2(1+1)
12	MCA-512	MCA-522	Information Technology in Agriculture	2(1+1)
Seminars and Research				
14	EXT-691	EXT-641	Doctoral Seminar-I	1(1+0)
15	EXT-692	EXT-642	Doctoral Seminar-II	1(1+0)
16	-	EXT-643	Comprehensive	NC
17	EXT-699	EXT-644	Thesis / Research	75
			Total	**100**

Semester wise Course Distribution

S. No.	Course code as per BSMA	Proposed Course code	Course Title	Credit Hours
Semester-I				
1	EXT-601	EXT-611	Policy Engagement and Extension	3(2+1)
2	EXT-602	EXT-612*	Methodologies for Social and Behavioural Research	3(2+1)
3	EXT-605	EXT-613	Risk Management and Climate Change Adaptation	3(2+1)
4	STAT	STAT-611	Multivariate Statistical Methods for Extension Research	3(2+1)
Semester-II				
5	EXT-603	EXT-621*	Technology Commercialization and Incubation	3(2+1)
6	EXT-604	EXT-622	Educational Technology and Instructional Design	3(2+1)
7	EXT-607	EXT-623	Facilitation for People centric Development	3(2+1)
8	MCA-512	MCA-522	Information Technology in Agriculture	2(1+1)
Semester-III				
9	EXT-691	EXT-641	Doctoral Seminar-I	1(1+0)
10	EXT-692	EXT-642	Doctoral Seminar-II	1(1+0)
11	-	EXT-643	Comprehensive	NC
12	EXT-699	EXT-644	Thesis / Research	75

Annexure-3

Course Contents

Ph.D. in Agricultural Extension Education

EXT 601 (EXT-611): Policy Engagement and Extension 3 (2+1)

I. Theory

Block 1: Why Policies Matter?

Unit 1: Understanding Policy

Why policies are important for extension? Role in providing structure, ensure funding and framework for providing functions-examples; Policy: definitions and types: Is policy a product or a process or both? Policies and institutions-How this influence defining organizational roles and performance in extension organizations- Role of policies in upscaling knowledge-Role of extension in influencing policies to enable innovation.

Unit 2: Policy Advocacy and Tools

Definition of advocacy, Approaches to policy advocacy-Advising, Media campaigning, Lobbying, Activism, Information Education Communication (IEC) and Behavior Change Communication (BCC); Advocacy for Rural Advisory Services (RAS); Policy advocacy strategy

Unit 3: Policy Analysis

Explain the meaning and use of policy analysis in decision- making; Describe different types of policy analysis- empirical, evaluative or normative policy analysis, retrospective/ prospective policy analysis, predictive/prescriptive/descriptive policy analysis; How to do policy analysis? - understand the process of policy analysis, highlight the different methods and techniques used in policy analysis, doing ethical policy analysis; Tools for policy impact- research tools, context assessment tools, communication tools, policy influence tools

Unit 4: Policy Development Process

Policy development process: Who drives policy change?: National Governments, Donors, Civil Society-varied experiences: Understanding the environment and key actors in policy space- problem identification-policy adoption, implementation and evaluation; stakeholder mapping, identifying opportunities and barriers, mobilising financial resources; Dealing with policy incoherence: identifying contradictions and challenges in policy implementation

Block 2: Using Evidence to Influence Policy Change

Unit 1: Influencing Policy Change

Generating evidence: Role of policy research; analyzing the usefulness and appropriateness of the evidence; Using evidence in policy advocacy; Understanding your audience: analyzing channels of influence; creating alliances; identifying policy champions; Defining goals and objectives; Developing advocacy messages: Policy papers, Policy briefs, good practice notes, *etc.*: Good practices in influencing policies Organising policy dialogues: Policy engagement strategy-Engaging with policy makers: GO and NGO experiences; Policy working groups; advisory panels; use of committees: Use of media including ICTs and social media for influencing policies.

Unit 2: Global Experience with Extension Policy

Extension policy in different countries: Explicit extension policy Vs extension as part of Agriculture Policy, Challenges in policy implementation: lack of capacities, financial resources, ownership, lack of stakeholder consultations: Strengthening capacities in extension to influence policies: Global Forum for Rural Advisory Services (GFRAS)'s efforts in strengthening extension policy advocacy: policy compendium, training modules, training for strengthening capacities to influence policies.

II. Practicals

- Analysis of country/state level agricultural/extension policy to understand the policy intentions from strengthening EAS
- Analysis of extension policy of other countries: policy intentions, processes adopted in development of the policy and mechanisms of policy implementation
- Interview key policy actors in EAS arena at the state/national level (eg: Director of Agriculture, Director of Extension in SAU, Chairman/Managing Director of Commodity Board. Member Agriculture, State Planning Board) to explore policy level challenges in EAS
- Identify what evidence policy makers look for from extension research? Is the evidence available? If so what form? (Reports, Briefs etc), If not, develop a plan
- Explore how different stakeholders influence policies (eg: policy advocacy of prominent NGOs, private sector and public sector) -What mechanisms and tools they use
- Identify policy level bottlenecks that constrain effective EAS delivery at the district level- Eg: Issues around linkages between KVK and ATMA; inter-departmental collaboration; public private partnerships; joint action etc.

III. Suggested Reading

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EXT 602 (EXT-612): Methodologies for Social and Behavioural Research 3(2+1)

I. Theory

Block 1: Advanced Methods for Improving Quality of Research Data

Unit 1: Measurement Properties of Research Instruments

Measurement properties – Dimensionality, reliability and validity; Dimensionality – Unidimensionality and multidimensionality, Methods of assessing dimensionality, Formative and reflective constructs; Validity- Importance, Internal validity - face validity; content validity, Substantive Validity, Structural Validity; External validity-Convergent and Discriminant Validity, known-group validity, Criterion-Related Validity, Consequential Validity, nomological validity; Methods of assessing various forms of validities – Judges rating, Lawshe's Content Validity Ratio, Item-objective congruence index; latent variable method; Reliability - Internal consistency reliability – Split-Half, Cronbach alpha; Temporal Stability reliability - test-retest method; Interrater Consistency and Consensus – inter rater reliability and interrater agreement; Alternative Forms or parallel forms reliability– Reliability of difference- Factors Affecting the Validity and Reliability of Test Scores; Generalizability Theory

Unit 2: Threats to Data Quality

Errors and biases; Errors – Meaning and sources; Types - Sampling error, Non-sampling or measurement error and Processing error – Meaning, causes; Effects of errors and biases on data quality; Bias in behavioural research – Meaning, causes, Types – Respondent and researcher biases; Methods of reducing errors and biases in surveys, questionnaires, personal interviews, focus groups and online methods

Block 2: Scales, Indexes and Tests

Unit 1: Scales, Indexes and Tests-1

Approaches to measurement and scale development - Classical test theory. Formative or index models, The C–OAR–SE approach and Item Response Theory; Item analysis in Classical test theory–item difficulty and item discrimination; Scoring performance in scales and tests – meaning, types and methods; Scale development strategies– deductive and empirical; Stimulus-centred scales – method of equally appearing intervals, paired comparison, Person scaling – Q methodology; Subject- centre scales– The Likert scale and Semantic Differential

Unit 2: Scales, Indexes and Tests-2

Steps in constructing a multi-dimensional scale using confirmatory factor analysis,; Response scales - Guttman's scalogram analysis and The Rasch method; Indexes – Meaning, types, importance; Similarities and differences with scales, Methods of constructing indexes; Common indexes used in extension. Measurement invariance – Meaning, types, methods of assessing measurement invariance. Tests– meaning, types, importance; steps in conducting various tests–knowledge test

Block 3: Emerging Research Approaches and Designs

Unit 1: Qualitative Research Methods

Qualitative methods – Meaning; Types – Ethnography, Grounded theory, Phenomenology, Ecological psychology, Discourse Analysis; Observational research; Case study research – Sampling and sample size; Data collection methods - In-

depth interviews, Focus groups, Direct observation, Record review; Content analysis; Unobtrusive Measures; Projective and semi-projective techniques; Selecting right qualitative method – Strengths and limitations of qualitative research; Analysis and interpretation of qualitative research data; Research synthesis – meaning, importance, methods; Systematic reviews and meta analysis – meaning, steps, and applications; Policy research

Unit 2: Emerging Approaches

Mixed methods research – meaning, purpose, types and applications; Participatory research – Meaning, importance, types, methods and tools and applications; Action research – Meaning, importance, Principles, Types, Steps in conducting action research, application in behavioural sciences. Social Network Analysis – Meaning, importance, types, steps in social network analysis, applications; Advanced methods of measuring perception and beliefs. Multi criteria decision making, analytical hierarchy approach

Block 4: Utilising Research Outputs

Unit 1: Publishing Research

Scholarly communication process; Research reports – Meaning, types, contents; Presentations–Meaning, types, principles of good presentation-Tell 'Em" and KISS 'Em" principles; Research publications–meaning, importance, types; Guidelines for preparing research papers-Peer review process, citation styles; Open access publishing; Publishing in social media. Software in academic writing

Unit 2: Ethics in Extension Research

Ethics in conducting behavioural research; Human subject research – Meaning, history, and ethical guidelines; Ethical aspects of collecting and using Indigenous knowledge and farmers technologies; Ethical practices in publishing; Plagiarism – meaning, sources, Identifying and correcting plagiarism in a research paper using anti-plagiarism software

II. Practicals

- Practice in developing research instruments
- Methods of assessing measurement properties of research instruments - dimensionality, reliability and validity
- Hands-on exercise in minimising errors and biases
- Hands-on experience in constructing tests, scale and indexes
- Practice in summated scale development using confirmatory factor analysis
- Hands on experience in assessing measurement invariance
- Practicing and collecting data using participatory tools and techniques, analyzing and interpreting qualitative data
- Hands-on experience in writing systematic review using meta-analysis
- Field practice in conducting action research
- Practical experience in writing research paper
- Hands on exercises using software for qualitative data analysis
- Practice in detecting and correcting plagiarism using software

III. Suggested Reading

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EXT 603 (EXT-613): Technology Commercialisation And Incubation 3(2+1)

Block 1: Technology Commercialisation and the Modern Context

Unit 1: Basics of technology commercialisation

Technology - Definition, functions, process of technological advancement– invention, discovery, innovation and technology; types of innovation - Basic research, Breakthrough innovation, Disruptive Innovation and Sustaining Innovation; Technology transfer and commercialization

Unit 2: Nature of Agricultural Technology

Agricultural technology – meaning, types; technology generation system; technology life cycle

Unit 3: Basics of Technology transfer and commercialisation

Technology transfer Vs Commercialisation; Technology commercialisation process – elements, models, systems and processes; Technology transfer model – research, disclosure, development and commercialisation

Block 2: Intellectual Property Resources (IPR) Management

Unit 1: Overview of Intellectual Property Resources

Introduction to IPR; Overview & Importance; Genesis; IPR in India and IPR abroad; Patents, copyrights, trademarks & trade secrets, geographical indication, industrial design; Emergence of IPR Regimes and Governance Frameworks - Trade-Related Aspects of Intellectual Property Rights (TRIPS), Convention on Biological Diversity (CBD), Cartagena Protocol, International Union for Protection of New Plant Varieties (UPOV), and BIMSTEC.

Unit 2: Systems for Protecting IP

IPR protection laws and systems – National IPR Policy; and IPR laws; procedures for filing IP protection; Systems of IP protection and management in agricultural universities and research institutions and also by stakeholders

Unit 3: Management of IPR

Mechanisms of IPR Management – Institutional arrangement, IP Management processes – invention disclosure; IP portfolio management; Infringement management

Unit 4: Protection and Management of Biological Resources

Introduction; National Biodiversity Act (2002); Protection of Plant Varieties and Farmers Rights Act (2001); Guidelines for registration and transfer of biological resources; Farmers rights; Mechanisms of documenting/ collecting, protecting and commercialising farmers varieties and other biological resources; National Biodiversity Authority, PPVFRA and other agencies involved in management of biological resources in India. Access to Genetic Resources and Sharing of Benefits

Unit 5: Protection, Management and Commercialisation of Grassrootand Farmers Innovations, Traditional and Indigenous Knowledge

Traditional and Indigenous Knowledge, Grassroot and Farmers Innovations – Meaning, forms and importance; Systems of documentation, registration, protection and commercialisation. Documentation of traditional indigenous knowledge - Traditional Knowledge Digital Library (TKDL), Community Biodiversity Registers

(CBRs), People's Biodiversity Registers (PBRs), Plant Biodiversity Register, and Honeybee Network.

Unit 6: Geographical Indications (GI) and Appellation of Origin

Geographical indications and appellation of origin – meaning, origin; Geographical Indications of Goods (Registration and Protection) Act (1999); Documentation, registration and commercialisation of GI protected materials and processes.

Unit 7: Genetically Modified Organisms (GMO), Agriculture and Biosafety

The Global Concerns on Use of Genetically Modified Organisms in Food and Agriculture; The Cartagena Protocol on Bio-safety; Regulation of GMO in India - Recombinant DNA Advisory Committee (RDAC), Institutional Bio-safety Committee (IBSC), Review Committee on Genetic Manipulation (RCGM), Genetic Engineering Approval Committee (GEAC), State Bio-safety Coordination Committee (SBCC) and District Level Committee (DLC). Laws and Acts for regulation of GMO - Guidelines for Research in Transgenic Plants, 1998; Seed Policy, 2002; Plant Quarantine Order, 2003; Regulation for Import of GM Products Under Foreign Trade Policy, 2006; National Environment Policy, 2006

Block 3: Technology Commercialisation

Unit 1: Technology Assessment and Refinement

Meaning; Importance; Approaches and methods of assessment and refinement of various technologies – stakeholder-oriented approaches including participatory technology assessment and refinement; assessment and refinement of traditional and indigenous knowledge and grassroot innovations

Unit 2: Technology Valuation

Returns to investment; IP Valuation-Oxford context, IP Valuation methods - Cost approach; Income approach - Discounted Cash Flow, Risk-Adjusted Net Present Value, Net Present Value with Monte Carlo Simulation and Real Options Theory; Market approach - Industry Standards Method, Rating/Ranking Method, Rules of Thumb Approach and Auction Method; Hybrid approaches; Royalty rate method

Unit 3: Technology Commercialisation Strategies

Meaning- approaches for technology commercialisation – technology scaling up, technology licensing, handholding, agripreneur development, technology business incubation

Unit 4: Scaling up of Technologies

Meaning, types and stages of technology scaling up; mechanisms

Unit 5: Technology Licensing

Meaning and types - Procedures of licensing, preparing licensing documents; Management of technology licensing process

Unit 6: Technology Takers and Entrepreneurship

Meaning; types of technology takers; Technology Taking as a Strategy; Types of entrepreneurship – agripreneurs, startups, small businesses, Producer Organizations, Self Help Groups, Clusters and other forms of entrepreneurship

Unit 7: Policy support for Technology Commercialisation and Entrepreneurship Development

Policy support for entrepreneurship development in India - National Policy on Skill Development and Entrepreneurship and other polices; Government of India Support for Innovation and Entrepreneurship – Startup India, Make in India, Digital India, Atal Innovation Mission and others; Entrepreneurship policy and schemes at different states of India; Organisations promoting entrepreneurship in India

Block 4: Technology Incubation

Unit 1: Basics of Technology Incubation

Meaning, functions and types; stakeholder-oriented incubation process – Livelihood incubation, village incubators

Unit 2: Technology Incubation in India

System of technology incubation- incubation process; its effectiveness; Managing profit oriented and non-profit incubators; Schemes for promoting incubators in India

Block 5: Technology Promotion and Essential Skills For Technology Commercialisation

Unit 1: Technology Promotion

Technology promotion – meaning, types, business meetings, scientist-industry/ entrepreneur meets, technology conclave, business plan competition, farmers fairs, technology shows

Unit 2: Dealing with Entrepreneurs, Agripreneurs and Other Stakeholders

Business communication; Business Etiquette; business networking

Block 6: Emerging Approaches in Technology Commercialisation and Incubation

Unit 1: Technology Scouting

Technology Scouting and Innovations in technology incubation

II. Practicals

- Understanding the technology commercialisation process – Visit to Technology Commercialisation Unit of ICAR Institute/ Agricultural University
- Understanding the IPR protection practices – Visit to Patent Attorney office
- Hands-on experience in drafting IPR application – Patent/Copyright/ Trademark
- Understanding protection of biological resources including plant varieties – Visit to PPVFRA Branch office/ ICAR Institute or Agricultural University involved in plant variety protection
- Documenting Traditional and indigenous knowledge – Field experience in using various protocols of using traditional and indigenous knowledge
- Protecting unique local goods through Geographical Indications – Hands on experiences in documenting and registering Geographical indications
- Technology assessment/ validation of traditional and indigenous knowledge – QuIK and other methods
- Hands on experience in technology valuation
- Hands on experience in technology licensing process including drafting agreements
- Understanding the Technology Business Incubation – Visit to Agri Business Incubator or Technology Business incubator
- Hands on experience in planning and organising technology promotion events
- Hands on experience in various techniques in business communication and Business etiquette

III. Suggested Reading

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Exploring grassroots innovations in India. The Journal of World Intellectual Property. 1-17. DOI: https://doi.org/10.1111/jwip.12097.

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EXT 604 (EXT-621): Educational Technology and Instructional Design 3(2+1)

I. Theory

Block 1: Educational Technology

Unit 1: The Landscape of Educational Technology and Instructional Design

Understanding various terms - educational technology, instructional design, instructional systems design, curriculum design, pedagogy, andragogy; Brief overview of the origin and evolution of ET and ID as theory and practice; what is the relevance of ET and ID relevant in extension and rural advisory services? Extensional professionals as instructional designers and architects of the learning experience

Unit 2: Theories of Learning

What is learning? Critical overview of Behaviorism, Cognitivism, Constructivism and Complex learning theories; instructional designers and learning theories; Types of learning or learning domains- Bloom's taxonomy of the cognitive domain, Krathwohl and Bloom's affective domain and Simpson's psychomotor domain

Unit 3: Technology Enabled Learning

What is the role of technology in education? Digital media, new tools and technology; Open and distance Learning (ODL); Online Education - Synchronous and Asynchronous learning models; eLearning, Massive Open Online Courses - SWAYAM, Open Education Resources (OERs), Course CERA, EduEx, CoL, RLOs; digital education and its applications in higher agricultural education; Smart classrooms and Campuses, Web-based remote laboratory (WBRL); Integrating media and digital tools into ID; types and implications of disruptive technologies for higher education and extension; Augmented learning; Adaptive learning; meaning, features and good practices in using open source Learning Management Systems (Moodle); Quality assurance and certification in e-learning.

Block 2: Instructional Design

Unit 1: Theories and Models of Instruction

Howard Gardner's Theory of Multiple Intelligences, David Kolb's Experiential Learning Cycle, Albert Bandura's Social Learning Theory, Rand Spiro's Cognitive Flexibility Theory and Its Application In eLearning, Wlodkowski's Motivational Framework for Culturally Responsive Adult Learning; ADDIE Model, Dick and Carey Model, SAM Model, Bloom's Taxonomy; integrating the theories of instruction into the practice of ID in extension and RAS ecosystem.

Unit 2: Creating Instruction

Overview of planning, designing and implementing the curricula and learning experiences; Needs Analysis - meaning, approaches and steps; Task and content analysis - meaning, approaches, steps and techniques (topic analysis, procedural analysis, and the critical incident method); Learner analysis – meaning, importance and approaches, relevance of Maslow's Hierarchy of Needs and learning styles, Captive Audience vs. Willing Volunteers, Universal vs. user-centered design, Learner Analysis Procedures; Writing learning objectives: Meaning of Learning Goal and Learning Objectives; ABCDs of well-stated objectives; Setting goals, translating goals into objectives; Contextualising ADDIE process within the Extension learning environment

Unit 3: Instructional Strategies

Organizing content and learning activities - scope and sequence of instruction; Posner's levels of organizing (Macro, Micro, Vertical, and Horizontal) and structures of organizing (content vs. media) instruction, Gagne's events of instruction, Edgar Dale's

Cone of Experience; Methods of Delivery- classroom teaching, programmed instruction, synchronous and asynchronous modes of distance education; Changing role of a teacher in classroom and teaching competencies

Unit 4: Evaluating Instruction

Meaning of Assessment, Measurement and Evaluation; Developing learner evaluations and their reliability & validity; assessment techniques for measuring change in knowledge, skill and attitude of learners - Objective Test Items, Constructed-Response Tests, Direct Testing, Performance Ratings, Observations and Anecdotal Records, Rubrics, Portfolios, Surveys and Questionnaires, Self- Reporting Inventories, Interviews; Conducting learner evaluation pre-, during and post-instruction; Formative and Summative Evaluation- meaning, approaches and steps; Evaluating Learner Achievement and the Instructional Design Process; Evaluating the success of instruction; Performance appraisal of teachers

Unit 5: Trends in Instructional Design

Alternatives to ADDIE model - Rapid prototyping and constructivist ID, reflections on instructional design as science and as an art; Relating ID models and process in extension learning environment; political economy of higher education in developed and developing countries; University assessment and rating methods, returns from agricultural higher education; research in education and instructional design.

II. Practicals

- Exercises on preparation of the Analysis Report that includes the task/content
- analysis and learner analysis and the Design Plan includes learning objectives and corresponding instructional strategies and assessment items
- Prepare course outline and lesson plan with an appreciation for diverse learning styles based on temperament, gender, and cultural/ethnic differences and deliver a lecture for UG/PG students
- Assessing learning styles through Barsch and Kolb inventories

- Development and testing of survey instruments for evaluating learning outcomes/ competencies of students
- Development and testing of survey instruments for performance appraisal / competency assessment of teachers.
- Design an online e-learning module on a topic of interest as a capstone project - integrate and apply the knowledge and skills gained from the course for creating an effective learning experience for a target audience
- Designing and developing a theme based knowledge portals
- Exercises on designing an online course using open source LMS like moodle or EdX
- Select and evaluate or design for social al media
- Prepare a short research paper on recent theories and models of instructional design
- Interview an instructional designer of your choice and prepare a synthesis report about what job roles he/she perform, What ID processes does he or she use, challenges faced
- Develop a prototype for one of the lessons in your design plan using PowerPoint or a website builder such as Weebly to create the screens integrating multimedia content and various functionalities
- Field visit to a virtual learning / augmented learning lab, e-learning labs, distance learning centres, etc.
- Hands-on practice with video-editing software, web conferencing and video conferencing solutions

III. Suggested Reading

Agarwal JC. 2007. *Essentials of Educational Technology Innovations in Teaching – Learning.* 2nd Ed. Vikas Publ. House.

Allen M. 2013. *Leaving ADDIE for SAM: An Agile Model for Developing the Best Learning Experiences* https://www.alleninteractions.com/about

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https://elearningindustry.com/Instructional Design Central–
https://www.instructionaldesigncentral.com/ Instructional Design–
http://www.instructionaldesign.org/theories/International Society for Educational Technology–

https://www.isfet.org/courses/ Educational Technology–
https://educationaltechnology.net/AESA-Agricultural Extension in South Asia–

http://www.aesanetwork.org/ GFRAS-Global Forum for Rural Advisory Services– http://www.g-fras.org/en/

EXT 605 (EXT-614): Risk Management and Climate Change Adaptation 3(2+1)

I. Theory

Block 1: Risk Management in Agriculture

Unit 1: Understanding Risk and Distress

Introduction to risk, risk management, uncertainty, sensitivity and distress, General risk theory, Risk analysis methods, Risk perception and decision making, Indicators of risk and distress in agriculture – identification, selection and assessment, Understanding the agrarian distress in Indian agriculture, Sources of distress in Indian farming - changing farm size, land use, cropping patterns, pricing policy, markets and terms of trade, Typology of crisis in agriculture; Droughts, floods and Indian agriculture, Distress and farmer suicides - causes and socio-economic consequences

Unit 2: Managing Risk and Distress

Ways to reducing/managing risk and distress in Indian agriculture; crop and life insurance; Developing support systems; Planning, implementation and evaluation of risk/distress management programs; Institutional frameworks for risk and disaster management - NDMA & SDMAs; Developing District Agriculture Contingency Plans; Risk management by diversification; Good practices and lessons from other countries; Responses of government, non-government and extension system to agrarian crisis; National Farmers Policy.

Unit 3: Extension Professionals and Risk management

Understanding social-psychological and behavioural dimensions of farmers under risk/distress; Risk perception and communication; Helping farmers manage farm level risks - mobilising resources, linking with markets, strengthening capacities; Working with village level risk management committees; Operational skills for preparing contingency and disaster management plans; Institutional and extension innovations in managing risk and distress; Policy and technological preferences for dealing with drought and flood.

Block 2: Adapting to Climate Change

Unit 1: Introduction to Climate Change Science

Basic concepts of and terms in climate change science; impacts of climate change; anthropogenic drivers of climate change, Climate change and Indian agriculture; climate adaptation vs. disaster risk reduction; anticipated costs of adaptation; climate change and poor; Overview of UNFCCC framework and institutions, Kyoto Protocol and beyond; India's National Action Plan on Climate Change and National Mission on Strategic Knowledge on Climate Change; National Coastal Mission, Institutional arrangements for managing climate change agenda.

Unit 2: Introduction to Climate Change Adaptation and Mitigation

Introduction to Climate Change Adaptation, Conducting a vulnerability assessment (CVI and SEVI frameworks), Identifying and selecting adaptation options; Global, national and state level initiatives and plans to support climate change adaptation, private sector and civil society initiatives and activities; Mainstreaming climate change adaptation into development planning, Financing climate adaptation and budgetary allocations for programmes, Gender and climate change adaptation, Agricultural development programmes and strategies towards climate change adaptation and mitigation, Community based and Ecosystem based adaptation

strategies, preparing evidence based intervention plans for vulnerability reduction at micro and macro-levels.

Unit3: Climate Smart Agriculture (CSA) and Extension &Advisory Services

Climate smart agriculture; Developing climate smart and climate resilient villages; Stakeholders and determinants involved in climate smart agriculture; Climate smart agriculture and EAS; Innovative extension approaches used in CSA; Climate information services, Farmers perceptions about climate change; Farm and household level manifestations and adaptation strategies; Barriers and limits to adaptation; Farmers feedback on performance of extension methods; Skills, competencies and tools required for extension professionals at different levels and development departments in up scaling CSA.

II. Practicals

- Hands-on practice in using risk assessment/analysis tools
- Case studies on risk / distress assessment in agriculture -Indian and global
- Lessons/Experiences from NICRA Project in agriculture and allied sectors
- Developing criteria, indicators and indices for assessment of risk, vulnerability and resilience
- Hands on practice on use of vulnerability and risk assessment tools and techniques
- Case studies on success stories of climate change adaptation and community-based initiatives
- Developing district and village level intervention plans for climate change adaptation
- Field Visits to State Disaster Management Authority
- Case studies on climate smart agriculture / villages from India and world
- Case studies on impact assessment of crop insurance programs, disaster management programs
- Capstone project on documenting ITKs and local practices related to reducing risk/climate resilience agriculture

III. Suggested Reading

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GFRAS-Global Forum for Rural Advisory Services– http://www.g fras.org/en/ **AESA-**Agricultural Extension in South Asia– http://www.aesanetwork.org/ **NICRA-**National Innovations in Climate Resilient Agriculture–http://www.nicra-icar.in/nicrarevised/

CRIDA-Central Research Institute for Dryland Agriculture–http :// www .crida.in/

UNCC: Learn- UN Climate Change Learning Partnership– https://www. uncc learn.org/

DST- Department of Science and Technology- Climate Change Programme, GoI– http://www.dst.gov.in/climate-change-programme

EXT 606 (EXT-623): Livelihood Development 3(2+1)

I. Theory

Block 1: Understanding of Livelihood Unit 1:

Concept of Livelihoods

Basic concepts of livelihood and Development, Types of development-Immanent/ inherent and interventionist/ intentional; Why promote livelihood; Livelihood intervention: definition, types-Spatial, segmental, sector –sub-sector; Systemic view of Livelihoods, Understanding Rural Livelihoods-Farm, Non-Farm, and off farm; Linkages with Farm and Off-farm Livelihoods; Economic Models

Unit 2: Livelihood Challenges

Livelihood Challenge- Political economy of Livelihoods, Issues of access to farm and non-farm livelihoods; Livelihoods from a Gender Perspective-Feminization of agriculture/ poverty, women in the unorganized sector, the issue of unpaid and informal work; Livelihood Coping Mechanism- Climate Change and Livelihoods; Livelihoods and Disasters

Block 2: Livelihood Analysis

Unit 1: Livelihood Frameworks

Sustainable Livelihoods Approaches (SLAs)-Definition and origins of SLA; Assets or capitals and capabilities in SLA and its linkage to the other capitals: Physical, Social, Economic, Human, Natural; Vulnerability Assessment- Shocks, trends, seasonality; Policies, institutional context and processes; Conceptual Frameworks-DFID, CARE, UNDP, OXFAM, BASIX livelihood triad, Nine square Mandala or Rural Livelihood System's Framework, etc.; Past, Present and possibilities for the future of the SLA, critiques of the approach

Unit 2: Designing Livelihood Intervention and Promotion

Designing a suitable livelihood intervention-Observing and Understanding the Local Economy; Selecting livelihood activities suitable for the poor in the area; Deciding on the interventions. Livelihood promotion approaches-Poverty and livelihood: Approaches and programs in India; Livelihood and a Rights Based Approach-MGNREGA and its critique; Livelihood and a Social Capital based approach: NRLM

Block 3: Livelihood Augmentation (LA)

Unit 1: Pathways for LA

Basic concepts; Pathways: a) Entrepreneurial strategies for LA; b) NRM based intervention; c) Market based interventions including Value-chain analysis; d) ICT based interventions; e) Livelihood and allied agriculture (dairy, poultry, Goatery, etc.) based livelihood; f) Forest based Livelihoods vis a vis Livelihood Protection and Promotion: Contribution of NTFP in supporting rural livelihoods

Note: Block 'A' and 'B' is theoretical; Block 'C' should be covered in the form practical's supported by few classroom discussion through cases

II. Practicals

- Village stays to understand the livelihood pattern of villagers and how the other socio-economic factors affect the livelihood of people
- Visit to institutes/ universities adopted and/or nearby villages to experience the life and natural resources in rural communities-understanding of village culture, evolution, social structure, livelihood pattern, trends, governance arrangements,

and the natural context (landscape layout, land use, vegetation types etc)

- Application of participatory rural appraisal skills for understanding village context; Engagement of working with rural communities and their grass-root institutions, understanding dynamics of working in a group
- Visit to different agri-business models as mentioned in the Block 'C'. Group assignments may be given to document the field experience in the form of case study of an enterprise/ entrepreneur/ members and other related stakeholders

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EXT 607 (EXT-622): Facilitation for People Centric Development 3(2+1)

I. Theory

Block 1: Introduction to Facilitation for Development Unit 1:

Facilitation for development in the AIS

Facilitation for development in the AIS; Understanding facilitation for development; Importance of facilitation as a core function of extension within the Agricultural Innovation Systems (AIS)

Unit 2: Principles, Attributes and Skills for Facilitation for Development

Basic principles of facilitation for development; Desired attributes of facilitator for development- Cognitive attributes, Emotional attributes (Emotional intelligence), Social, behavioural and attitudinal attributes; Technical skills of a facilitator for development- Design processes, Facilitation techniques and tools, the art of questioning and probing, Process observation and documentation, Visualisation

Block 2: Facilitating Change in Individuals, Groups and Organisations

Unit 1: Realise Potential- Self-Discovery

Self-discovery to realise our potentials, Tools for self-discovery, formulating a personal vision, Taking responsibility for your own development

Unit 2: Group Dynamics and Working Together

Understanding the dynamics of human interaction, Group dynamics and power relations, Managing relationships, Shared vision and collective action, Tools for team building

Unit 3: Organizational Change Process

Organizational change process, Organizational learning to adapt to changing environments, Enhancing performance of organizations, Leadership development, Tools for organizational change

Block 3: Facilitating Operational Level Multi-Stakeholder Engagements

Unit 1: Multi-Stakeholder Interactions

Defining stakeholders, Development of collective and shared goals, Building trust and accountability, Tools for stakeholder identification and visioning

Unit 2: Innovation and Policy engagement Platforms

Visualising innovation platforms (IPs), Why are IPs important?, Different models of IPs for multi-stakeholder engagement, policy engagement platforms, Generating issues and evidence for policy action, Advocacy for responsive policy processes

Block 4: Brokering Strategic Partnerships, Networking And Facilitation

Unit 1: Linkages, Partnerships, Alliances and Networking

Brokering linkages and strategic partnerships, Identification of critical links, Knowledge brokering, Creating linkages with markets, Learning alliances and networking, Coordination of pluralistic service provision within the AIS, The concept of action learning and reflective practitioners, Networking

Unit 2: Facilitating Capacity Development

Facilitating Capacity Development-Facilitate participation and learning in development programs and projects. Virtual platforms- skills for strengthening dialogue, collaboration, shared commitment amongst diverse actors and stakeholders

II. Practicals

- Practicing facilitation techniques,
- Self-discovery exercises,
- Working together and interaction (task based),
- Arrangement for multi-stakeholder interactions,
- Understanding organisational change process tools and techniques,
- Case analysis on organisational change process,
- Participating with innovation platforms,
- Policy engagement platforms,
- Stakeholder analysis mapping,
- Exercise on networking skills,
- Facilitating capacity building programmes
- Facilitating virtual platforms
- Filed visit to multi-stakeholder partnership projects

III. Suggested Reading

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- **UMaine**– The University of Maine–https://extension.umaine.edu/community/strengthening-your-facilitation-skills/
- **GFRAS**– Global Forum for Rural Advisory Services– http://www.g-fras.org/en/

STAT 607 (EXT-624): Multivariate Statistical Methods for Extension Research 3(2+1)

I. Theory

Block 1: Overview of Multivariate Statistical Methods

Unit 1: Basics of Multivariate Statistical Methods (MVSM)

What is multivariate data analysis; Basic concepts in MV – variate, measurement error; Power analysis and effect size; SPSS software

Unit 2: Classification and Types of MVSM

Independence and dependence techniques; Factor analysis – principal component, exploratory factor analysis; Multiple correlation and multiple regression; Discriminant analysis; Logistic regression; Cluster analysis; Conjoint analysis; Multi-Dimensional Scaling/ Perceptual mapping; Correspondence analysis; Structural equation model

Unit 3: Selecting Appropriate MVSM

Selection based on purpose - Dimension reduction, identifying latent variables, strength of relationship among multiple dependent/ independent variables, identifying choice and estimating their utility; etc and type of variables – metric and non-metric

Unit 4: A Structured Approach for Building Multivariate Statistical Models

Steps in planning and conducing MVSM

Unit 5: Basic Econometric Methods-1

Nature of regression analysis; Two variable and multivariable regression models; Linear and non-linear regression models; Estimation methods

Unit 6: Basic Econometric Methods-2

Simultaneous-equation models; Panel data models; **Forecasting** - Time series and other models

Block 2: Data Preparation and Cleaning

Unit 1: Missing Data Analysis and Outlier Management

Missing data - Meaning, types, methods of missing data processing, advantages and limitations, **Outliers-** Meaning, types, methods for identifying and managing outliers

Unit 2: Testing Assumptions of MVSM and Data Transformation

Testing assumption of parametric analyses – normality, linearity, multicollinearity; Data transformation methods

Block 3: Methods for Assessing Human Choice/ Preferences and Decision- making

Unit 1: Assessing Human Preference Structures Using Conjoint Analysis

Meaning- Importance, guidelines for selecting variables, steps in designing a conjoint experiment – objectives, design, data collection and analysis. Applications in extension

Unit 2: Assessment of Adoption of Agricultural Technologies Using Limited Dependent Variable Models

Meaning, importance, types – logit, probit and tobit and their variations; steps in analysis and interpretation of results, applications in extension

Unit 3: Multidimensional Scaling

Meaning, importance and types, steps and applications in extension

Unit 4: Multi-criteria decision-making

Meaning, importance, methods – analytical hierarchy process, Applications in extension

Block 4: Methods of Assessing Association and Causality

Unit 1: Multiple Correlations and Multiple Regressions

Meaning, importance, types, methods of estimation, analysis and interpretation of results, application sin extension

Unit 2: Discriminant Analysis

Meaning, types, steps in conducting discriminant analysis, Applications in extension

Block 5: Methods Of Grouping Objects/ Variables Based On Latent Variables

Unit 1: Principal Component Analysis (PCA) and Common Factor Analysis Meaning, importance, types of factor analysis, difference between types, steps in conducting PCA/ Common Factor Analysis, applications in extension

Unit 2: Structural Equation Modelling (SEM) – Two units

Meaning, importance, types – confirmatory factor analysis and structural model; steps in conducting SEM, Applications in extension

Unit 3: Cluster Analysis

Meaning, importance, types – Steps; Applications in extension

Block 6: Emerging MV Statistical Methods

Unit 1: Emerging MV Statistical Methods

Canonical correlation, partial least square (PLS)

II. Practicals

- Hands on experience of following methods using SPSS/ AMOS software
- Selecting appropriate MVSM
- Missing data analysis and outlier management
- Testing assumptions of MVSM and data transformation
- Assessing human preference structures using conjoint analysis
- Assessment of adoption of agricultural technologies using limited dependent variable models – logit, probit and tobit.
- Multidimensional scaling
- Multiple correlation and multiple regression
- Discriminant analysis
- Principal Component Analysis (PCA) and Common Factor Analysis
- Structural Equation Modeling (SEM)
- Cluster analysis

III. Suggested Reading

Agresti, A. 2002. *Categorical data analysis*. Second edition. New York, NY: John Wiley & Sons. Belsley, D. A. 1991. *Conditioning diagnostics: Collinearity and weak data in regression*. NewYork, NY: Wiley.

Bollen, K.A. 1989. *Structural equations with latent variables*. New York: John Wiley and Sons. Burnham, K. P. and Anderson, D. R. 2002. *Model selection and multimodel inference*. New

York, NY: Springer.

Byrne BM. 2010. *Structural equation modeling with AMOS: Basic concepts, applications, and programming*. New York: Routledge.

Chambers, J., Cleveland, W., Kleiner, B., and Tukey, P. 1983. *Graphical methods for data analysis*. Wadsworth.

Field A. 2013. *Discovering statistics using IBM SPSS Statistics*, 4th edition. Sage, London. Greene, W. 2000. *Econometric Analysis* Fourth edition. New York, NY: Wiley.

Hair JJF, Black WC, Babin BJ and Anderson RE. 2010. *Multivariate Data Analysis: A Global Perspective*. 7th Edition, Pearson.

Hosmer, D. W. and Lemeshow, S. 2000. *Applied logistic regression*. Second edition. New York, NY: John Wiley & Sons

Kelloway, K. E. 1998. *Using LISREL for structural equation modeling: A researcher's guide*.

Thousand Oaks: Sage

Long, J. S. 1997. *Regression models of categorical and limited dependent variables*. Thousand Oaks, CA: Sage

Ray, S. 2016. *A comprehensive guide to data exploration*. https://www.analyticsvidhya.com/ blog/2016/01/guide-data-exploration/

Sivakumar SP, Sontakki BS, Sulaiman RV, Saravanan R, Mittal R. 2017. *Manual on Good Practices in Extension Research & Evaluation*. Agricultural Extension in South Asia. http://www.aesanetwork.org/manual-on-good-practices-in-extension-research-and-evaluation/

Stokes, M. E., Davis, C. S., and Koch, G. G. 2000. *Categorical data analysis using the SAS system*. Cary, NC:

Annexure II

कृषि महाविद्यालय, उम्मेदगंज–कोटा
COLLEGE OF AGRICULTURE, UMMEDGANJ- KOTA
(कृषि विश्वविद्यालय, कोटा)
(Agriculture University, Kota)
उम्मेदगंज, कैथून रोड, कोटा – 324 001 (राज.)
Ummedganj, Kaithoon Road, Kota- 324 001 (Raj.)
Tel:0744-2941655
Email:coak@aukota.org

Dr. S.K. Jain
DEAN

F. 14 ( ) COA/Kota/2026/ 599-609 **Date :** 02/5/26

NOTIFICATION

In pursuance of the Resolution No. **AUK/AC-25/2026-01/15** of the Academic Council meeting held on 24.02.2026 and the subsequent approval of Board of Management vide Resolution No. BOM-28/2026/05 in its meeting held on 02.04.2026, it is notified to re- initiate the **M.Sc. (Agri.) Entomology** programme in the Department of Entomology, College of Agriculture, Ummedganj, Kota with an intake capacity of **four seats (2 normal + 2 payment)**, from the Academic Session **2026–27**.

Dean and Faculty Chairman

Copy to following for information: -

1. The P.S. to respected Vice-Chancellor, Agriculture University, Kota.
2. The Registrar, Agriculture University, Kota.
3. The Comptroller, Agriculture University, Kota.
4. The Dean COA, Hindoli / CH&F, Jhalawar.
5. The Director, Education/Student Welfare/ Extension Education/ Research/HRD/PM&E, Agriculture University, Kota.
6. The Controller of Examinations, Agriculture University, Kota.
7. Head/ Incharge of all the Departments, Faculty of Agriculture, AU, Kota
8. Academic Incharge (UG/ PG), COA, Kota.
9. O/I, College Website, COA, Kota
10. Nodal Officer, Website, AU, Kota.
11. Guard file.

Dean and Faculty Chairman

2

Annexure-2

Nomenclature of the Degree programme

S. No.	Discipline/ Departments	English Name	Hindi Name
1	Entomology	M.Sc. (Agri.) Entomology	निष्णात (कृषि) कीट विज्ञान

Detailed Course Programme (Credit Requirement) for M.Sc. Degree Programme
As per BSMA guidelines the Credit Requirements for M.Sc. Degree Programmes

S. No.	Course Structure	Credit Hrs.
1	Major Courses	20*
2	Minor Courses	08
3	Supporting Courses	06
4	Common courses	05
5	Seminar	01
6	Comprehensive	-
7	Thesis/Research	30
	Total	**70**

Proposed Course Titles, Course Code and Credit Loads

S. No.	Course code	Course Title	Credit Hours
Major Courses-20			
1	ENTO 511*	Insect Morphology	3 (2 + 1)
2	ENTO 512*	Insect Ecology	3 (2 + 1)
3	ENTO 513**	Concepts of Integrated Pest Management	2 (2 + 0)
4	ENTO 521*	Insect Taxonomy	3 (1 + 2)
5	ENTO 522*	Insect Anatomy and Physiology	3 (2 + 1)
6	ENTO 523	Toxicology of Insecticides	3 (2 + 1)
7	ENTO 524	Pests of Field Crops	3 (2 + 1)
8	ENTO 525	Post Harvest Entomology	2 (1 + 1)
9	ENTO 531**	Biological Control Insect Pests and Weeds	3 (2 + 1)
10	ENTO 532	Pests of Horticultural and Plantation Crops	3 (2 + 1)
11	ENTO 533	Apiculture	3 (2 + 1)
12	ENTO 534	Insect Vectors of Plant Pathogens	2 (1 + 1)
13	ENTO 535	Vertebrate Pest Management	2 (1 + 1)
Minor Courses-8			
1	PL PATH 512	Techniques in Detection and Diagnosis of Plant Diseases	2 (0+2)
2	PL PATH 514	Plant Nematology	3 (2+1)
3	PL PATH 523	Diseases of Fruits, Plantation and Ornamental Crops	3 (2+1)
4	PL PATH 529	Integrated Disease Management	3 (2+1)
5	PL PATH 533	Diseases of Field and Medicinal Crops	3 (2+1)

S. No.	Course code	Course Title	Credit Hours
6	PL PATH 532	Principles of Plant Disease Management	3 (2+1)
Supporting Courses-6			
1	STAT- 511	Statistical Methods for Applied Sciences	4 (3+1)
2	STAT- 521	Experimental Designs	3 (2+1)
Common Courses-5			
1	CC-511	Library and Information Services	1(0+1)
2	CC-512	Technical Writing and Communications Skills	1(0+1)
3	CC-521	Intellectual Property and its management in Agriculture	1(1+0)
4	CC-522	Basic Concepts in Laboratory Techniques	1(0+1)
5	CC-531	Agricultural Research, Research Ethics and Rural Development Programmes	1(1+0)
Seminars and Research			
1	ENTO-541	Master's Seminar	01
2	ENTO-542	Research	30
		Total	**70**

*** Core Course**
**** Compulsory Courses**

Semester wise Course Distribution

S.No.	Codes	Course titles	Credit hrs.
		Semester-I	
1.	ENTO 511*	Insect Morphology	3 (2 + 1)
2.	ENTO 512*	Insect Ecology	3 (2 + 1)
3.	ENTO 513**	Concepts of Integrated Pest Management	2 (2 + 0)
		Semester-II	
4.	ENTO 521*	Insect Taxonomy	3 (1 + 2)
5.	ENTO 522*	Insect Anatomy and Physiology	3 (2 + 1)
6.	ENTO 523	Toxicology of Insecticides	3 (2 + 1)
7.	ENTO 524	Pests of Field Crops	3 (2 + 1)
8.	ENTO 525	Post Harvest Entomology	2 (1 + 1)
		Semester-III	
9.	ENTO 531**	Biological Control Insect Pests and Weeds	3 (2 + 1)
10.	ENTO 532	Pests of Horticultural and Plantation Crops	3 (2 + 1)
11.	ENTO 533	Apiculture	3 (2 + 1)
12.	ENTO 534	Insect Vectors of Plant Pathogens	2 (1 + 1)
13.	ENTO 535	Vertebrate Pest Management	2 (1 + 1)
		Credit Seminar	
14.	ENTO 541	Master's Seminar	01
		Semester-IV	
15.	ENTO 542	Master's Research	30
16.	**Minor Courses**		8
17.	**Supporting Courses**		6
18.	**Common Non-Credit Courses**		5 NC

Annexure-3

Course Contents

M.Sc. (Agri.) Entomology

ENTO 511	INSECT MORPHOLOGY	3(2+1)

Objective

To acquaint the students with the external morphology of the insect's body and the functioning of various body parts.

Theory

UNIT I

External Morphology: Insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation.

Head- Origin, structure and modification; mouthparts, antennae, their types and functioning; tentorium and neck sclerites.

Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; wings: structure and modifications, venation, wing coupling apparatus and mechanism of flight; legs: structure and modifications.

Abdomen- Segmentation and appendages; genitalia and their modifications.

UNIT II

Insect sense organs (mechano-, photo- and chemo- receptors); organogenensis at pupal stage; insect defense; chaetotaxy; morphological traits in relation to forensic entomology.

UNIT III

Types of immature stages in insect orders, morphology of egg, nymph/larva and pupa, identification of different immature stages of crop pests and stored product insects. Comparative study of life history strategies in hemi- metabola and holometabola, immature stages as ecological and evolutionary adaptations, significance of immature stages for pest management.

Practical

Preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia; dissection of genitalia. Types of immature stages in insects; their collection, rearing and preservation.

Learning outcomes

Students are expected to have a complete understanding of the comparative morphology of the external features of insects that can be utilized in taxonomy, ecology and applied entomology.

Suggested Reading:

Chapman, RF. 1998. *The Insects: Structure and Function*. Cambridge Univ. Press, Cambridge.

Duntson, PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publ., New Delhi.

Evans, JW. 2004. *Outlines of Agricultural Entomology*. Asiatic Publ., New Delhi. Gillott, C. 1995. *Entomology*, 2nd Ed. Plenum Press, New York, London.

Gullan, P.J. and Cranston, P.S. 2000. *The Insects, An Outline of Entomology*, 2nd Ed. Blackwell Science, U.K.

Richards, OW and Davies, RG. 1977. *Imm's General Text Book of Entomology*. 10th Ed. Chapman and Hall, London.

Snodgross, RE. 1993. *Principles of Insect Morphology.* Cornell Univ. Press, Ithaca. Tembhare, D.B. 2000. *Modern Entomology*, Himalaya Publishing House, Mumbai. Chu, HF. 1992. *How to Know Immature Insects*. William Brown Publication, Iowa. Peterson, A. 1962. *Larvae of Insects*. Ohio University Press, Ohio.

Stehr, FW. 1998. *Immature Insects*. Vols. I, II. Kendall Hunt Publication, Iowa.

5

ENTO 512 INSECT ECOLOGY 3(2+1)

Objective

To teach the concepts of ecology, basic principles of distribution and abundance of organisms and their causes. Study life tables, constructing life tables, organization of communities, diversity indices. Train students in sampling methodology, calculation of diversity indices, relating insect population fluctuations to biotic and/or abiotic causes.

Theory

UNIT I

History and definition. Basic Concepts. Organisation of the Biological world. Plato's Natural Balance vs Ecological Dynamics as the modern view. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalised action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology.

UNIT II

Basic concepts of abundance- Model vs Real world. Population growth basic models – Exponential vs Logistic models. Discrete vs Continuous growth models. Concepts of Carrying capacity, Environmental Resistance and Optimal yield. Vital Statistics- Life Tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. Population dynamics- Factors affecting abundance- Environmental factors, dispersal and migration, Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) - aestivation, hibernation.

UNIT III

Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain- web and ecological succession. Interspecific interactions- Basic factors governing the interspecific interactions- Classification of interspecific interactions - The argument of cost- benefit ratios. Competition- Lotka-Volterra model, Concept of niche ecological homologues, competitive exclusion. Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies.

UNIT IV

Community ecology- Concept of guild, Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity- stability debate, relevance to pest management. Pest management as applied ecology. Climate change and insect pest/ natural enemy population; ecological engineering.

Practical

Types of distributions of organisms. Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters- Measures of central tendencies, Poisson Distribution, Negative Binomial Distribution. Determination of optimal sample size. Learning to fit basic population growth models and testing the goodness of fit. Fitting Holling's Disc equation, Assessment of prey-predator densities from natural systems and understanding the correlation between the two. Problem solving in ecology. Field visits to understand different ecosystems and to study insect occurrence in these systems.

Learning outcomes

The students are expected to be well versed with the basic concepts of ecology, ecological succession, population ecology, community ecology, nutritional ecology and different insect- ecosystem interactions.

Quantification of insect diversity and abundance, life table analyses, predator-prey and host- parasitoid relations, functional and numerical responses, niche breadth and overlap.

Suggested Reading

Begon, M., Townsend, C.R. and Harper, J. L. 2006. Ecology: From Individuals to Ecosystems. 4th Ed. Blackwell Publishing, USA/ UK/ Australia.

Chapman J. L. and Reiss MJ. 2006. Ecology: Principles and Applications. 2nd Ed. Cambridge Univ. Press, Cambridge.

Fowler, J., Cohen, L. and Jarvis, P. 1998. Practical Statistics for Field Biology. 2nd Ed. John Wiley & Sons, Chichester, West Sussex PO19 8SQ, England.

Gotelli N. J and Ellison AM. 2004. A Primer of Ecological Statistics. Sinauer Associates, Inc., Sunderland, MA.
Gotelli N. J. 2001. A Primer of Ecology. 3rd Ed. Sinauer Associates, Inc., Sunderland, MA
Gupta RK. 2004. Advances in Insect Biodiversity. Agrobios, Jodhpur.
Krebs CJ. 1998. Ecological Methodology. 2nd Ed. Benjamin-Cummings Publ. Co., New York.
Krebs CJ. 2001. Ecology: The Experimental Analysis of Distribution and Abundance. 5th Ed. Benjamin- Cummings Publ. Co., New York.
Magurran AE. 1988. Ecological Diversity and its Measurement. Princeton Univ. Press, Princeton.
Price PW. 1997. Insect Ecology. 3rd Ed. John Wiley, New York.
Real LA and Brown JH. (Eds). 1991. Foundations of Ecology: Classic Papers with Commentaries. University of Chicago Press, Chicago.
Schowalter, Timothy D. 2011. Insect Ecology – An Ecosystem Approach. 3rd Ed. Academic Press, London, UK/ CA, USA.
Southwood TRE and Henderson PA. 2000. Ecological Methods. 3rd Ed. Methuen and Co. Ltd., London.
Speight MR, Hunta MD and Watt AD. 2006. Ecology of Insects: Concepts and Application. Elsevier Science Publ., The Netherlands.
Townsend, Colin R., Begon, Michael and Harper, John L. 2008. Essentials of Ecology. 3rd Ed. Blackwell Publishing, USA/ UK/ Australia.
Wilson EO and William H Bossert WH. 1971. A Primer of Population Biology. Harvard University, USA.
Wratten SD and Fry GLA.1980. Field and Laboratory Exercises in Ecology. Arnold, London.

ENTO 513 CONCEPTS OF INTEGRATED PEST MANAGEMENT 2(2+0)

Objective

To familiarize the students with principles of insect pest management, including concept and philosophy of IPM. Train students in computation of ETL and implementing IPM programmes.

Theory

UNIT I

History, origin, definition and evolution of various terminologies. Importance of resistance, principles, classification, components, types and mechanisms of resistance. National and international level crop protection organizations; insecticide regulatory bodies; synthetic insecticide, bio-pesticide and pheromone registration procedures; label claim of pesticides – the pros and cons.

UNIT II

Concept and philosophy, ecological principles, economic threshold concept and economic consideration. Insect- host plant relationships; theories and basis of host plant selection in phytophagous insects.

UNIT III

Tools of pest management and their integration- legislative, quarantine regulations, cultural, physical and mechanical methods; semiochemicals, biotechnological and bio-rational approaches in IPM. Pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes. ITK-s in IPM, area-wide IPM and IPM for organic farming; components of ecological engineering with successful examples.

UNIT IV

Characterization of agro-ecosystems; sampling methods and factors affecting sampling; population estimation methods; crop loss assessment direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses; global and Indian scenario of crop losses. Computation of EIL and ETL; crop modeling; designing and implementing IPM system. Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of

resistant crop varieties in India and world.

Learning outcomes

Students are expected to have significant knowledge of IPM concepts, estimation of losses due to insect pests, computation of ETL, EIL and should be able take management decisions.

Suggested Readings

Dhaliwal GS and Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ., New Delhi.

Horowitz AR and Ishaaya I. 2004. Insect Pest Management: Field and Protected Crops. Springer, New Delhi.

Ignacimuthu SS and Jayaraj S. 2007. Biotechnology and Insect Pest Management. Elite Publ., New Delhi.

Pedigo RL. 2002. Entomology and Pest Management. 4th Ed. Prentice Hall, New Delhi.

Norris RF, Caswell-Chen EP and Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall, New Delhi.

Subramanyam B and Hagstrum DW. 1995. Integrated Management of Insects in Stored Products. Marcel Dekker, New York.

ENTO 521	INSECT TAXONOMY	3(1+2)

Objective

To sensitize the students on the theory and practice of classifying organisms (with special reference to animals) and the rules governing the same. To introduce the students to the classification of insects up to the level of families with hands-on experience in identifying the families of insects with an emphasis on the practical aspects.

Theory UNIT I

History of insect classification; principles of systematics and its importance. Identification, purpose, methods character matrix, taxonomic keys. Descriptions- subjects of descriptions, characters, nature of characters, analogy v/s homology, parallel v/s convergent evolution, intraspecific variation in characters, polythetic and polymorphic taxa, sexual dimorphism. Brief evolutionary history of insects-introduction to phylogeny of insects and Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- and the Orders contained. International Code of Zoological Nomenclature, Phylocode, its brief explanation and uses. Process of speciation and interbreeding allopatric species. Molecular systemnatics, DNA barcoding, karyological and biochemical approaches in taxonomy. Insect labeling protocols and procedures.

UNIT II

Distinguishing characters, general biology, habits and habitats of insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera – Odonata and Ephemeroptera. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid Orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera.

UNIT III

Distinguishing characters, general biology, habits and habitats of insect orders and economically important families contained in them (Continued). Division Neoptera – Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpoid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.

Practical

Study of Orders of insects and their identification using taxonomic keys. Identification of immature insects to orders and families, in endopterygote orders *viz*., Diptera, Lepidoptera, Hymenoptera and Coleoptera using key. Keying out families of insects of different major Orders: Odonata, Orthoptera,

Blattodea, Mantodea, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera. Field visits to collect insects of different orders.

Learning outcomes

Students are expected to know the evolution of arthropods, especially insects and other hexapods, and their hierarchical classification.

Acquire working skills for collecting, mounting, and preserving insects.

Understand the basic concepts of taxonomic hierarchy, identification, taxonomic characters, variations, taxonomic keys and preparation of taxonomic papers.

Identify insects of economic importance up to family levels, taking up the insect orders of agriculture and veterinary importance.

Suggested Reading

CSIRO 1990. *The Insects of Australia: A Text Book for Students and Researchers*. 2nd Ed. Vols. I and II, CSIRO. Cornell Univ. Press, Ithaca.

Freeman S and Herron JC. 1998. *Evolutionary Analysis*. Prentice Hall, New Delhi.

Gullan, P.J. and Cranston, P.S. 2010. *The Insects: An outline of Entomology*. 4th Ed. Wiley-Blackwell Publications, West Sussex, UK.

Mayr, E. 1971. *Principles of Systematic Zoology*. Tata McGraw Hill, New Delhi.

Richards OW and Davies RG. 1977. *Imm's General Text Book of Entomology*. 10th Ed. Chapman and Hall, London.

Ross HH.1974. *Biological Systematics*. Addison Wesley Publ. Company.

Triplehorn CA and Johnson NF. 1998. *Borror and DeLong's Introduction to the Study of Insects*. 7th Ed. Thomson/ Brooks/ Cole, USA/Australia.

ENTO 522	INSECT ANATOMY AND PHYSIOLOGY	3(2+1)

Objective

To impart knowledge about the anatomy and physiology of insect body systems; nutritional physiology; and their applications in entomology.

Theory

UNIT I

Scope and importance of insect physiology; physiology of integument, moulting, chemistry of cuticle, biosynthesis of chitin; growth, hormonal control, metamorphosis and diapause; pheromone secretion, transmission, perception and reception.

UNIT II

Physiology and mechanism of digestion, circulation, respiration, excretion, reproduction, secretion (exocrine &endocrine glands) and nerve impulse transmission in insects. embryonic and post-embryonic development.

UNIT III

Importance of insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular microorganisms and their role in physiology; artificial diets.

Practical

Latest analytical techniques for analysis of free amino acids of haemolymph; determination of chitin in insect cuticle; examination and count of insect haemocytes; preparation and evaluation of various diets; consumption, utilization and digestion of natural and artificial diets.

Learning outcomes

Students are expected to have a thorough understanding of insect growth and development, physiology of exoskeleton, endoskeleton and different organ systems; action and role of hormones, pheromones, physiology of nutrition and its application.

Suggested Reading

Chapman RF.1998. *Insects: Structure and Function*. ELBS Ed., London.

Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publ., New Delhi.
Gullan, P.J. and Cranston, P.S. 2000. *The Insects*: *An Outline of Entomology*, 2nd Ed. Blackwell Science, U.K.
Kerkut GA and Gilbert LI. 1985. *Comprehensive Insect Physiology, Biochemistry and Pharmacology.* Vols. I- XIII. Pergamon Press, New York.
Patnaik BD. 2002. *Physiology of Insects*. Dominant Publishers, New Delhi.
Richards OW and Davies RG. 1977. *Imm's General Text Book of Entomology.* 10th Ed. Vol. 1. *Structure, Physiology and Development.* Chapman and Hall, New York.
Simpson, SJ. 2007. *Advances in Insect Physiology*, Vol. 33, Academic Press (Elsevier), London, UK.
Wigglesworth VB.1984. *Insect Physiology.* 8th Ed. Chapman and Hall, New York.

ENTO 523 TOXICOLOGY OF INSECTICIDES 3(2+1)

Objective

To orient the students with structure and mode of action of important insecticides belonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.

Theory

UNIT I

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.

UNIT II

Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature; categorization of insecticides on the basis of toxicity – criteria for bees, beneficial insects and other insects in general; structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds/ new insecticide molecules; nano-pesticides; drawbacks of insecticide abuse.

UNIT III

Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides- synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity. bioassay definition, objectives, criteria, factors, problems and solutions.

UNIT IV

Insecticide metabolism; insect-pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.

UNIT V

Insecticide residues, their significance and environmental implications; procedures of insecticide residue analysis. Insecticide Act, registration procedures, label claim, and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

Practical

Insecticide formulations and mixtures; laboratory and field evaluation of bio-efficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity. Toxicity to beneficial insects. Pesticide appliances. Working out doses and concentrations of pesticides. Procedures of residue analysis.

Learning outcomes

Students are expected understand the concept of toxicity, bio-efficacy, insecticide

formulations, modes of action of insecticides, estimation of insecticide residues and have significant know-how about the functioning of various types of spray equipments.

Suggested Readings

Chattopadhyay SB. *1985. Principles and Procedures of Plant Protection.* Oxford and IBH, New Delhi.
Gupta HCL.1999. *Insecticides: Toxicology and Uses.* Agrotech Publ., Udaipur.
Ishaaya I and Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action.* Narosa Publ. House, New Delhi.
Matsumura F. 1985. *Toxicology of Insecticides.* Plenum Press, New York.
Perry AS, Yamamoto I, Ishaaya I and Perry R. 1998. *Insecticides in Agriculture and Environment.* Narosa Publ.House, New Delhi.
Prakash A and Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publication, New York.
Pedigo, L.P. and Marlin, E. R. 2009. *Entomology and Pest Management*, 6th Edition, Pearson Education Inc.,Upper Saddle River, New Jersey 07458, U.S.A.
Dovener, R.A. Mueninghoff, J.C. and Volgar, G.C. 2002. Pesticides formulation and delivery systems: meetingthe challenges of the current crop protection industry. ASTM, USA
Dodia, D.A. Petel, I.S. and Petal, G.M. 2008. *Botanical Pesticides for Pest Management*. Scientific Publisher (India), Jodhpur.
Ishaaya, I. and Degheele, D. 1998. *Insecticides with Novel Modes of Action: Mechanism and Application*. NorosaPublishing House, New Delhi.
Mathews G.A. 2002. *Pesticide Application Methods*. 4th Ed. Intercept. UK.
Otto, D. and Weber, B. 1991. *Insecticides: Mechanism of Action and Resistance*. Intercept Ltd., U.K.
Roy, N.K. 2006. *Chemistry of Pesticides*. Asia Printograph Shahdara Delhi.
Krieger, R. I. 2001. *Handbook of Pesticide Toxicology*. Vol-II. Academic Press. Orlando Florida.

ENTO 524 PESTS OF FIELD CROPS 3(2+1)

Objective

To familiarize the students about nature of damage and seasonal incidence of pestiferous insects that cause loss to major field crops and their effective management by different methods.

Theory

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors. Insect pest scenario in relation to climate change.

UNIT I

Polyphagous pests: grasshoppers, locusts, termites, white grubs, hairy caterpillars, and non- insect pests (mites, birds, rodents, snails, slugs etc.). Insect pests of cereals and millets and their management.

UNIT II

Insect pests of pulses, oilseeds and their management.

UNIT III

Insect pests of fibre crops, forage crops, sugarcane, tobacco, and their management.

Practical

Field visits, collection and identification of important pests and their natural enemies; detection and estimation of infestation and losses in different crops; study of life history of important insect pests.

Learning outcomes

Students are expected to acquire knowledge of insect pests of field crops, their nature of damage, life history traits and effective management.

Suggested Readings

David, BV and Ramamurthy, VV. 2001. *Elements of Economic Entomology.* Popular Book Depot, Chennai.

Dhaliwal GS, Singh R and Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ., New Delhi.
Dunston AP. 2007. *The Insects: Beneficial and Harmful Aspects*. Kalyani Publ., New Delhi Evans JW. 2005. *Insect Pests and their Control*. Asiatic Publ., New Delhi.
Nair MRGK. 1986. *Insect and Mites of Crops in India.* ICAR, New Delhi. Prakash I and Mathur RP. 1987. *Management of Rodent Pests.* ICAR, New Delhi.
Saxena RC and Srivastava RC. 2007. *Entomology at a Glance*. Agrotech Publ. Academy, Udaipur.

ENTO 525	Post Harvest Entomology	2(1+1)

Objective of the course:
To focus on requirement and importance of grain and grain storage, to understand the role of stored grain pests and to acquaint with various stored grain pest management techniques for avoiding losses in storage.

Theory

Unit I
Introduction, history of storage entomology, concepts of storage entomology and significance of insect pests. Post-harvest losses in toto vis-à-vis total production of food grains in India. Scientific and socio-economic factors responsible for grain losses. Concept of seed vault.

Unit II
Important pests namely insects, mites, rodents, birds and microorganisms associated with stored grain and field conditions including agricultural products; traditional storage structures; association of stored grain insects with fungi and mites, their systematic position, identification, distribution, host range, biology, nature and extent of damage, role of field and cross infestations and natural enemies, type of losses in stored grains and their effect on quality including biochemical changes.

Unit III
Ecology of insect pests of stored commodities/ grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities. Stored grain deterioration process, physical and biochemical changes and consequences. Grain storage- types of storage structures i.e., traditional, improved and modern storage structures in current usage. Ideal seeds and commodities' storage conditions.

Unit IV
Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows. Role of bird pests and their management. Control of infestation by insect pests, mites and microorganisms. Preventive measures- Hygiene/ sanitation, disinfestations of stores/ receptacles, legal methods. Curative measures- Non-chemical control measures- ecological, mechanical, physical, cultural, biological and engineering. Chemical control prophylactic and curative-Characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants. Insecticide resistance in stored product pests and its management; recent advances (MAS, PPP, HS) in storage pest management; integrated approaches to stored grain pest management.

Practical
Collection, identification and familiarization with the stored grains/ seed insect pests and nature of damage caused by them; Detection of hidden insect infestation in stored food grains; Estimation of uric acid content in infested produce; estimation of losses in stored food grains; Determination of moisture content in stored food grains; Familiarization of storage structures, demonstration of preventive and curative measures including fumigation techniques; Treatment of packing materials and their effect on seed quality; Field visits to save grain campaign, central warehouse and FCI warehouses and institutions engaged in research or practice of grain storage like CFTRI, Mysore; IGSMRI, Hapur, etc. (only where logistically feasible).

Learning outcome
Students are expected to acquire knowledge of pestiferous insects, mites, rats and birds affecting stored produce, their nature of damage, life history traits and effective management. Detection of insect

infestation and familiarization with different storage structures. Learning preventive and curative measures to manage infestation in storage houses.

Suggesting Reading

Hall DW. 1970. Handling and Storage of Food Grains in Tropical and Subtropical Areas. FAO. Agricultural Development Paper No. 90 and FAO, Plant Production and Protection Series No. 19, FAO, Rome.

Jayas DV, White NDG and Muir WE. 1995. Stored Grain Ecosystem. Marcel Dekker, New York.

Khader V. 2004. Textbook on Food Storage and Preservation. Kalyani Publishers, New Delhi.

Khare BP. 1994. Stored Grain Pests and Their Management. Kalyani Publishers, New Delhi.

Subramanyam B and Hagstrum DW. 1995. Interrelated Management of Insects in Stored Products. Marcel Dekker, New York

ENTO 531 BIOLOGICAL CONTROL OF INSECT PESTS AND WEEDS 3(2+1)

Objective

To train the students with theory and practice of biological control, mass production techniques and field evaluation of various biological control agents like parasitoids, predators and various entomopathogenic microorganisms.

Theory

UNIT I

History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation. History of insect pathology, infection of insects by bacteria, fungi, viruses, protozoa, rickettsiae, spiroplasma and nematodes.

UNIT II

Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects. Epizootiology, symptomatology and etiology of diseases caused by the above and the factors controlling these. Defense mechanisms in insects against pathogens.

UNIT III

Mass production of quality bio-control agents- techniques, formulations, economics, field release/application and evaluation. Development of insectaries, their maintenance.

UNIT IV

Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies- Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

Practical

Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers. Visits to bio-control laboratories to learn rearing and mass production of egg, egg- larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds. Field collection of parasitoids and predators. Hands-on training in culturing, identification of common insect pathogens. Quality control and registration standards for biocontrol agents.

Learning outcomes

Students are expected to have a good understanding of the role of natural enemies in managing pest populations below those causing economic damage.

Learn the techniques for mass production of quality bio-agents and their optimal use in IPM.

Suggested Readings

Burges HD and Hussey NW. (Eds). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.
De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman and Hall, New York.
Dhaliwal GS and Arora R. 2001. *Integrated Pest Management: Concepts and Approaches.* Kalyani Publ., New Delhi.
Gerson H and Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual.* Chapman and Hall, New York.
Huffaker CB and Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press, London.
Ignacimuthu SS and Jayaraj S. 2003. *Biological Control of Insect Pests*. Phoenix Publ., New Delhi.
Saxena AB. 2003. *Biological Control of Insect Pests*. Anmol Publ., New Delhi.

Van Driesche and Bellows TS. Jr. 1996. *Biological Control*. Chapman and Hall, New York.

ENTO 532 Pests of Horticultural and Plantation Crops 3(2+1)

Objective

To impart knowledge on major pests of horticultural and plantation crops regarding the extent and nature of loss, seasonal history, their integrated management.

Theory

Systematic position, identification, distribution, host range, bionomics and seasonal abundance, nature and extent of damage and management of insect pests of various crops.

Unit I

Fruit Crops- mango, guava, banana, jack, papaya, pomegranate, litchi, grapes, ber, fig, citrus, aonla, pineapple, apple, peach and other temperate fruits.

Unit II

Vegetable crops- tomato, potato, radish, carrot, beetroot, cole crops, French beans, chow-chow, brinjal, okra, all gourds, drumstick, leafy vegetables, etc.

Unit III

Plantation crop- coffee, tea, rubber, coconut, arecanut, cashew, cocoa, etc.; Spices and Condiments- pepper, cardamom, clove, nutmeg, coriander, chillies, turmeric, ginger, beetlevine, etc.

Unit IV

Ornamental, medicinal and aromatic plants and pests in polyhouses/ protected cultivation.

Practical

Collection and identification of important pests and their natural enemies on different crops; Study of life history of important insect pests and non-insect pests.

Learning outcome

Students are expected to acquire knowledge of insect pests of horticultural, medicinal and plantation crops, their nature of damage, life history traits and effective management.

Suggested Reading

Atwal AS and Dhaliwal GS. 2002. Agricultural Pests of South Asia and their Management. Kalyani Publishers, New Delhi.
Butani DK and Jotwani MG. 1984. Insects and Vegetables. Periodical Expert Book Agency, New Delhi.
Dhaliwal GS, Singh R and Chhillar BS. 2006. Essential of Agricultural Entomology. Kalyani Publishers, New Delhi.
Srivastava RP. 1997. Mango Insect Pest Management. International Book Distr., Dehra Dun.
Verma LR, Verma AK and Goutham DC. 2004. Pest Management in Horticulture Crops: Principles and Practices. Asia tech Publ., New Delhi.

ENTO 533 APICULTURE 3 (2+1)

Objective

To impart knowledge about the honey bees, and their behaviour and activities; bee husbandry, bee multiplication, bee enemies and diseases and their management; hive products, apitherapy; and managed bee pollination of crops

Theory

UNIT I

Historical development of apiculture at global level and in India; Classification of bees; global distribution of genus Apis and races; Morphology and anatomy of honey bee; Honey bee biology, ecology, adaptations; Honey bee behaviour – nest founding, comb construction, brood care, defense, other in-house and foraging activities; Bee pheromones; Honey bee communication.

UNIT II

Commercial beekeeping as an enterprise; Design and use of bee hives; Apicultural equipment; Seasonal bee husbandry; Honey bee nutrition and artificial diets; Absconding, swarming, drifting-causes and management; Curbing drone rearing; Laying worker menace-causes, signs and management.

UNIT III

Bee genetics; Principles and procedures of bee breeding; Screening of honey bee colonies; Techniques in mass queen bee rearing; Mating nuclei and their establishment; Selective mating; Queen bee management; Bee packages.

UNIT IV

Ectoparasitic and endoparasitic bee mites – biology, ecology, nature and symptoms of damage, management tactics; Wax moths, wasps and ants – biology, ecology, nature and symptoms of damage, management tactics; Predatory birds, their damage potential and management tactics; Pesticide poisoning to honey bees, signs and protection; Protocols in evaluation of pesticide toxicity to honey bees.

UNIT V

Honey – composition, properties, crystallization, post-harvest handling and processing; Honey quality standards and assessment; Apicultural diversification potential and profitability; Production/ collection of bee pollen, propolis, royal jelly, bee venom and bees wax and their post-harvest handling; Apitherapy; Value addition of hive products; Development of apiculture project.

UNIT VI

Non-Apis pollinators, their augmentation and conservation; Role of bee pollinators in augmenting crop productivity; Managed bee pollination of crops

Practical

Morphological characteristics of honey bee; Mouthparts; digestive, respiratory and reproductive adaptations in different castes of honey bees; Recording of colony performance; Seasonal bee husbandry practices; Swarming, queen lessness, swarming, laying workers menaces, etc. and their remedies; Innovative techniques in mass queen bee rearing; selection and breeding of honey bees; Instrumental insemination; formulation of artificial diets and their feeding; Production technologies for various hive products; Bee enemies and diseases and their management; Recording pollination efficiency; Application of various models for determining pollination requirement of crop; Developing a beekeeping project.

Learning outcome

Students are expected to have a comprehensive knowledge of bee biology, physiology and bee keeping/ apiculture. With practical training it is expected that students develop entrepreneurial skills for apiculture.

Suggested Reading

Abrol DP and Sharma D. 2009. Honey Bee Mites and Their Management. Kalyani Publishers, New Delhi, India.

Abrol DP. 2009. Honey bee Diseases and Their Management. Kalyani Publishers, New Delhi, India.

Abrol DP. 2010. Beekeeping: A Compressive Guide to Bees and Beekeeping. Scientific Publishers, India.

Abrol DP. 2010. Bees and Beekeeping in India. Kalyani Publishers, New Delhi, India.
Abrol DP. 2012. Pollination Biology: Biodiversity Conservation and Agricultural Production. Springer.
Atwal AS. 2001. World of Honey Bees. Kalyani Publishers, New Delhi- Ludhiana, India.
Atwal AS. 2000. Essentials of Beekeeping and Pollination. Kalyani Publishers, New Delhi Ludhiana, India.
Bailey L and Ball BV. 1991. Honey Bee Pathology. Academic Press, London.
Crane Eva and Walker Penelope. 1983. The Impact of Pest Management on Bees and Pollination. Tropical Development and Research and Institute, London.
Free JB. 1987. Pheromones of Social Bees. Chapman and Hall, London.
Gatoria GS, Gupta JK, Thakur RK and Singh Jaspal. 2011. Mass Multiplication of Honey Bee Colonies. ICAR, New Delhi, India.
Grahm Joe M. 1992. Hive and the Honey Bee. Dadant & Sons, Hamilton, Illinois, USA.
Grout RA. 1975. Hive and the Honey Bee. Dadant & Sons, Hamilton, Illinois, USA. Holm
E. 1995. Queen Rearing Genetics and Breeding of Honey Bees. Gedved, Denmark.
Laidlaw HH Jr and Eckert JE. 1962. Queen Rearing. Berkeley, University of California Press.
Laidlaw HH. 1979. Contemporary Queen Rearing. Dadant & Sons, Hamilton, Illinois, USA.
Mishra RC. 2002. Perspectives in Indian Apiculture. Agro-Botanica, Jodhpur, India.
Mishra RC. 1995. Honey Bees and their Management in India. I.C.A.R., New Delhi, India.
Morse AA. 1978. Honey Bee Pests, Predators and Diseases. Cornell University Press, Ithaca and London. Rahman, A. 2017. Apiculture in India, ICAR, New Delhi.
Ribbands CR. 1953. The Behaviour and Social Life of Honey Bees. Bee Research Association Ltd., London, UK.
Rinderer TE. 1986. Bee Genetics and Breeding. Academic Press, Orlando.
Sardar Singh. 1962. Beekeeping in India. I.C.A.R., New Delhi, India (Reprint: 1982).
Seeley TD. 1985. Honey Bee Ecology. Princeton University Press, 216 pp.
Snodgrass RE. 1925. Anatomy and Physiology of the Honey Bee. Mc Graw Hill Book Co., New York & London.
Snodgrass RE. 1956. Anatomy of the Honey Bee. Comstock Publishing Associates, Cornell Univ. Press, Ithaca, New York.

ENTO 534 Insect Vectors of Plant Pathogens 2(1+1)

Objective of the course:
To teach the students about the different groups of insects that act as vectors of plant pathogens, vector-plant pathogen interaction, and management of vectors for controlling diseases.

Theory

Unit I
History of developments in the area of insects as vectors of plant pathogens. Important insect vectors and their characteristics; mouth parts and feeding processes of important insect vectors. Efficiency of transmission.

Unit II
Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors.

Unit III
Transmission of plant viruses by aphids, whiteflies, mealy bugs and thrips.

Unit IV
Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers.

Unit V
Transmission of plant viruses by psyllids, beetles and mites. Epidemiology and management of insect transmitted diseases through vector management.

Practical
Identification of common vectors of plant pathogens- aphids, leafhoppers, whiteflies, thrips, beetles, nematodes; Culturing and handling of vectors; demonstration of virus transmission through vectors-aphids, leafhoppers and whiteflies; Vector rearing and maintenance; Estimating vector transmission efficiency, studying vector-virus host interaction.

Learning outcome

Students are expected to be well versed with insect vectors of plant pathogens, acquire knowledge on disease transmission and vector management techniques.

Suggested Reading

Basu AN. 1995. Bemisia tabaci (Gennadius) – Crop Pest and Principal Whitefly Vector of Plant Viruses. Oxford and IBH, New Delhi.

Harris KF and Maramarosh K. (Eds.). 1980. Vectors of Plant Pathogens. Academic Press, London.

Maramorosch K and Harris KF. (Eds.). 1979. Leafhopper Vectors and Plant Disease Agents. Academic Press, London.

Youdeovei A and Service MW. 1983. Pest and Vector Management in the Tropics. English Language Books Series, Longman, London.

ENTO 535	Vertebrate Pest Management	2(1+1)

Objective of the course:

To impart knowledge on vertebrate pests like birds, rodents, mammals and others of different crops, their biology, damage they cause and management strategies.

Theory

Unit I

Introduction to vertebrate pests of different crops; biology of vertebrate pests such as rodents, birds and other mammals.

Unit II

Bio-ecology of birds of agricultural importance, patterns of pest damage and assessment, roosting and nesting systems in birds; management of pestiferous birds; conservation of predatory birds.

Unit III

Bio-ecology of rodents of agricultural importance, patterns of pest damage and assessment, burrowing pattern and habitat of rodents; management of pestiferous rodents.

Unit IV

Bio-ecology of higher vertebrates of agricultural importance, patterns of damage and assessment, their habitat; management of pestiferous vertebrates.

Unit V

Management strategies- physical (trapping, acoustics and visual), chemical (poisons, repellents, fumigants and anticoagulants), biological (predators, parasites), cropping practices, alteration of habitats, diversion baiting and other eco-friendly methods Operational practices- baiting, equipments and educative programmes.

Practical

Identification of important rodents, birds and other vertebrate pests of agriculture, food preference and hoarding; Social behaviour, damage assessment, field survey, population estimation, management strategies: preventive and curative methods.

Learning outcome

Students are expected to be well versed with vertebrate pest diversity, their nature of damage, life history traits, behaviour and effective management.

Suggested Reading

Ali S. 1965. The Book of Indian Birds. The Bombay Natural History Society, Bombay.

Fitzwater WD and Prakash I. 1989. Handbook of Vertebrate Pest Control. ICAR, New Delhi.

Prakash I and Ghosh PK. 1997. Rodents in Indian Agriculture. Vol. I. State of Art Scientific Publ., Jodhpur.

Prakash I and Ghosh RP. 1987. Management of Rodent Pests. ICAR, New Delhi.

Prater SH. 1971. The Book of Indian Animals. The Bombay Natural History Society, Bombay. Rahman A. 2020. Protective and Productive Entomology Narendra Publishing House, New Delhi

Course Curricula for Undergraduate Program in Natural Farming

UG-Certificate (Natural Farming) UG-Diploma (Natural Farming) B.Sc. Ag. (Hons.) Natural Farming

INTRODUCTION

Agrological practices are gaining importance across the globe aiming to address the issues in agriculture especially for achieving the sustainability without affecting the ecosystems. In this endeavour, Government of India is focusing on various alternate options to make agriculture self-sustainable. Natural farming is one such avocation and it is gaining importance among the farmers. However, well trained human resource is essential to promote natural farming. Considering the above, ICAR constituted a committee to develop curricula for Undergraduate and Postgraduate Degree programs in Natural Farming. Subsequently, a Sub-committee was constituted for realignment and restructuring of syllabus for UG Degree on Natural Farming as per NEP-2020 and Sixth Deans" Committee framework.

Development and restructuring of undergraduate program in Natural Farming has been done as per NEP guidelines to build strong foundation of knowledge among students with increased practical exposure and skilling to build competence and confidence for the application of the gained knowledge.

This curriculum framework puts down the appropriate curricular goals, content, pedagogical approaches and also specifies the allocation of time for different curricular activities that is proportional to the intended learning outcomes.

The syllabus is based on Bhartiya Prakartik Krishi Paddhati (BPKP) in India to enhance production, sustainability, saving of water, improvement in soil health and farmland ecosystem and reducing the market inputs. These important aspects of natural farming are considered as cost- effective and suitable for livelihood of large number of farmers and sustainable rural development.

The restructured course curriculum aims at strengthening critical thinking, creativity, communication and collaboration among the students. An immersion- cum-foundation program of three weeks is included at the start of the course which is aimed at instilling life

and social skills, social awareness, ethics and values, knowing and being, team work, leadership, creativity, etc. More emphasis has been given on skill enhancement courses, experiential learning, projects, industry attachments, flexibility in choice of courses via electives and also through online courses.

Provision has also been made for advanced skill enhancement through project work or experiential learning/ incubation, etc. Through such activities, more emphasis has been given on conceptual learning than rote learning as well as for inculcating ingenuity and critical thinking. Besides, as per NEP-2020, provision for multiple exit and entry options have also been included.

The details of the semester- wise course structure for the Undergraduate Courses in Natural Farming (UG-Certificate, UG-Diploma and B.Sc. Ag. (Hons.)) Natural Farming have been prepared after having multistage in-depth deliberations and discussions through virtual meetings and personal communications with the members of committee It is expected that the course curriculum will strengthen the knowledge and skill base of the students and meet the expectations of the NEP-2020 towards making India a knowledge superpower and realizing the dream of Atmanirbhar Bharat.

HIGHLIGHTS

- The whole course program of B.Sc. Ag (Hons.) Natural Farming is of 166+10* (*NC-MOOC) = 176 credit hours. The minimum eligibility requirement for admission in undergraduate program on Natural Farming will be the same as in case of B.Sc. Agriculture (Hons.). After the admission of students in the university, the students will register for the Foundation Course of 3 weeks duration in the 1st semester. The course will include discussions on operational framework of academic process in university, sessions from alumni, business leaders, University academic and research managers and classes on personality development (instilling life and social skills, social awareness, ethics and values, team work, knowing and being, leadership, etc.) and communication skills. Steps will be taken to identify the strength and weakness of students (with remedial measures), diverse potentialities will be taken into account and cultural integration of students from different backgrounds will be encouraged. It will also create a platform for students to learn from each other's life experiences.
- The first year of the course is dedicated for knowledge and skill enhancement in Natural Farming including Indian heritage and applied aspects of natural farming. After satisfactory completion of 40 credits of courses in two semesters and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Certificate in Natural Farming on exit. The students continuing the study further, would not have to attend the internship after 1st year.
- The skill program during the first year is termed as Skill Enhancement Courses (SEC). The students will have flexibility and choice in selection of skill development area from a basket of SEC modules to be offered by the parent institute. After one- week common orientation on different skill enhancement modules, students will take up either one or more modules (maximum 4) as per the local needs and gain complete hands-on experience on these modules. In addition to the modules proposed in this report, the SAUs can formulate other modules relevant to the respective regions or modify the titles

of the proposed modules.

- An institution (University or College) is at liberty, and in fact it should work in partnership with capable organizations/ companies/ NGOs/ progressive entrepreneurs for running various SEC programs. In such cases, while the parent institution will control admission process, develop the content and delivery of the program and monitor the learning and skill development by students and the evaluation can be done jointly by the collaborating partners.
- The second year has been designed with the practical exposure on natural farming as well as some part of fundamental courses related to agricultural sciences with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of natural farming. After satisfactory completion of the courses of 2nd year and subsequent completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Diploma in Natural Farming on exit. The students continuing the study further, would not have to attend the internship after 2nd year.
- The third year and fourth year courses have been designed to impart in depth details including specialized knowledge to the students in the major disciplines. In order to inculcate the moral and experiential habits in students to, research methodology and ethics were also added besides Student READY (Rural and Entrepreneurship Awareness Development yojana) include Rural Agricultural Work Experience program/experiential learning/internship and student projects.
- There will be adequate choice of electives/ specialized courses for the students in the final year. The Universities will have flexibility to include more courses as electives depending on specific needs. The objective is to enable the student to acquire deeper understanding in any particular field. As regards individual course contents, universities/colleges may modify the content to the extent of 20 percent whenever necessary as per the regional demands and needs. There will be choice of elective/ specialization in final year for students.
- Students will also be given freedom to opt 20 credits of non-credit courses from MOOC or any other portal in on line mode to groom up her/his passion and add on the knowledge components based on her/ his choice. There will also be flexibility to complete these non-credit elective courses of 20 credits throughout the span of the degree program.
- The online courses can be from any field such as Agriculture, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including Foreign Languages, Communication Skills/ Music, etc. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses. These online courses will be non-gradial as separate certificates would be issued by institutes offering the courses. However, the university/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.
- In eighth semester of the degree Program, students will be offered 20 credits from Student READY Programs including RAWE/Project work/industrial attachment experiential learning, internship or any other option mentioned by the parent institute. The project work may be Natural Farming-based project/research based project or Industry based project depending on the interest of the students.

Entry and Exit Options

The entry and exit options for the UG Program in Natural Farming are shown in the figure 1.

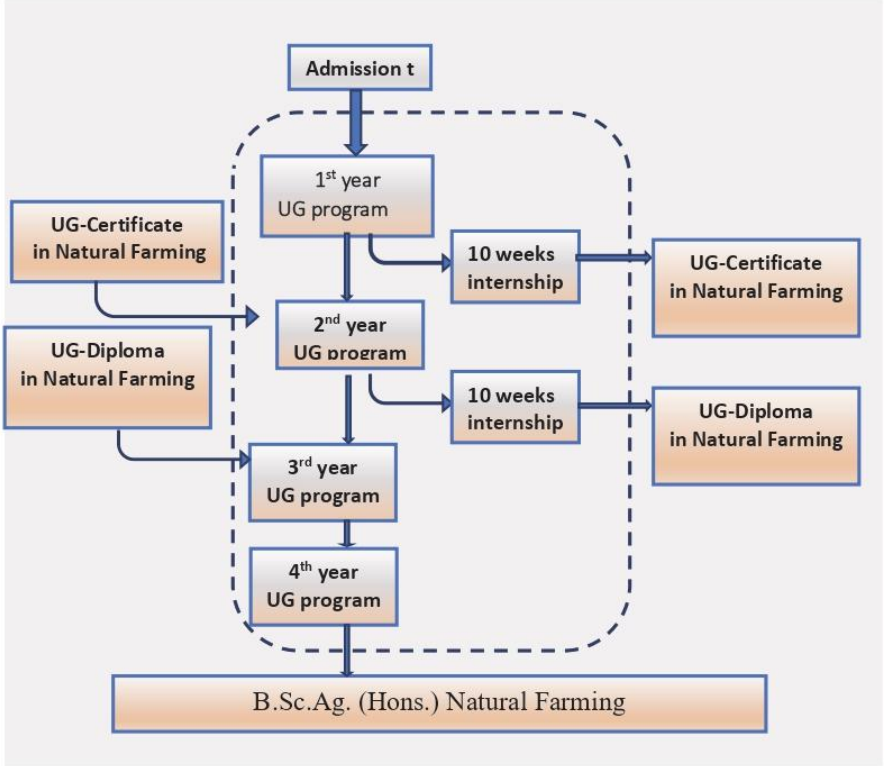


Fig 1. Entry and Exit Option in B.Sc.Ag. (Hons.) Natural Farming

Exit options

UG-Certificate in Natural Farming (exit after first year and completion of 10 weeks' internship)

UG-Diploma in Natural Farming (exit after second year and completion of 10 weeks' internship)

B. Sc. Ag. (Hons.) Natural Farming (on successful completion of four-year degree requirements)

The Universities may also consider allowing lateral entry for the candidates having Diploma in Natural Farming from Polytechnic colleges or other institutions approved by UGC/ICAR at the State and National level program) may be allowed admission into the 3rd year of the UG program, following the norms of lateral entry in respective universities/ institutions.

Admission

The minimum eligibility requirement for admission in undergraduate program on Natural Farming will be the same as in case of B.Sc. (Hons.) Agriculture.

Academic Program

Semester Wise Course Distribution

1st Year

Semester I

S. No	Course Title	Credit Hours	Total Credits
1.	Deeksharambh (Induction cum Foundation course)	2 (0+2)NG	21(10+11)
2.	Indian Heritage of Natural Farming	3 (2+1)	
3.	Principles and Practices of Natural Farming	4 (3+1)	
4.	Bhumi Suposhan (Soil Nutrition)	3 (2+1)	
5.	Farming based Livelihood System	3 (2+1)	
6.	Communication Skills	2 (1+1)	
7.	Skill Enhancement Course (SEC-I)	2 (0+2)	
8.	Skill Enhancement Course (SEC-II)	2 (0+2)	
9.	NCC-I/NSS-I	1 (0+1)	
10.	Physical Education, First Aid and yoga Practice	1 (0+1)	

Semester II

S. No	Course Title	Credit Hours	Total Credits
1.	Cow- based Natural Farming	3 (1+2)	21 (9+12)
2.	Soil Biology in Natural Farming	3 (2+1)	
3.	Integration of Horticulture Crops under Natural Farming	2 (1+1)	
4.	Insect Ecology, Nematodes and Pest Management	3 (2+1)	
5.	Entrepreneurship Development and Business Management	3 (2+1)	
6.	Personality Development	2 (1+1)	
7.	Skill Enhancement Course (SEC-III)	2 (0+2)	
8.	Skill Enhancement Course (SEC-IV)	2 (0+2)	
9.	NCC-II/NSS-II	1 (0+1)	

2nd Year

Semester III

S. No	Course Title	Credit Hours	Total Credits
1.	Crop Management in Natural Farming	3 (2+1)	21 (11+10)
2.	Production of Bio-inputs	2 (1+1)	
3.	Farm Power and Machinery	3 (1+2)	
4.	Livestock and Poultry Production	3 (2+1)	
5.	Management of Plant Diseases	2 (1+1)	
6.	Biodiversity Conservation	2 (1+1)	
7.	Physical Education, First Aid and Yoga Practice	1 (0+1)	
8.	Skill Enhancement Course (SEC-V)	2 (0+2)	
9.	Environmental Studies and Disaster Management	3 (2+1)	

Semester IV

S. No	Course Title	Credit Hours	Total Credits
1.	Elements, Characteristics and Design of Natural Farming Systems	3 (2+1)	22 (13+9)
2.	Improvement of Traditional and Under-Utilized Crops	3 (2+1)	
3.	Agro-Ecosystem Analysis for Natural Farming	2 (1+1)	
4.	Beneficial Insects	3 (2+1)	
5.	Quantification and Valuation of Ecosystem Services	3 (2+1)	
6.	Agricultural Marketing and Trade	3 (2+1)	
7.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
8.	Skill Enhancement Course (SEC-VI)	2 (0+2)	

Semester V

S. No	Course Title	Credit Hours	Total Credits
1.	Post-Harvest Management –I	3 (2+1)	20 (12+8)
2.	Bio- resources and Agricultural Waste Management	3 (2+1)	
3.	Medicinal and Aromatic Plants	2 (1+1)	
4.	Seed Production Technology	3 (2+1)	
5.	Value Chain Management in Natural Farming	2 (1+1)	
6.	Renewable Energy Sources	2 (1+1)	
7.	Natural Farming and Human Health	2 (1+1)	
8.	Fundamentals of Entomology	3 (2+1)	
9.	Educational Tour	CNC	

Semester VI

S. No	Course Title	Credit Hours	Total Credits
1.	Indian Traditional Knowledge	3 (2+1)	20 (14+6)
2.	Post-Harvest Management-II	3 (2+1)	
3.	Standards and Certification for Natural Farming	3 (2+1)	
4.	Aqua-based Natural Farming	3 (2+1)	
5.	Marketing of Natural Farming Produce	3 (2+1)	
6.	Agronomic Practices	2 (1+1)	
7.	Intellectual Property Rights	1 (1+0)	
8.	Principles of Agricultural Economics and Farm Management	2 (2+0)	

Semester VII

S. No	Course Title	Credit Hours	Total Credits
1.	Community Mobilization for Natural Farming	2 (1+1)	21 (13+8)
2.	Water Management	2 (1+1)	
3.	Research Methodology and Ethics	2 (1+1)	
4.	Weather Forecasting	3 (2+1)	
5.	Basic and Applied Agricultural Statistics	3 (2+1)	
6.	Elective Course-I	3 (2+1)	
7.	Elective Course-II	3 (2+1)	
8.	Elective Course-III	3 (2+1)	

Semester VIII

S. No	Course Title	Credit Hours	Total Credits
1.	For Student opting for 4 Year B.Sc. Ag. (Hons.) Natural Farming Degree Student READY (RAWE/Industrial Attachment/ Experiential Learning/Hands on Training/Project Work)/ Internship	20 credits	**20(0+20)**

Table 2: Semester wise Credit Allocation (NF)

Semester	Total Credits	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Non-Gradial	Online Courses/ MOOC
I	21	10	3(2)		1(3) + 2(4)+1(8)	4	-	2(1)	**10**
II	21	11	3(5)		1(3) + 2(7)	4	10(12)	-	
III	21	15	--	3(6)	1(8)	2	-		
IV	22	14	3(9)	3 (10)	----	2	10(13)	-	
V	20	20	-	-	-	-	-	2(11)	
VI	20	20	-	-	-	-	-	-	
VII	21	12+9*	-	-	-	-	-	-	
VIII	20	-	-	-	-	-	20	-	
Total	**166**	**111**	**9**	**6**	**8**	**12**	**20**	**4**	**10**

(1) *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks duration).
(2) Farming based Livelihood systems.
(3) NCC/NSS/NSO.
(4) Communication Skills.
(5) Entrepreneurship Development and Business Management.
(6) Environmental Studies and Disaster Management.
(7) Personality Development.
(8) Physical Education, First Aid and Yoga Practices.
(9) Agriculture Marketing and Trade.
(10) Agriculture Informatics.
(11) Study tour (10-14 days).
(12) Only for those opting for an exit with UG-Certificate.
(13) Only for those opting for an exit with UG-Diploma.

Section-Wise Course Breakup

Course Category	Course Title	Credit Hours
Induction cum Foundation course	*Deeksharambh*	2 Weeks (Non gradial)
Common Courses	Farming Based Livelihood Systems	3 (2+1)
	Communication Skill	2 (1+1)
	Entrepreneurship Development and Business Management	3 (2+1)
	Personality Development	2 (1+1)
	Environmental Studies and Disaster Management	3 (2+1)
	Agricultural Marketing and Trade	3 (2+1)
	Agricultural Informatics	3 (2+1)
	NCC/NSS/NSO-I	2 Courses each of 1 (0+1) credits
	Physical Education, First Aid and Yoga Practices	2 credits
	Total Credits	**23**

Course Category	Course Title	Credit Hours
Core courses (Major and Minor)	Indian Heritage of Natural Farming	3 (2+1)
	Principles and Practices of Natural Farming	4 (3+1)
	Bhumi Suposhan (Soil Nutrition)	3 (2+1)
	Cow- Based Natural Farming	3 (1+2)
	Soil Biology in Natural Farming	3 (2+1)
	Integration of Horticulture Crops Under Natural Farming	2 (1+1)
	Insect Ecology, Nematodes and Pest Management	3 (2+1)
	Crop Management in Natural Farming	3 (2+1)
	Production of Bio-Inputs	2 (1+1)
	Farm Power and Machinery	3 (1+2)
	Livestock and Poultry Production	3 (2+1)
	Management of Plant Diseases	2 (1+1)
	Biodiversity Conservation	2 (1+1)
	Elements, Characteristics and Design Of Natural Farming Systems	3 (2+1)
	Improvement Of Traditional and Under-Utilized Crops	3 (2+1)
	Agro-Ecosystem Analysis for Natural Farming	2 (1+1)
	Beneficial Insects	3 (2+1)
	Quantification and Valuation of Ecosystem Services	3 (2+1)
	Post-Harvest Management –I	3 (2+1)
	Bio- Resources and Agricultural Waste Management	3 (2+1)
	Medicinal and Aromatic Plants	2 (1+1)
	Seed Production Technology	3 (2+1)
	Value Chain Management in Natural Farming	2 (1+1)
	Renewable Energy Sources	2 (1+1)
	Natural Farming and Human Health	2 (1+1)
	Fundamentals of Entomology	3 (2+1)
	Indian Traditional Knowledge	3 (2+1)
	Post-Harvest Management-II	3 (2+1)
	Standards and Certification for Natural Farming	3 (2+1)
	Aqua-Based Natural Farming	3 (2+1)
	Marketing of Natural Farming Produce	3 (2+1)
	Agronomic Practices	2 (1+1)
	Intellectual Property Rights	1 (1+0)
	Principles of Agricultural Economics and Farm Management	2 (2+0)
	Community Mobilization for Natural Farming	2 (1+1)
	Water Management	2 (1+1)
	Research Methodology and Ethics	2 (1+1)
	Weather Forecasting	3 (2+1)
	Basic and Applied Agricultural Statistics	3 (2+1)
	Total Credits	**102 (63+39)**
Elective courses	9 Credits will be taken from list of choice based course list or department wise courses to be decided by host institution	9
	Total Credits	**9**
	Skill Enhancement Course I	2 (0+2)
Skill Enhancement Courses	Skill Enhancement Course II	2 (0+2)
	Skill Enhancement Course III	2 (0+2)
	Skill Enhancement Course IV	2 (0+2)
	Skill Enhancement Course V	2 (0+2)
	Skill Enhancement Course VI	2 (0+2)
	Total Credits	**12 (0+12)**
Student READY		20
	Total Credits	**20**

SUMMARY OF CREDIT DISTRIBUTIONS

Type of course(s)		Credit hours
Core courses	:	111
Skill Enhancement courses	:	12
Multidisciplinary/ Common courses	:	23
Student READY/Internship	:	20
*Online courses (non-gradial)	:	10
Grand Total	:	**166+10***

The credits of *Deeksharambh* (0+2) and Study tour (0+2) being non-gradial have not been included in the total 166 credit hours.

Detailed Syllabi

Semester I

Deeksharambh(Induction cum Foundation Course) **2 (0+2) (Non-Gradial)**

The details of activities will be decided by the host universities. The structure should include, but not restricted to:

(i) Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University.

(ii) Interaction with alumni, business leaders, scientists and prospective employers

(iii) Group activities to identify the strength and weakness of students (with expert advice for their improvement), streaming of the students as per their aptitude for research entrepreneurship or others through psychometric test as well as to create a platform for students to learn from each other's life experiences

(iv) To identify the students having difficulty in mathematics and enrolling them for 1 non-gradial remedial course on mathematics of one credit

(v) Activities to enhance cultural integration of students from different backgrounds.

(vi) Classes on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, Knowing and Being etc.) and communication skills.

Indian Heritage of Natural Farming **3 (2+1)**

Objectives

1. To impart knowledge on the heritage of natural farming in ancient India and various techniques of *Vedic Krishi*.
2. To develop skills on *Vedic Krishi* practices for practicing natural farming.

Theory

The heritage of natural farming, Pioneers and scholars of natural farming and their contribution to the heritage of natural farming, Ancient methods of livestock management, health, nutrition, soil fertility and plant protection, Description on ancient methods of rainfall prediction, Importance of seed and their collection, storage, removal of weed seeds and seed uniformity, Discussions on important rare documents like *Krishi-Parashar*, *Sitadhyaksha* chapter in *Kautilya Arthashastra* (Acharya Kautilya-321 BC), *Kashyapiya Krishi Sukti* (by sage Kashyap-c.800 CE), *Vrikshayurveda* (by Vaidya

Surapala), *Upavanavinod* (Nalini, 2011), *Vishwavallabha* (by Chakrapani Mishra-1577 CE), *Brihat Samhita* (by Varahamihi- 600 AD), *Lokopakara* (1000-year-old manuscript), *Nuskha Dar Fanni-Falahat*-The Art of Agriculture(by Prince Dara Shikoh-1650 CE), *Krishi Gita-Agricultural Versus* (15th century by Vidwan C Govinda Warriar), etc. Measurement of wealth on natural resources, '*Gau-dhan*' (Cows), '*Ashwa-dhan*' (Horses), '*Gaj-dhan*' (Elephants) etc. as all different forms of wealth.

'*Vidya-dhan*'. The most important wealth '*dhanya*' or rice/crops, Mode of the transactions in the society through '*dhanya*'. Broad tradition of 'natural farming', propounded by advocates such as Dr Y.L Nene, (Asian Agri History Foundation), Narayana Reddy (Karnataka), Shripad Dabholkar (Maharashtra), G Nammalvar (Tamil Nadu), Partap C Aggarwal (Madhya Pradesh) and Bhaskar Hiroji Save (Gujarat). Rich heritage of plant protection in natural farming, Identification of disorders; Surapala's Vrikshayurveda describes various plant diseases based on Tridosha (Vata, Pitta, Kapha) Siddhanta of Ayurveda along with symptoms and remedial measures. Plant protection practices, Kunapajala, Herbal Kunapajala and other indigenous liquid concoctions.

Practical

Visit of natural farms to understand the concept, components and management practices. Identification of plant and animal-based products used in Vrikshayurveda for plant nutrition and crop protection. Preparation of Vrikshayurveda based on-farm inputs for nutrient, pest and disease management. Documentation of vrikshayuveda technology knowledge- base for resource conservation, soil health and plant protection.

Suggested Readings

1. Akbar R. 2000. Nuskha Dar Fanni-Falahat (The Art of Agriculture) by Prince Dara Shikoh (1650 CE): AAHF Classic Bulletin 3. Asian Agri- History Foundation, Secunderabad, AP, India. 88pp.
2. Ayachit SM. 2002. Kashyapi Krishi Sukti (A Treatise on Agriculture by Kashyapa). Brig Sayeed Road, Secunderabad, Telangana: Asian Agri- History Foundation **4**:205.
3. Beniwal, SPS and Pandey ST. 2022. Soil nourishment and conservation according to soil agriculture heritage of India, Bhumi Suposhan Commemorative Publication 43-56p
4. Beniwal, SPS, Nene yL, and Pandey ST. 2020. Relevance of *Vrikshayurveda* and Traditional Knowledge for Eco-friendly Sustainable Agriculture to Meet SDGs in India. *Asian Agri-History* **1**:3-22.
5. Bhat, M and Ramakrishna. 1992. Varahmihira's Brihat Samhita. Motilal Banarasidas, Delhi India 561pp.
6. Das, P, Das, SK, Arya, HPS, Reddy, Subba G, Mishra, A and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission Mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.
7. Gupta, PK and Gupta, AK ed. 2019. Smriti Jaagran Ke Harkaare, Jeevika Livelihoods Support organization, Jabalpur, MP, India.
8. Kumar, B. Mohan 2008. Krishi Gita (Agricultural Verses) by Vidwan C Govinda Warriar (Ed.): AAHF Classic Bulletin 7. Asian Agri-History Foundation, Secunderabad, AP, India. 134pp.

9. Nalini, S. 1996. Vrikshayurveda (The Science of Plant Life) by Surapala. AAHF Classic Bulletin 1. Asian Agri-History Foundation, Secunderabad, AP, India. 94pp.
10. Nalini, S. 1999. *Krishi-Parashara (Agriculture by Parashara) by Parashara*, Secunderabad, Telangana: AAHF Classic Bulletin, Asian Agri-History Foundation. 104pp.
11. Nalini, S. 2004. Vishva Vallabha (Dear to the World: The Science of Plant Life) by Chakrapani Mishra (1577 CE): AAHF Classic Bulletin 5. Asian Agri-History Foundation, Secunderabad, AP, India. 134pp.
12. Nalini, S. 2011. Upavana Vinoda (Woodland Garden for Enjoyment) by Sarangdhara (13th century CE): AAHF Classic Bulletin 8. Asian Agri-History Foundation, Secunderabad, AP, India. 64pp.
13. Nene YL. 2006. Kunapajala – A Liquid Organic Manure of Antiquity; Asian Agri History **4**: 315-21.
14. Nene YL. 2012 A. Potential of some methods described in Vrikshayurveda in crop yield increase and disease management. *Asian Agri-History* **1**: 45- 54p.
15. Nene YL. 2012 B. Crop Disease Management Practices in Ancient, Medieval, and Pre- modern India. *Asian Agri-History* **3**: 185-201p.
16. Saxena, RC, Choudhary SL and Nene yL. 2009. A Textbook on Ancient History of Indian Agriculture. AAHF Text Book. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP, and Rajasthan Chapter of Asian Agri-History Foundation, Udaipur, India. 139pp.
17. Sreenivasa, AV. 2004 a. Herbal kunapa. Asian Agri-History **8**:315–17.
18. Sreenivasa, AV. 2004 b. Manujala: A liquid manure. Asian Agri-History **8**: 319–21.
19. Sreenivasa, AV. 2005. INDSAFARI – An organic pesticide for tea. Asian Agri-History **9**:317–19.
20. Watt G. 1889. A dictionary of the economic products of India, *Central Secretariat Library*. https://indianculture.gov.in/rarebooks/dictionary- economic-Products-India- vol-iv

Principles and Practices of Natural Farming **4 (3+1)**

Objectives

1. To make the students aware about the agro-ecology, concept and principles.
3. To impart knowledge on various principles and practices in natural farming.
4. To impart knowledge about different methods of natural farming.

Theory

Natural farming: Concept and importance. Modern agriculture and need for new strategies, origin of concept of natural farming, Agroecology: Concept and Principles, history of development in agro-ecology, Natural farming: principles, philosophy and components, Merits and demerits of natural farming, Principles of Fukuoka and other methods of natural farming, Practices of Natural Farming - case studies, Types of natural farming systems (Community based natural farming, Palekar's Natural Farming, Bio-dynamic, homa farming, natu- eco farming, rishi Krishi, panchagavvya Krishi, yogic farming etc., Scope of natural farming in modern time, Laws of nature, Indian philosophy /Bhartiya Chintan of Pancha Mahabhoot and their role in human life and

development, Important management practices for crops, fruits, vegetables and animals in natural farming, comparison of conventional, organic and natural farming production systems, Scientific aspects of ecological and natural farming for supporting food, nutritional and livelihood security - food sovereignty, livelihood of farmers and rural communities, biodiversity and conservation of biodiversity, Sustainable soil health and clean water, Ecological pest protection, Climate resilient food production, Indigenous farming systems prevalent in India and other countries. Government schemes supporting natural farming (PKVY, BPKP, National Mission on Natural Farming), Start-Ups in chemical free agriculture, Digital India.

Practical

Identification of indigenous crops and practices, Study of different farming systems and their characterization, Students' visit to natural farms to study the various components and practices of natural farming, Development of natural farm inventarity, Analysis of ancient Indian and modern natural farming, Bio- dynamics, homa farming, natu-eco farming, rishi Krishi, panchagavvya Krishi, Yogic farming and practical field application of these practices, Design of natural farm based on locally available resources, Preparation of on- farm inputs for nutrients, pest and disease management. Documentation of indigenous technology knowledge (ITK) for nutrient, insect, pest disease and weed management, Development of documentary on management of natural farm.

Suggested Readings

1. Behera, UK. 2013. A Text Book of Farming Systems. Agrotech Publishing House, Udaipur, Rajasthan
2. Das, P., Das, S.K., Arya, H.P.S., Reddy, Subba G., Mishra, A. and others- Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi
3. Ecological Farming, 2015. The seven principles of a food system that has people at its heart, Greenpeace.
4. Fukuoka M. 1978. The One-Straw Revolution: An Introduction to Natural Farming. Rodale Press, Emmaus, PA. 181 pp
5. Hill S.B. and ott P. (eds.). 1982. Basic Techniques in Ecological Farming. Berkhauser Verlag, Basel, Germany, 366 pp.
6. Kamlagat Prakritkriti by Acharya Devvrat, pp 1-166.
7. Khurana, A. and Kumar, V. 2020. State of organic and Natural Farming: Challenges and Possibilities, Centre for Science and Environment, New Delhi.
8. Malhotra R. and Babaji SD. 2020. Sanskrit Non Translatables- The importance of Sanskritizing English. Amaryllis, New Delhi, India.
9. Nicole Faires. 2016. The Ultimate Guide to Natural Farming and Sustainable Living: Permaculture for Beginners (Ultimate Guides)
10. Prathapan Paramu. 2021. Natural Farming Techniques: Farming without tilling
11. Reyes Tirado. 2015. Ecological Farming- The seven principles of a food system that has people at its heart. Greenpeace Research laboratories. University of Exeter, ottho Heldringstraat.

12. Sharma, S. K., Choudhary, R., Ravishankar, N., Jat, G., Sharma, R. K., Yadav, S. K. and Jain, R. K. 2022. Natural Farming: Concept, Importance, Scope and Status. Technical Bulleting, Directorate of Research, Maharana Pratap University of Agriculture and Technology, Udaipur. Pp 1-16.
13. Shripad A. Dabholkar and Prayog Pariwar. 2021. Plenty For All: Natural Farming A To Z Prayog Pariwar Methodology.

Bhumi Suposhan (Soil Nutrition) **3 (2+1)**

Objectives

1. To impart knowledge on various properties of soils, soil evaluation procedures, factors of soil fertility and management of biological processes through natural farming practices
2. To develop skills among students on soil management practices under natural farming

Theory

Soil as a natural medium for plant growth, Status of soil degradation; Weathering of rocks and minerals, Soil genesis and classification; Concept of essential, beneficial, functional and trace elements in soils; Role of essential nutrients in plants, their deficiency and toxicity symptoms and diagnosis, Nutrient movement in soils and mechanisms of nutrients uptake by plants, Cycling of nutrients in soils (C, N, P, S, secondary and micronutrients), Importance of physical, chemical, and biological properties of soil, Factors affecting soil fertility, Methods of soil fertility evaluation: physical, chemical and biological, origin, formation, extent of distribution and characteristics of acid soils, acid sulphate soils, alkali soils, saline soils and their management, Formation of soil organic matter and its management in agroecosystem, carbon sequestration, soil carbon and nitrogen management indices, Soil quality and health, soil quality indicators, characteristics of a healthy soil, Principles of supporting healthy rhizosphere interactions for improved soil fertility, Best management practices (BMPs) for promoting soil health and monitoring of soil-health: minimum tillage, mulching, organic residue incorporation, cover crops, green manuring, crop rotation, conducive environment for beneficial microbes, mixed cropping, intercropping, composts, FYM, biochar, bio- culture formulations, Sing Khad, (Horn manure), *Kunapajal*, Samadhi Khada, biogas manures (liquid and solid), etc., Principles and methods of production of various organic manures, Sources of contamination in soil and reclamation by bioremediation processes (Phytoremediation, phytoextraction, phytostabilization and microbial bioremediation), Ancient classification of soil based on soil fertility, irrigation, physical characteristics, and crop suitability; Ancient practices for soil enrichment under natural farming, Traditional festivals of the region with respect to soil health, Schemes promoting soil health in India.

Practical

Soil sampling methods, processing, and storage, Determination of soil texture (feel method, hydrometer method and international pipette method), Determination of soil bulk density, particle density, porosity, and water holding capacity, Determination of soil pH and EC, Determination of soil organic carbon, Determination of available nitrogen, Determination of available phosphorus, Determination of available potassium, Determination of available secondary plant nutrients (Ca, Mg, S,), Determination of available micronutrients (Zn, Fe, Cu, Mn, B, Mo), Plant sample digestion procedure, Analysis of important nutrient elements in plant, Studies on important ITKs for selection of crop-soil combination, Quantification of carbon-neutral farming practices.

Suggested Readings

1. Akshay Krishi Parivar.2022. Bhumi Suposhan-Commemorative Publication of the Nationwide Bhumi Suposhan and Samrakshan Abhiyan. AKP ublication No.11. Pp.212.
2. Biswas, T.D. and Mukherjee S.K. (1987) Text Book of Soil Science. Tata McGraw- Hill Publishing Company, New Delhi. ISBN 13, 0074516795, 9780074516799. Pp. 314.
3. Choudhary, S.L., G.S. Sharma and Y.L. Nene (2000) Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the summer school held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India. Pp.363.
4. Das, D.K. (2015) Introductory Soil Science. 4th edn, Kalyani Publishers, ISBN-13.978-9327257540
5. Das, P., Das, Reddy, G.S., Das S.K., Rani G., Mishra A., Gupta H.P., Verma L.R., Ray D.P., Singh R.P., Kavia Z.D., and Arya H.P.S. (2004) Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 To 7, Indian Council of Agricultural Research, New Delhi.
6. Gaur, A.C. (1999). Microbial Technology for Composting Residues by Improved Methods. ICAR, New Delhi. Pp. 78.
7. Havlin, J.L., Tisdale S.L., Nelson W.L. and Beaton J.D. (2016) Soil Fertility and Fertilizers. 8th edn, Pearson Education India. ISBN 978-9332570344.
8. Indian Society of Soil Science (2012) Fundamental of Soil Science, published by Indian Society of Soil Science (ISSS). 2nd edn, ISBN 13 8190379747.
9. Rattan, R.K., Katyal J.C., Dwivedi B.S., Sarkar A.K., Bhattacharyya T., Tarafdar J.C. and Kukal S.S. (2015) Soil Science: An Introduction. Indian Society of Soil Science, New Delhi. ISBN 13, 978-8190379779
10. Weil, RR and Brady NC. (2021) The Nature and Properties of Soil. 15th edn, ISBN 978-9356062719.
11. Yawalkar, K.S., Agarwal J.P. and Bokde S. (2012) Manures and Fertilizers. Agri- Horticultural Publishing House. Pp. 288.

Farming based Livelihood Systems 3 (2+1)

Objective

To disseminate the knowledge and skill how farming systems can be a source of livelihood

Theory

Concept of farming system and integrated farming system- Definition, goal and advantages, Classification of farming systems, Components of farming systems- Crops and cropping systems, Livestock and poultry, Fishery and Secondary enterprises, Integration of components in farming system, Factors affecting integration of components in IFS, Selection of crops and cropping systems for various enterprises, Feasibility of different cropping systems for different agro- climatic zones, Horticultural crops and cropping systems feasible for different farming systems, Livestock and poultry as a component of integrated farming systems, Study of different livestock components

feasible for IFS (Dairy, Piggery, goatry, poultry, duckry etc.), Aqua culture as a component of IFS, Duck/Poultry cum Fish, Dairy cum fish, Piggery cum fish etc. Problems, profitability and prospects, Sericulture as a component of IFS: Scope and potentiality of sericulture for small and marginal farmers of states, some suitable module of IFS for different agro-ecological situations, Commercial livestock production- problems and prospects, Design for livestock shed and their maintenance, Importance of feed processing unit for livestock production, Silage and hay production, Marketing, Concept of sustainable farming system and their indicators.

Practical

Study of IFS models for different agroclimatic zones, Preparation of IFS model in groups, Recycling of organic waste in IFS, Study of production and profitability of IFS, Market survey for IFS products, Preparation of organic manures in IFS, Study of crops and cropping systems for diversification in IFS, Visit to farmer's field for feasibility study for scientific intervention in IFS, Study of Integrated Organic Farming Systems.

Suggested Readings

1. Indian Institute of Farming Systems Research, Modipuram.
2. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced income and employment, Indian Council of Agricultural Research, New Delhi.
3. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
4. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-
5. Walia, S S and U S Walia, 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

Communication Skills 2 (1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication.

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested readings

1. Allport, G W, 1937, Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Gyles Brandreth, 1994, How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale, 1997, The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter S J, 2012, Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata, 2011, Communication Skills. Oxford University Press.
6. Neuliep James W, 2003, Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan, 1998, Body Language. Sudha Publications, Delhi.
8. Raman M and Singh P, 2000, Business Communication. Oxford University Press.
9. Seely J, 2013, Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson A J and Martinet A V, 1977, A Practical English Grammar. Oxford University.

Skill Enhancement Course

Objective

- To enhance the employment potential and to set up small business enterprises skills of volunteers, a list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities. Each volunteer will have the option to select two skill-areas out of this list of issues related environment.
- Environmental conservation, enrichment and sustainability, climatic change, natural resource management (rainwater harvesting, energy conservation, forestation, waste land development and soil conservations) and waste management. Disaster management. Introduction and classification of disaster, rehabilitation, and management after disaster; role of NSS volunteers in disaster management.
- Entrepreneurship development. Definition, meaning and quality of entrepreneur; steps in opening of an enterprise and role of financial and support service institution.
- Formulation of production-oriented project. Planning, implementation, management, and impact assessment of project. Documentation and data reporting. Collection and analysis of data, documentation, and dissemination of project reports

Skill Enhancement Courses 4 (0+4)

Two Courses each of (0+2) credits of skill enhancement courses will be offered from indicated list of skill enhancement courses.

National Cadet Corps (NCC-I) **1(0+1)**

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.
- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

Or

National Service Scheme (NSS-I) **1 (0+1)**

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

All the activities related to the National Service Scheme are distributed under four different courses viz., National Service Scheme I, National Service Scheme II, National Service Scheme III and National Service Scheme IV each having one credit load.

The entire four courses should be offered continuously for two years.

A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one-day camp in a year and one special camp for duration of 7 days at any semester break period in the two years. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

Semester I: Introduction and Basic Components of NSS

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.

- NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan*. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism
- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

Physical Education, First Aid, Yoga Practices and Meditation **1(0+1)**

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga.

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory &Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga,

- Asanas (Definition and Importance) Padmasan, Gaumukhasan, Asanas (Definition and Importance) Padmasan,Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra

- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics

Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, first aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Semester II

Cow Based Natural Farming 3 (1+2)

Objectives

1. To acquaint the students about practicing natural farming involving cow and its relationship with farming activities
2. To impart skill on farming practices and technologies in cow based natural farming

Theory

Sociology of natural farming, Indian Livestock scenario, Indigenous breeds of cattle, Differentiating features of indigenous, crossbred and exotic cattle, Traditional livestock farming practices, Draft animal power in natural farming, Feeding cattle at various phases, Forage production, Hay making, Preventive health care practices, Bio efficacy of cow urine on crop production, Effect of different natural inputs on yield, quality and soil properties, Effects of cow urine and its major constituents on pasture properties, Cow based rearing systems: land, feed and water requirement of traditional farming method, Advantages of cow based natural farming methods, Economics of cultivation and comparison with currently adopted practices, Role of cow based farming system in utilising the available cattle (*Desi* cow) as valuable resource, Cost of cultivation under cow based natural farming, Composition and constituents of desi cow milk vs cross breeds; role of tryptophan precursor of serotonin in relaxing human mind and better sleep, role of A2 Milk in controlling blood sugar level. Sustainable agriculture and fodder business, Natural farming business and entrepreneurship development, Supply chain management, Application of bio gas in agriculture, Traditional therapies for various ailments, ITKs in cow based natural farming.

Practical

Identification and characteristics of various cattle breeds, fodder varieties and feed ingredients; Visit to dairy farm to study the various components and their utilization, Visit to *gau-shala*, Visit to an institute involved in cow based natural farming, Design and development of cow based natural

farm, Identification of herbal plants used for livestock treatment, Ethno veterinary medicines,; Feed and fodder conservation practices-Silage and Hay making, Concentrate making techniques including ration balancing for cow based farms, Calf management under natural Farm, Value addition of milk from dairy, Grassland management, Value addition of by-products from cow based natural farm, Bio- inputs preparation for natural farms, Traditional practices followed in cow-based natural farms, Record keeping and economics of cow based natural farming, Preparation of inputs for cow based natural farming, Demonstration of renewable energy sources in cow based natural farms.

Suggested Readings

1. Gaur, AC, Handbook of organic Farming and Biofertilizers.
2. Dahama, AK organic Farming for sustainable agriculture. Agrobios (India), Jodhpur.
3. Banerjee, GC. 1989. Text Book of Animal Husbandry. oxford and IBH.
4. Chander, M, and Subrahmanyeswari, B. 2017. organic Livestock Farming. Indian Council of Agricultural Research.
5. Das, P, Das, SK, Arya, HPS, Reddy, G, Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi
6. ICAR. 2022. Handbook of Animal Husbandry. ICAR Publication.
7. Nivsarkar, A. E., Vij, P. K. and Tantia, M. S. 2000. Animal Genetic Resources of Indian Cattle and Buffalo, by ICAR- KAB, New Delhi- 110012, pp 382.
8. Sastry, N.S.R., and Thomas, C.K. 2019. Livestock Production Management. Kalyani Publishers, New Delhi.
9. Sastry, NSR and Thomas, C.K. 1991. Dairy Bovine Production. Kalyani Publishers.
10. Taparia, A.L.2007.A Historical overview of Animal Husbandry in Ancient and Medieval India. In. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp.151-156.
11. Thomas, C.K. and Sastry, NSR. 2013. Livestock Production Management. Kalyani Publishers.

Soil Biology in Natural Farming 3 (2+1)

Objectives

1. To impart knowledge on various aspects of soil biology, biological interactions and their roles in management of soil quality and productivity.
2. To develop skills among students on isolation, purification, identification and use of soil beneficial microbes and fauna in natural farming system

Theory

Soil as a habitat for life, concept of soil biome and its components, Soil organic matter: Definition and its characterization, Biochemical processes of formation of soil organic matter, SOM as carbon source for soil biota, Decomposition processes, reaction order and its dynamics, Soil biodiversity

and its methods of evaluation, Soil microbiota: its distribution and abundance, metabolism and physiology, classification of soil microorganisms and their importance in soil processes, Soil fauna (microfauna, mesofauna, macrofauna and megafauna): distribution, abundance, diversity and interactions; Factors affecting soil biodiversity, Significance of biota in soil development, Soil biological interactions: Functions and processes, Above- ground and below-ground biotic linkages, Rhizosphere, spermosphere, phyllosphere and their use in crop growth and development, Habitat adaptive fitness benefits to host crops in terms of tolerance to abiotic and biotic stresses, Biological nitrogen fixation: Symbiotic (*Rhizobium*-legume, Actinorhizal, *Azolla-Anabaena*), Associative (*Azotobacter*, *Azospirillum*, *Gluconacetobacter*, etc.), Free-living (BGA, *Klebsiella,* etc.), Microbiological methods of composting: various composting techniques, biofortification of various organic manures, *In- situ* decomposition techniques of crop residues using decomposers, Mechanisms of Biological Nitrogen Fixers (BNF), factor affecting BNF, Microbial mediated nutrient availability and exchange in soil, Nutrient mobilization, Arbuscular mycorrhizal symbiosis: its types, biochemical basis of interactions and benefits to host crops, Soil enzymes -characterization and mode of action, Agricultural management impacts on soil enzyme activities, Soil health, soil sickness, soil resistance concept, indicators and evaluation criteria, ITKs on soil health management through enriching soil microbiome.

Practical

Hands on microscopy and examination of microbes, Microbiological media and methods of sterilization, Isolation and purification of microbial cultures, Enumeration of microbial population in soil- bacteria, fungi, actinomycetes, Isolation of *Azospirillum*, *Azotobacter*, BGA, *Rhizobium,* Determination of microbial biomass C and N, Assay for soil enzyme activities, Assay for carbon substrate utilization, Determination of earthworm population and biomass, Estimation of soil carbon active pool (Co_2 evolution, SMBC), Estimation of different carbon fractions of soil, Estimation of soil carbon stock.

Suggested Readings

1. Bloem J., Hopkins D.W. and Benedetti A. 2006. Microbiological Methods for Assessing Soil Quality. CABI Publishing. Wallingford.
2. Chhonkar, P. K., Bhadraray S., Patra A. K. and Purkayastha T. 2007. Experiments in Soil Biology and Biochemistry. Westville Publishing House, New Delhi. Pp. 169.
3. Elasas, J.D.V, Jansson J.K. and Trevors. 2006. Modern Soil Microbiology. 2nd edn. CRC Press. Boca Raton.
4. Indian Society of Soil Science. 2015. Introduction to Soil Science. ISSS, New Delhi.
5. Kannaiyan, S, Kumar K and Govindarajan, K. 2004. Biofertilizers Technology. Scientific Publ.
6. Lal, R and Shukla, MK. 2004. Principles of Soil Physics. Marcel Dekker.
7. Mengel, K and Kirkby, EA. 1982. Principles of Plant Nutrition. International Potash Institute, Switzerland. Mortvedt JJ, Shuman LM, Cox FR and Welch RM. 1991. Micronutrients in Agriculture. 2nd Ed. SSSA, Madison.
8. Paul, E.A. 2007. Soil Microbiology, Ecology and Biochemistry, Third Edition. Academic Press, Amsterdam. Pp.514.

9. Richard Bardgett.2005. The Biology of Soil. A Community and Ecosystem Approach. oxford University Press. Pp.231.
10. Subba Rao, N. S. 2009. Soil Microorganisms (4th edn of Soil Microorganisms and Plant Growth), oxford and IBH Publishing Co. Pvt. Ltd. pp. 387.

Integration of Horticultural Crops under Natural Farming **2 (1+1)**

Objectives

1. To acquaint the students with package and practices for horticultural crops under natural farming.
2. To impart the practical training on horticultural crop production.

Theory

Importance and scope of horticulture crops in natural farming, Soil management in relation to nutrient and water uptake and their effect on soil environment, Intercrops- types and its role in nutrient management, Biological efficiency of cropping systems in horticulture, Planting of fruit plants in combination with annual crops – principles and strategies, Types of planting system for fruit plants in natural farming, Competitive and complimentary effect of root and shoot systems, Type of mulches - sod mulch and organic mulches for soil moisture and nutrients management, Irrigation – defined systems of irrigation for natural farming in fruit crops, Soil microbes and their role for sustainable horticultural crop production system, Canopy management, Training and pruning, Methods of training and training of important fruit trees, High density planting (HDP) and meadow orchards and their management, Rejuvenation of old orchards - top working and frame working, Integrated pest and disease management (IPDM), Integrated nutrient management (INM), Crop regulation in relation in fruit crops, Management of resources constraints in existing systems, Climate aberrations and mitigation measures of horticultural crops, Management of fruit plants of important tropical, sub-tropical and temperate fruit crops under natural farming, Mulching of fruit crops and Whapasa management, ITK for management of fruit plants under natural farming system.

Practical

Selection of site for farm system design for establishment of natural farming of horticulture crops, different planting systems and its layout – Triangular system, contour lines, double row system, rectangular and square, Preparation of pit and procedures for filling, Soil depth and slope for fruit tree plantation, Irrigation methods and application of water to fruit crops, Growing of intercrops ginger, turmeric, colocasia, cowpea, cabbage and green manuring, Filler crops – definition and their use in young orchard, Training and pruning methods of important tropical, sub-tropical and temperate fruit crops, Weed management in orchards, Use of plant-based products and microbes for plant protection of tropical, sub- tropical and temperate fruit crops, Mulching of fruit crops and Whapasa management

Suggested Readings

1. Agriculture. ICAR. Document 2, Supplement 1. 84-100 pp.
2. Agriculture. ICAR. Document 2, Supplement 2. 111-136 pp.
3. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous

Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.

4. Horticultural Crops / Pest and Disease Management / Soil and Water conservation/ Soil fertility Management. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 and 2); Document 3; Publ: ICAR New Delhi.
5. Horticultural Crops. 2004. Inventory of Indigenous Technical Knowledge in
6. Horticultural Crops. 2004. Inventory of Indigenous Technical Knowledge in
7. K. K. Sharma and N.P. Singh. 2021. Soil and orchard Management. Daya Publishing House.

Insect Ecology, Nematodes and Pest Management **3 (2+1)**

Objectives

1. To teach students the insect ecology and effect of biotic and abiotic factors on pests
2. To impart practical knowledge on various plant protection options under natural farming
3. To impart knowledge on plant parasitic nematodes and management options under natural farming

Theory

Insect Ecology - Introduction, environment and its components, Effect of abiotic factors – temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents, Effect ofbiotic factors – food competition, natural and environmental resistance, Categories of pests, Storage pests. Solutions for insect-pest control in natural farming: surveillance, perimeter weeding, conventional land preparation, host plant resistance, interaction of plant resistance traits and biocontrol agents, crop rotation and planting practices (date of sowing), intercropping/ mixed cropping, trap crops, border crops, sanitation, conserving natural enemies via habitat enrichment, Physical control strategies to reduce pest incidence, Mechanical control, Behavioral control (repellents and anti-feed ants plants, Biological control (Importation, Conservation, Augmentation; Parasitoids predators and Pathogens), Factors affecting success of biological control: Narrow host range/ Climatic adaptability/ Synchrony with host life cycle / High reproductive potential / Efficient search ability/ Short handling time / Survival at low host density, Botanicals (Plant extracts), Plant bioformulations: agniaster, brahmaster, neemaster, dasparni ark etc. Management of stored grain pests by non-chemical methods.

History and economic importance of nematodes: General characters of plant parasitic nematodes, their morphology, symptomatology and control of important plant parasitic nematodes of field and fruits by non-chemical methods, Use of various plant bioformulations like agniaster, brahmaster, neemaster, dasparni ark *etc.* for nematodes and pest management.

Practical

Sampling techniques for estimation of insect-pests and nematodes populations, Collection of insect-pests, nematodes, natural enemies and their identification, Diversity of insect- pests, nematodes, Calculation of diversity indices, Preparation of different bioformulations and their application methods.

Suggested Readings

1. DeBach, P. (1973). Biological control of Insect Pests and Weeds. Chapman and Hall, New York. 844p.
2. Dhaliwal. G.S., Ram Singh and Vikas Jindal. 2013. A Textbook of Integrated Pest Management. Kalyani Publishers, Ludhiana, pp. 617.
3. Panwar, V.P.S. 2014. Agricultural Insect Pests of Crops and Their Control. Kalyani, Publishers, New Delhi.
4. Pest and Disease Management. Inventory of Indigenous Technical Knowledge in Agriculture. Document 1; Document 2; Document 2 (Supplement 1& 2); Document 3; Publication: ICAR New Delhi.
5. Southwood, T.R.E. and Henderson, P.A. (2000) Ecological Methods. Third Edition, Blackwell Science, USA, 575p.
6. Walia, R.K. and Bajaj, H.K. 2014. Textbook of Introductory Plant Nematology (2nd edn), Kalyani Publishers, New Delhi.

Entrepreneurship Development and Business Management: 3 (2+1)

Objectives

1. To provide student an insight into the concept and scope of entrepreneurship.
2. To expose the student to various aspects of establishment and management of a small business unit.
3. To enable the student to develop financially viable agribusiness proposal.

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

- Charantimath P.M., 2009., Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
- Desai V., 2015, Entrepreneurship: Development and Management, Himalaya Publishing House.
- Desai,Vasant. Desai, 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House
- Gupta CB. 2001. Management Theory and Practice. Sultan Chand and Sons.
- Grover Indu. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
- Khanka SS. 1999. Entrepreneurial Development. S. Chand and Co.
- Mehra P. 2016, Business Communication for Managers. Pearson India, New Delhi.
- Pandey M. and Tewari D. 2010. The Agribusiness Book. IBDC Publishers, Lucknow.
- Singh D. 1995. Effective Managerial Leadership. Deep and Deep Publ.
- Singhal R.K. 2013. Entrepreneurship Development and Management, Katson Books.
- Tripathi PC and Reddy PN. 1991. Principles of Management. Tata McGraw Hill.

Personality Development 2 (1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability.

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested reading

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. 21st (rep.) New Delhi.Tata McGraw-Hill.
2. Heller, Robert, 2002, Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim, 2003, Reducing Stress. Essential Manager series. Dk Publishing.
4. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5. Mile, D.J, 2004, Power of Positive Thinking. Delhi. Rohan Book Company.
6. Pravesh Kumar, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
7. Smith, B., 2004, Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R., 2009, Social and Personality Development (6th edn). Belmont, CA: Wadswor.

Skill Enhancement Courses **4 (0+4)**

Two Courses each of (0+2) credits of skill enhancement courses will be offered from indicated list of skill enhancement courses.

National Cadet Corps (NCC-II) **1 (0+1)**

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

Or

National Service Scheme (NSS-II) **1(0+1)**

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

All the activities related to the National Service Scheme are distributed under four different courses viz., National Service Scheme I, National Service Scheme II, National Service Scheme III and National Service Scheme IV each having one credit load.

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- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies
- Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Semester III

Crop Management in Natural Farming 3 (2+1)

Objectives

1. To acquaint students with the concepts of selection of crops and their cultivation practices under specific agroecological zones following natural farming principles
2. To train the students about package of practices of different crops under natural farming

Theory

Selection of crop and variety – Criteria for selection of crops in natural farming, Traditional and indigenous variety - Advantages and disadvantages - Classification of crops - factors affecting selection of crops and variety, Importance of pulses of legumes in natural farming, Weather management- Concept of weather and climate, Factors affecting crop production: climatic factors, edaphic, biotic, physiographic etc., micro-climate management techniques, Windbreaks and shelter belts, Management of weather in natural farms, Seed, sowing and Irrigation– Importance and concept of seed selection, seed treatment, Seed rate- Factors affecting seed rate and seed germination, sowing- time, method and depth, indigenous methods and animal drawn techniques, time and method of irrigation, management of irrigation, ITKs in seed, sowing and water management, Crop

Geometry: Definition of crop geometry and crop density, types of crop geometry, importance of crop geometry, thinning, gap filling, optimum plant population, factor affecting plant population, relation of crop geometry and growth, relation of crop geometry and yield, Weed management: Classification of weeds and their importance, methods of weed management, practices of weed management in natural farming, Nutrient management: Sources of nutrient application and their management in natural farming and modern agriculture, maintenance of soil health and plant health, under natural farming, Package of practices of crops under natural farming.

Practical

Selection of crops for natural farming according to agro-ecological zones, Know how on agro-met observatory and data interpretations, Calculation of seed rate for sowing, Plant geometry and population calculation, Traditional seed treatment methods, Preparation of traditional nutrient supply concoctions and their uses, Traditional knowledge techniques in crop management and on-farm waste management, Study of methods of crop residue management, Study of important methods of plant protection, Irrigation efficiency, Preparation of crop calendar for different sowing seasons under various micro-climates.

Preparation of contingency crop plan for natural farming, yield estimation in naturally grown crops, Field visit to natural farm, Documentation of sustainable natural farming practices.

Suggested Readings

1. 100 Herbs for making JADAM Natural Pesticide: The way to Ultra-Low- Cost agriculture (JADAM organic Farming) by Geol yu, youngsang Cho, et al. (2016).
2. Agronomy Principles and Practices. 2017 by E. Somasundaram and M. Mohamed Amanullah, New India Publishing Agency, New Delhi.
3. Crops and Cropping Systems. 2004. *In*: Inventory of Indigenous Technical Knowledge in Agriculture Document 2 (Supplement 1) pp 9-26. Publ: ICAR, New Delhi.
4. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.
5. Fundamentals of Agronomy, Gopal Chandra De, 2017, oxford and IBH publication.
6. Natural, Organic, Biological, Ecological and Biodyanamic Farming by V. N. Tivari (2010).
7. Principles of Agronomy, S.R. Reddy, 2020, Kalyani Publications. New Delhi.
8. Principles of Agronomy, T. Yellamanda Reddy and G. H. Shankara Reddy, 2016, Kalyani Publications, New Delhi.
9. Scientific Pulse Production, 2003, by P.S. Rathore and S.K. Sharma, Yash Publishing House, Bikaner, pp. 1-269.
10. The Ultimate Guide to Natural Farming and Sustainable Living: Permaculture for Beginners (Ultimate Guides) by Nicole Faires (2016).
11. Vrikshayurvedic Farming: The Traditional Indian Agriculture by C and Mujh R Nandha Kumar Swaminathan (2017)

Production of Bio-inputs **2 (1+1)**

Objective

1. To impart knowledge on types of bio-inputs, their functions, compositions, application doses and impacts on soil processes
2. To develop skills among students in mass production of various bioinputs, their application methods and quality control

Theory

Definition and types of bioinputs, Importance of bioinputs, Mechanism of action of bioinputs, Quality standards of bioinputs, Methods of production and application doses of bioinputs, Factors affecting the product quality, Green manures, *Achhadana*, Cow-based bioproducts (*Beejamrutha, Jeevamrutha, GhanJeevamrutha* and other inputs (*agniaster, brahmaster, neemaster, sonthaster, Khatti lassi, dasparni ark, Kanupajala and saptdhanyaankur*) for pest, disease and nutrient management, compositions/ingredients of various bioinputs and their relative merits, Effects of bioinputs on soil biological components, their activities, soil enzymes and overall soil fertility, Impact of bioinputs on plant physiological activities and physiological stress indicators, Influence of bioinputs on plant-microbe and plant- faunal interactions, Initiatives taken by government(central/state), NGOs and other organizations in India for promotion of bioinputs under natural farming perspectives, Economic considerations, viability, marketing and export potential of different bioinputs, Quality aspects, grading, packaging, handling, and establishment of internal control system for bioinputs, Project formulation on bioinputs in natural farming.

Practical

Definition and types of bioinputs, compositional analysis (nutritional and microbiological), Assay on mode of action of bioinputs, Preparation of animal manure-based bioinputs and their uses, Preparation of *Beejamrutha, Jeevamrutha, Ghana Jeevamrutha*, soil microbes based improved bioinputs, mass production and its uses; Preparation of *Bramhaster* and their uses, Preparation of *Agniaster*, *Neemaster* and *Dashparni ark*, their mass production and uses, Preparation of plant-extract based bioinputs, Ginger-Garlic- Chilli extract and their use, Preparation of fermented butter milk and their uses, Preparation of herbal *kunapajala* and Neem -based concoctions and their specific uses, Study of physical, chemical and biological characteristics of important bioinputs, Determination of plant physiological stresses upon application of bioinputs.

Suggested Readings

1. Agri-History Report No. 1. Asian Agri-History Foundation. pp. 36.
2. Choudhary SL and Saxena RC. 2007. Plant Protection in Medieval and Modern Indian Agriculture. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 455-480.
3. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.

4. Gaur, A.C. 1999. Microbial Technology for Composting of Agricultural Residues by Improved Methods. Indian Council of Agricultural Research, New Delhi, Pp.78.
5. Nene YL. 2003. Crop Disease Management Practices in Ancient, Medieval, and Pre- modern India. Asian Agri-History. Vol. 7(3):185-201.
6. Nene YL. 2007.Plant Pathology in India Prior to Twentieth Century. *In.* Nene yL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 441-454.
7. Palaniappan, S.P. and Anandurai, K.1999. organic Farming – Theory and Practice. Scientific Pub. Jodhpur
8. Pest and Disease Management / Soil and Water conservation/ Soil fertility Management/ Garbage disposal and Management. *In*: Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 and 2); Document 3; Publ: ICAR New Delhi.
9. Saharan, B. S., Parshad, J., Kumar, D., and Sharma, N. (2021). Plant-Microbial Interactions in Natural/organic Cultivation of Horticultural Plants. Plant- Microbial Interactions and Smart Agricultural Biotechnology (pp. 115-128). CRC Press.
10. Saharan, B. S., and Nehra, V. (2011). Plant growth promoting rhizobacteria: A critical review. Life Sci Med Res, 21(1), 30.
11. Sharma, Arun. Biofertilizers. Agrotech Publishing Academy, Udaipur
12. Sreenivasa, Ayangarya Valmiki. 2006. organic Tea – A Vrikshayurveda Experience.

Farm Power and Machinery **3 (1+2)**

Objectives

1. To enable the students to understand the basic of farm power and machinery use in natural farming
2. To gain the knowledge and skills necessary to effectively and efficiently manage farm machinery, optimize power utilization, and improve overall farm productivity.

Theory

Mechanization in agriculture: its potential and prospects, Sources of farm power, Draught animal power and its relevance to Indian Agriculture, Familiarization with different engine systems, Familiarization with different systems of I.C. engines, working principles of I C engines, Components of IC engine, Use of bio- diesel/bio-ethanol as alternative fuel for engines, Familiarization with tractor, Introduction to primary and secondary tillage equipment, Energy efficient improved tools and equipment's in natural farming: Introduction to rotavator, planter, vegetable transplanter, bed former, disk harrow, mulch laying equipment, Ergonomically improved hand tools for intercultural operations: wheel hoe, long handle hoe, garden tools, labour saving/drudgery reducing tools, Plant protection equipment: knapsack sprayer, power sprayer, threshing and shelling machinery, Animal drawn farm equipment/tools: Animal drawn bund former, Seed drill, Planters, cultivator, ITK in farm machinery, ITKs on farm tools.

Practical

Study of different engine systems, Study of the different components of IC engines, Familiarization with tractor, Familiarization with tools and equipment for input production in field,

Familiarization with tractor drawn primary and secondary tillage implements, Familiarization with animal drawn primary and secondary tillage implements, Familiarization with tractor drawn seed-cum- fertilizer drills their seed metering mechanism and calibration, Familiarization with animal drawn seed-cum-fertilizer drills their seed metering mechanism and calibration, Familiarization with planters, Familiarization with transplanters. Familiarization with different inter-cultivation equipment, Familiarization with different types of sprayers, Familiarization with different types of dusters, Familiarization with harvesting machinery, Familiarization with threshing machinery.

Suggested Readings

1. Akshay Krishi Parivar (2022). Bhumi Suposhan-Commemorative Publication of the Nationwide Bhumi Suposhan and Samrakshan Abhiyan. AKP Publication No.11. pp212.
2. Dakshinkar N.P. and M. Singh, (2022). Draught Animal Power and its relevance to Indian Agriculture. *In:* Bhumi Suposhan, Akshay Krishi Parivar. pp 80-87.
3. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission Mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.
4. Peshwe D.R., Ram Kumar Sing, K.A. Deshmukh and S. Chopra. 2018. Advances and Research in Agricultural Tools. Publ: MME Publishing House Nagpur.
5. Pimental D. (1980). Handbook of Energy Utilization in Agriculture, CRC
6. Rahudkar WB (2007). Ancient Agricultural Implements. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 389-396.
7. Rathore NS, Joshi S and Choudhary N (2022). Digital Technologies for Agriculture, NIPA Genx Electronic, Recourses and Solutions Pvt. Ltd.
8. Sahay J (2006). Elements of Agricultural Engineering, Standard Publishers Distributers, New Delhi.
9. Sangwan Satpal. (2007). Level of Agricultural Technology in India (1757- 1857). Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation.pp.397-413.
10. Tillage and Interculture Management/Farm Implements. In: Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 & 2); Document 3; Publ: ICAR New Delhi.

Livestock and Poultry Production 3 (2+1)

Objectives

1. To impart knowledge and skill in rearing of livestock and poultry production
2. To make them aware about basics of livestock and poultry production including managemental aspects under natural farming.

Theory

Historical account of livestock rearing in Vedic, medieval and modern era in India including free range, semi-intensive and intensive systems and major pastoral systems in India, Demographic

distribution and characteristics of livestock (cattle, buffalo, sheep, goat, and poultry) and economy, Common farm management practices of livestock and poultry including housing, feeding, watering, sanitation, pest and disease management, Common vices of animals (cattle, buffalo, sheep, goat), their prevention and care. General principles of sewage disposal and purification, Solid and liquid manure management, Compost making. Ventilation requirements, Presumptive standards for permissible air pollution in buildings, Respiratory exchange in domestic animals, Importance and method of ventilation, Livestock and poultry rearing and carbon footprints, Breeding strategies and biotechnological tools for the improvement of dairy cattle, buffalo, sheep, goat, swine and poultry, Natural breeding for livestock and poultry, Methods of conservation – Livestock and poultry conservation program s in the state and the country, Fodder production and conservation - Importance of grasslands and fodder in livestock production and their management, Structures for storage of feeds and fodders, Scarcity fodders and preservation of green fodder, Recycling of animal shed washings and wastes in fodder production and use of recycle waste., Disposal, utilization and recycling of waste, etc. Sheep, goat, rabbit farming and swine farming: role and importance in natural farming, Classification of poultry with respect to production characters, age and standards, Production characters of other avian species, Description of indigenous fowls and their value in rural farming, Livestock production management - Housing systems, layout and design of different buildings for animals, Selection of site: General principles affecting the design and construction of building for housing for various livestock species. Scavenging system of management – Low input technology, backyard and semi- intensive units; their management and economic achievements.

Deep litter management – Control of litter-borne diseases and recycling of litter, Cage management – Different types; Advantages and disadvantages. Management of growers, layers, broilers and breeders, Stress management.

General management and feeding practices of calves, heifers, pregnant, lactating and dry animals, bulls and working animals. Systems of feeding, restricted feeding, phase feeding. Unconventional feed ingredients -Herbal Bio enhancers.

Protection and welfare of livestock, poultry and working animals. Draught ability of cattle and buffaloes; Routine animal farm operations and labour management, Animal farm accounts and records.

Indigenous technical knowledge related to livestock rearing and veterinary practices, Indigenous technical knowledge pertaining to health and management of livestock.

Classification of poultry with respect to production characters, age and standards; Description of indigenous fowls and their value in rural farming, Specific strains developed for rural poultry production their acceptability and importance in rural eco-system.

Brooding management – Types of brooders, preparation of shed, Importance of environmental factors; Housing – Types of poultry houses, space requirements. Feeding management– Classification of nutrients, Nutrient requirements and feed formulations, Feeding systems; Water management.

Sheep and goat farming: Introduction and scope in the country, Important breeds (exotic and indigenous) and their characteristics, Housing and feeding. Management of sheep and goat for optimal production.

Principles of disease and pest management, Ayurvedic, homeopathic, ethno-medicines, General principles of medication for livestock and poultry in natural farming.

Candling, sexing, grading, packing and disposal of hatchery waste. Trouble shooting hatchery failures, Poultry waste management, pollution and environmental issues, mixed and integrated poultry farming under natural landscape. Vertical and horizontal integration in poultry production, Management of ducks, turkeys, Japanese quails and guinea fowls.

Practical

Identification of indigenous breeds of livestock, small ruminants and poultry and other avians. Acquaintance with natural livestock farms (dairy and small ruminant), backyard poultry and other avians, Layout plans for different livestock houses and poultry, Fodder production and conservation: Visit to the fodder farm, Familiarization with various types of fodders in the states and India. Livestock waste utilization and recycling/ Familiarization with various fertilizers and manures. Human handling and restraining of cattle, buffalo, sheep and Goat: clipping, shearing, dipping, spraying and spotting sick animals, Determination of body weight using different measurements, Training of breeding males: detection of heat, Identification and care of pregnant animals, Care of neonatal and young stock, Diagnosis, prevention and treatment of important diseases and pests of livestock, small ruminants and poultry and other avians, Economic traits of broilers, egg-type chicken and breeders, Poultry farm and hatchery equipment, Brooding arrangement in broiler farms, ITKs related to livestock management, Vaccination, deworming and medication of birds, Keeping records and their maintenance, Feed ingredients and its quality assessment, Fundamentals in poultry post-mortem examination for sample collection and dispatch. Economics and preparation of project report for establishing livestock, fodder and poultry farms/festivals related to animals, Participation and documentation of the region-specific festivals related to animals.

Suggested Readings

1. Banerjee, G.C. 2019. A Textbook of Animal Husbandry. (8th Ed.). oxford and IBH Publishing, New Delhi
2. Chander Mahesh Chander and B. Subrahmanyeswari, B. 2017. organic Livestock Farming, Published by Indian Council of Agricultural Research, 2017
3. Chatterjee, B.N., and Das, P.K. 1989. Forage Crop Production. oxford and IBH Publishing Co.
4. Dakshinkar, N.P. and Singh, M. 2022. Draught Animal Power and its Relevance to Indian Agriculture. In: Akshay Krishi Parivar, Bhumi suposhan: commemorative publication of the nationwide bhumi suposhan and samrak shanjan abhiyan. Akshay Krishi Parivar Publication Number 11. pp. 80-87.
5. Ghotge, N.S. 2004. Livestock and Livelihoods, the Indian Context. Foundation Books, New Delhi.
6. ICAR. 2022. Handbook of Animal Husbandry, ICAR New Delhi.
7. Mission Unit, Division of Agricultural Extension, ICAR, New Delhi. (2003). Veterinary and Animal Husbandry. Inventory of Indigenous Technical Knowledge in Agriculture (Document 1, Document 2 (Supplement 1 and 2) and Document 3). ICAR, New Delhi.
8. Sreenivasaiah, P.V. 2006 Scientific Poultry Production – A unique encyclopedia, 3rd edn.
9. Uprit, S. 2022. Livestock Dung Based Model Sustainable Agriculture through Healthy and Enriched Soil. In: Akshay Krishi Parivar, Bhumi Suposhan: Commemorative publication of the

nationwide bhumi suposhan and samrak shanjan abhiyan. Akshay Krishi Parivar Publication Number 11. pp. 88-96.

10. Veterinary and Animal Husbandry. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 and 2); Document 3; Publ: ICAR New Delhi

Management of Plant Diseases **2 (1+1)**

Objectives

1. To teach students the important plant diseases and plant pathogenic organisms.
2. To impart practical knowledge on crop loss assessment and disease management methods under natural farming.
3. To impart practical knowledge on the preparation of inputs for the management of plant diseases under natural farming.

Theory

Plant disease management under natural farming: Causes / factors affecting disease development, Disease triangle and tetrahedron and classification of plant diseases, Important plant pathogenic organisms, different groups: fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes , Pathogenesis, Koch's postulates, Role of enzymes, toxins and growth regulators in disease development, Defense mechanism in plants, Epidemiology: Factors affecting disease development, survey, surveillance and vigilance, Crop loss assessment and models, Principles and pre-requisites of forecasting of diseases, Principles and methods of plant disease management, Symptoms, etiology, disease cycle and management of major diseases of field crops and horticulture crops, Methods of plant disease control: Host plant resistance, cultural, mechanical, physical, legislative, biological control, Ecological management of crop environment, Role of soil microbiome in disease management, Suppressive soils, concepts and potentialities for managing soil borne pathogens, Application of khatti lassi, jungle ki Kandi, sontha aster for the management of various types of diseases, Plant growth promoting rhizobacteria (PGPR) and their use in plant protection, Heritage perspective of plant protection (Drumraksha), Plant Protection through Botanicals, ITKs related to management of plant diseases.

Practical

Acquaintance with various laboratory equipment and microscopy, Collection and preservation of disease specimens, Preparation of media, isolation and Koch's postulates, General study of different structures of fungi, Study of symptoms of various plant diseases, Study of representative fungal genera, Staining and identification of plant pathogenic bacteria, Transmission of plant viruses, Study of phanerogamic plant parasites, Preparation of extracts of natural plant products as fungicides, Field visit for the diagnosis of field problems, Collection and preservation of plant diseased specimens for Herbarium, Preparation of pressed and well mounted specimens, Preparation and methods of application of Khattilassi, Jungle ki Kandi, Sontha aster for disease management, Bio-surfactants and their use.

Suggested Readings

1. Alexopoulos, C. J. C.W. Mims, and M. Blackwell. 2007. Introductory Mycology. 4th edn, Wiley India Pvt. Limited,880p.
2. Choudhary SL and Saxena RC. 2007. Plant Protection in Medieval and Modern Indian Agriculture. Nene YL. Ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 455-480.
3. George N. Agrios. 2006. Plant Pathology 5th edn. Elsevier
4. James B. Sinclair and onkar Dev Dhingra. 1995. Basic Plant Pathology Methods. 2nd edn, CRC Press, 448p.
5. Nene YL. 2007. Plant Pathology in India Prior to Twentieth Century. Nene YL. Ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 441-454.
6. Pest and Disease Management. Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 and 2); Document 3; Publication - ICAR, New Delhi.
7. Saharan, B. S. and V. Nehra. 2011. Plant growth promoting rhizobacteria: A critical review. Life Sci Med Res.21(1): 30.
8. Saharan, B. S., R. K. Sahu, and D. Sharma. 2011. A review on biosurfactants: Fermentation, current developments and perspectives. Genetic Engineering and Biotechnology Journal, 1-14.
9. Singh R.S. 2017. Introduction to Principles of Plant Pathology. 4th edn CBS Publishers and Distributors, 416p.

Biodiversity Conservation 2 (1+1)

Objectives

1. To impart knowledge on biodiversity in different agro-ecological zones
2. To develop skills on assessment of biodiversity, procedures of biodiversity valuation and strategies of biodiversity conservation.

Theory

Definition, Genetic diversity, Species diversity, Ecosystem diversity: Structural and functional aspects. Agro ecological zones in India with a brief understanding of diversity in soil types, temperature, rainfall, watershed atlas of India, Seasons and season cycle in India, Festivals and seasons, Importance of local biodiversity, Bio-geographic classification of India, The value of biodiversity and conservation, India as a mega diversity nation, Hotspots of biodiversity: criteria for determining hot spots, Threats to biodiversity- habitat loss, pollution, species introduction, global climate change, overexploitation, poaching. Rare species, Extinction: mass extinction, extinction processes, Human factors: social, economic, political and remedial actions, Endangered and endemic species of India, common plant species, common animal species, Conservation of biodiversity- strategies for conservation: i*n-situ* and *ex-situ* conservation, Conservation practices in India and world- organizations involved in resource conservation: IUCN, WWF, UNEP, UNESCO, Biodiversity International, IPGRI, FAO, BSI, ZSI. General account on activities of DBT, BSI, NBPGR, ZSI, FSI, NBFGR and NBAGR NFPTCR, Sacred groves, Biodiversity register, Conservation of biodiversity, Salient provisions of Biological Diversity Act, 2002, Role of Gramsabha

in biodiversity conservation, Ancient Indian culture in biodiversity conservation, Role of biodiversity in SDGs, Ecological economics, Mission Life Style for Environment (Mission LiFE).

Practical

Field survey for studying plant species diversity in a village/region, Study of the morphology and reproductive structures of the types of micro-flora and micro- fauna, Staining of fungal filaments by Cotton Blue, Methylene Blue, Preparation of sterilization media, principles of isolation, pure culturing, Collection, identification and submission of non-wood forest products, Visit to forest to study genus/species distribution, Notes on pest and diseases of forest plants (any four), Study of ITKs on biodiversity conservation and documentation of tangible and non-tangible benefit of biodiversity conservation, Orientation about biodiversity register and its activities.

Suggested Readings

1. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 To 7, Indian Council of Agricultural Research, New Delhi.
2. Dubey, R. C. and Maheswari, D.K. (2010). A Text book of Microbiology, S. Chand and Company, New Delhi.
3. Gadgil, M., and Seshagiri Rao, P. R. (1998). Nurturing biodiversity an Indian agenda. Ahmedabad: Centre for Environment Education.
4. Krishnamoorthy, K.V (2004) An Advanced text book on Biodiversity- Principles and Practice: oxford and IBH publishing company Pvt. Ltd. New Delhi. 10
5. Krishnamurthy, K.V. (2003). Text Book on Biodiversity, Science Publishers, New Hampshare.
6. Puri, GS, Gupta RK, Meher-Homji VM, Puri S. (1989). Forest ecology. Volume 2. Plant form, diversity, communities and succession. oxford& IBH Publishing Co. Pvt. Ltd., New Delhi
7. Sayan Bhattacharya (2014). Forest and biodiversity conservation in ancient Indian culture: A review based on old texts and archaeological evidences. International Letters of Social and Humanistic Sciences. pp35-46.
8. Shahid N., Daniel E. Bunker, A.H., Michel L. and Charles Perrings (2009). Biodiversity, Ecosystem Functioning, and Human Wellbeing: An Ecological and Economic Perspective, oxford University Press, New York.
9. Sharma P.D. (2003). Ecology and Environmental Sciences, Rastogi Publications, Meerut, India
10. Trivedi, P. C. (2007). Global Biodiversity status and conservation. Pointer publishers Jaipur India.

Physical Education, First Aid, Yoga Practices and Meditation **1 (0+1)**

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory &Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga,

- Asanas (Definition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.

Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Skill Enhancement course **2 (0+2)**

One Course of (0+2) credits of skill enhancement courses will be offered from indicated list of skill enhancement courses.

Environmental Studies and Disaster Management **3 (2+1)**

Objectives

1. To acquaint students with the significance of environmental principles and remediation procedures
2. To develop skills among students on environmental impact assessment

Theory

Multidisciplinary nature of environmental studies: Definition, scope and importance. Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems, (a) Forest resources: Use and over- exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forest and tribal people, (b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems, (c) Mining resources: Use and exploitation, environmental effects extraction and using mineral resources, case studies, (d) Food resources: World food problem, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies, (e) Energy resources: Growing energy needs, renewable and non-renewable energy resources, use of alternate energy sources, case studies, (f) Land resources: Land as resources, land degradation, man induced landslides, soil erosion and desertification, Role of an individual in conservation of natural resources, Equitable use of resources for sustainable lifestyles. Ecosystem: Concept of ecosystem, structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristics features, structure and function of the following ecosystems: (a) Forest ecosystem, (b) Grassland ecosystem, (c) Desert ecosystem d. Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and its conservation: Introduction, definition genetic, species and ecosystem diversity and biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social ethical, aesthetic and option values. Biodiversity at global, national and local level, India as a mega-diversity nation, Hot-sports of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife, man-wildlife conflicts. Endangered and endemic spices of India. Conservation of biodiversity: In–situ and Ex-situ conservation of biodiversity.

Environmental pollution: Definition, cause, effects and control measures of: (a) Air Pollution, (b) Water Pollution, (c) Soil Pollution, (d) Marine Pollution, (e) Noise Pollution, (f) Thermal pollution e.g. nuclear hazards. Solid Waste Management: causes, effects, and control measures of urban and industrial wastes, Role of an individual in prevention of pollution.

Social issues and the environment: From Unsustainable to sustainable development, urban problem related to energy, water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust Dies, Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation, public awareness.

Human Population and the Environment: Population growth, variation among nations, population explosion, Family welfare Program, Environment and human health: Human Rights, Value Education, HIV/AIDS, Women and Child welfare, Role of information technology in environment and human health.

Disaster Management: Natural Disaster: Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, climatic changes: global warming, sea level rise, ozone depletion. Man Made

Disasters-Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road, rail, air and sea accidents.

Disaster Management: Effect to migrate natural disaster at national and global levels, International strategy for disaster reduction, Concept of disaster management, national disaster management framework, financial arrangement, role of NGOs, community-based organization and media, Central, state, district and local administration, Armed forces in disaster response, Disaster response, Police and other organizations.

Suggested Readings

1. Environmental Science by Dr Y. K. Singh, New Age International (P) Ltd.
2. Palanisamy, PN: Environmental Science, 3rd edn, Pearson India.
3. Textbook for Environmental Studies by Erach Bharucha, University Grants Commission.

Semester IV

Elements, Characteristics and Design of Natural Farming Systems 3 (2+1)

Objectives

1. To make students aware about concept, function and design of natural farming as a system approach
2. To train students on different advanced methodologies for analyzing and designing agro-ecological specific natural farming units.

Theory

Natural Farming Systems: Concept, importance, approaches, determinants and characteristics, Strength and weakness of natural farming systems, Ecosystems: Concept and components, System approach and concept for farming systems, natural farming systems and ecosystem analysis, The water cycle, nutrient Cycle and energy cycle, Types of ecosystems: Natural ecosystems and agri-ecosystems, concept and classification of ecosystem services, Concept and elements of natural systems, Classification of farming types (based on geographical condition, levels of technology and external input use, labour, demand of produce, etc.), Subsistence farming, Intensive subsistence and primitive subsistence, Traditional farming, intensive conventional farming, integrated farming, conservation agriculture, eco-agriculture, ecologically intensive agriculture (Sustainable intensifications) biodynamic farming, permaculture, cow based farming, cosmic energy farming, prakritik shaswat yogic farming, natural farming, agnihoter farming (homa farming), astrology and astronomy in agriculture, vastu practices, Important agri-based, horti-based, animal based, agro forestry, aqua farming system models, The prairie model, Natural system models at the basis of mimicry (the rain forest model, the dry forest model, Concept of ecosystem based integration of crops, livestock, horticulture and fish farming as complimentary activities, Traditional integrated farming system models based on natural farming principles, Comparison of natural ecosystems, traditional farming system and modern agriculture, Production syndrome in natural farming, Hypotheses and concepts in designing the natural farming system models (Biodiversity and the mimicry hypothesis, productivity, resilience, equilibrium and stability, Levels of organization for

nature mimicry in agro-ecosystems), Principles for cropping and farming system design based on natural ecosystem mimicry, Steps for development of agricultural systems based on mimicking natural ecosystems, Economic evaluation and comparative analysis of different farming systems and natural systems, optimization methodology: a potential approach for system, natural farming system and ecosystem analysis and design.

Practical

Identification and characterization of different natural and agro-ecosystems in the rainfed, hill and mountain, arid, coastal and irrigated regions, Study on characterization of natural eco-systems and intensive farming system, Study on characteristics of elements of water cycle in natural ecosystem and farming system, Study on characteristics of elements of nutrient cycle in natural ecosystem and farming system, Study on characteristics of elements of energy cycle in natural farming, Comparative biodiversity analysis in natural and conventional farming systems, Calculation of biodiversity index for different farming systems, Designing of cropping/farming and natural farming systems, Study and representation of resource flow and recycling in different farming systems, Budgeting: Farm records and farm book keeping in natural farming system, Cost and profit analysis of different components and whole system, Designing of natural farming systems models in different agro-ecosystems, Designing farming systems/natural farming systems using mathematical tools/optimization methodology.

Suggested Reading

1. Agroforestry: Principles and Practices, A. P. Dwivedi, 2019. oxford IBH Publication.
2. Ahimsak Rishi-Krishi Deshpande Farming Technique. http:// rishikrishi.co.in/index. html
3. Behera, U. K. 2013. A Text Book of Farming Systems. Agrotech Publishing House, Udaipur.
4. Behera, U.K. and France, J. 2022. Farming systems research: Concepts, design and methodology. Advances in Agronomy 177: 1-49
5. Compendium of Success Stories of Natural Farming Publishing Agency: NITI Aayog. 2022. ISBN: 978-81- 953811-4-2.
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7. Manna, M. C., Rahman, M. M., Naidu, R., Fazle Bari, A.S.M., Singh, A. B., Thakur, J.K., Ghosh, A., Patra, A. K., Chaudhari, S. K. and Subbarao, A. 2021. organic farming: A prospect for food, environment and livelihood security in Indian agriculture. Advances in Agronomy, 170: 101-153.
8. Minamino Y. 1994. Manifesto of Nature Farming. In the Front of organic Agriculture. Fumin-Kyokai, Tokyo, 195pp.
9. Natural Farming: A Practical Guide by Pat Coleby (2004)
10. Sharma, S. K., Choudhary, R., Jat, G., Chhipa, B. G., Jain, D., Gupta, L., yadav, S. K., Jain, R. K., Verma, A., Trivedi, A. and Jain, P. 2022. Compendium- Natural Farming: Perspectives and Prospects in Changing Agriculture Scenario, ICAR- Centre for Advanced Faculty Training on organic Farming, Directorate of Research, MPUAT, Udaipur 313001 (Rajasthan). Pp 1-419. https://cbp.icar.gov.in/ebook22.aspx

11. Sharma, S. K., Choudhary, R., Ravishankar, N., Jat, G., Sharma, R. K., yadav, S.K. and Jain, R. K. 2022. Natural Farming: Concept, Importance, Scope and Status. Directorate of Research, MPUAT, Udaipur 313001 (Rajasthan). Pp 1-1.
12. The Principles of Spiritual Farming - Volume II by Subash Paleker.

Improvement of Traditional and Underutilized Crops **3 (2+1)**

Objectives

1. To gain the knowledge on different types of traditional and underutilized crops
2. To train the students on the methods of improvement techniques.

Theory

Importance of traditional and underutilized crops, Genetic basis of crop Improvement: Laws of inheritance; qualitative and quantitative traits, multiple factor hypothesis, pureline theory, components of phenotypic variance, GXE interaction, heritability, breeder's equation, populations/ landraces/ farmers' varieties/ cultivars, Hardy Weinberg equilibrium and factors affecting it, Assortative and disassortative mating, Difference between self-pollinated, cross pollinated and clonal populations, Important physiological parameters for crop improvement- Photosynthesis, transpiration, water and mineral Details of the Course regulation, Breeding objectives under natural farming systems- Nutrient Use Efficiency, Tolerance to micronutrients, mineral deficiencies and toxicities, Weed competitiveness, Enhanced Interaction with Rhizospheric microorganisms, Multiple disease and insect resistance, Quality, Earliness/ crop duration to suit multiple cropping system and agro- ecologies, Wider adaptability and stability, Broad genetic base / population heterogeneity, High yield, Multipurpose crops- stay green, food, feed, fiber and fuel. Plant breeding techniques: Domestication, introduction, Selection, hybridization; Breeding self-pollinated crops- Pureline selection, mass selection, pedigree selection, mass selection, SSD, backcross breeding, Breeding cross pollinated crops- Population improvement, recurrent selection, composite and synthetic varieties, Improving clonally propagated crops- Clonal selection, Farmer participatory plant breeding. Molecular markers, Marker Assisted Selection (MAS), comparison of MAS vs. Phenotypic selection.

Practical

Study of floral biology of different crops, Hybridization techniques, DUS characterization important land races and traditional varieties of crops, Breeding methods for natural farming, Study of root characteristics of crops grown under natural and other production systems, Learning of techniques of participatory plant breeding, Techniques of conservation of plant genetic resources, PRA for mapping indigenous crops and their characteristics, Seed identification and collection for natural farming systems, Identification of important land races and traditional varieties of crops, Identification of important land races and traditional varieties of fruit crops.

Suggested Readings

1. Chahal, G.S. and S.S. Ghosal. 2019. Principles and Procedures of Plant Breeding.
2. Chopra, V.L. 2004. Plant Breeding. oxford and IBH Publishing Co Pvt Ltd, New Delhi.
3. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission Mode Project on Collection, Documentation

and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.

4. Dawson JC, Murphy KM, Jones SS. Decentralized selection and participa- tory approaches in plant breeding for low-input systems. *Euphytica*. 2008; 160:143–54.
5. Fess TL, Kotcon JB, Benedito AV. Crop breeding for low input agriculture: a sustainable response to feed a growing world population. *Sustainability*. 2011; 3:1742–72.
6. Geographical Indications of Plant Species. *In:* Inventory of Indigenous Technical Knowledge in Agriculture Document 5; Publ: ICAR, New Delhi.
7. Lammerts van Bueren ET, 2002. organic plant breeding and propagation: Concepts and strategies. Ph. D. Thesis, Wageningen University, Netherlands.
8. Lammerts van Bueren, E.T., Jones, S. S., Tamm, L., Murphy, K.M., Myers, J.R., Leifert, C. and Messmer, M.M. (2011). The need to breed crop varieties suitable for organic farming, using wheat, tomato and broccoli as examples: A review. NJAS - Wageningen, Journal of Life Sciences 580: 193-205.
9. Phillips SL, Wolfe MS. Evolutionary plant breeding for low input systems. J Agric Sci.2005; 143:245.
10. Ranganathan Nithya. 2018. Druma Vichitrikaranam - The Ancient Approach to Plant Mutagenesis, Asian Agri-History, Vol. 22(3): 218-225.
11. Singh A K. 2007. Plant Biodiversity and Agriculture in India: A Historical Perspective.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 493-505.

Agro-Eco System Analysis for Natural Farming **2 (1+1)**

Objectives

1. To enhance the knowledge about the concepts, types and tools adopted in agro- ecosystem
2. To study the techniques and strategies adopted in natural farming and as a tool in agro-ecosystem analysis

Theory

Definition of system, system hierarchy, Introduction, and concept of agro- ecosystem, Properties of agro-ecosystem, Types of agro ecosystem analysis, Tools and techniques used in agro-ecosystem analysis, agro-ecosystem analysis and sustainable agriculture, Steps involved in agro-ecosystem analysis, Methodology of agro-ecosystem analysis, Energy flow of agro-eco system analysis, Participatory rural appraisal related terms – RRA, PRA, PLA, PLAM, and philosophy of PRM, Participatory planning framework, Importance of participation, Principles of participatory extension, Participatory technology development process

Practical

Simulated exercise on space related methods, Time related methods, Flow related methods, Documentation of participatory technology development process, conducting agro-ecosystem analysis using PRA tools and techniques in village situation, Learn the techniques of action plan development.

Suggested Readings

1. Adhikary. 2006. Participatory Planning and Project Management in Extension Science. Agrotech. Publ. Academy.
2. Agro-ecosystem Analysis for Research and Development by Gordon R. Conway.
3. Handbook and agro-ecosystem analysis and agro-ecological zoning: A tool for district land use planning- NAFR Lao-Swedish Upland Agriculture and Forestry Research Program
4. Singh B.K. 2008. PRA/PLA and Participatory training. Adhyayan Publ. and Distr.

Beneficial Insects 3 (2+1)

Objectives

1. To teach students the role of beneficial insects viz., pollinators, decomposers, predators and parasitoids, soil builders, productive insects
2. To impart knowledge on the beneficial insects used under natural farming

Theory

Ecological understanding of insects in natural farming, Study of their life cycle, population dynamics and interaction with other abiotic and biotic components in a natural farming ecosystem, Decomposers (insects) in natural farming system, Pollinators in natural farming systems: their kinds, types, diversity, conservation and profitable use for enhancing.

Productivity in terms of quality and quantity, Natural enemies of poriferous insect's generalist predators, specific predators, parasitoids (egg, larval, pupal and intermediary), Insects in ecological communities, Insects as food, soil builders and insects of aesthetic value, Promotion of required habitat for friendly insects, Pollinators: Honey -bee biology, commercial methods of rearing, equipment used, seasonal management, bee enemies and diseases, Bee pasturage, bee foraging and communication, Insect pests and diseases of honey bee, Role of pollinators in cross pollinated plants, Types of silkworms, voltinism and biology of silkworm, Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves, Rearing, mounting and harvesting of cocoons, Pests and diseases of silkworm, management, rearing appliances of mulberry silkworm and methods of disinfection, Species of lac insect, morphology, biology, host plant, lac production – seed lac, button lac, shellac, lac- products, Indigenous technical knowledge on management of insect pests, Knowledge and importance of beneficial insects in ancient India.

Practical

Rearing dung beetles for decomposing organic wastes as manure, Pollinators: Diversity, species richness and their use in enhancing productivity of crops, Natural enemies- diversity: species richness, their conservation in *in-situ* and wherever possible, artificial rearing for using pest management. Collection of beneficial insects, study of life cycle and habitats of beneficial insects, crop wise applications of beneficial insects for pest control.

Suggested Readings

1. Atwal AS. 2001. The World of the Honey Bee. Kalyani Publishers, New Delhi.
2. Bukhari R and Bhatt RA.2022 Fundamentals of Sericulture. Narendra Publishing House,

C-21, Varun Apartment, Sector 9, Rohini, Delhi

3. Choudhary, S.L., G.S. Sharma and Y.L. Nene (Eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the Summer School held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India. pp.363.
4. Danstan P. Ambrose. 2018. The Insects: Beneficial and Harmful Aspects, Kalyani Publishers
5. David V. Alford. 2019. Beneficial Insects. CRC Press. 400 p.
6. Graham JM. 2015. The hive and honey bee. Dadant and Sons Publication, USA
7. Mishra RC. 2013. Perspective in Indian Apiculture. Agrobius Publication Jodhpur, India
8. Pradip VJ. 2008. Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac culture and Agriculture Pests and their controls. Discovery Publishing Pvt. Ltd., New Delhi
9. Prasad. T.V. 2019. Handbook of Entomology (4th edn). New Vishal Publications
10. Reddy, A, Anusha, C., Ramprasad, B., Kumar, R and V. Daravath. 2022. Importance of Beneficial Insects in Agriculture. Research Trends in Multidisciplinary Research and Development (pp.7-24). Wiser Publications, Germany.

Quantification and Valuation of Ecosystem Service **3 (2+1)**

Objectives

1. To orient the students with basic concepts of ecosystems services
2. To impart skills on quantification and valuation of ecosystem services

Theory

Ecosystem Services (ES)-Meaning, Concept and its importance, Classification of Ecosystem Services - Provisioning, Regulating, Supporting and Cultural services, Basics of natural capital, Quantification of ecosystem services-Direct and Indirect approaches, Valuation of Ecosystem Services and its need, Ecosystem valuation methods-Revealed preference methods: Market pricing, Production function, Hedonic pricing methods, Travel cost method and Random utility models, Stated preference methods-Contingent valuation method and choice modelling, Cost based approaches of Ecosystem Valuation- opportunity cost, Cost of alternatives or substitute goods, Replacement cost method, Methods for obtaining Non- economic Values-Focus groups, Citizens' Juries, Health-based valuation , Q- methodology and Delphi surveys, Payment for ecosystem services (PES), Governance and policy issues in ecosystem services, Challenges in valuation of ecosystem services.

Practical

Ecosystem Valuation methods- Direct and indirect methods of calculation, An overview-Millennium Ecosystem Services (MEA) Assessment, Case studies on payment for ecosystem services (PES), Case studies in Ecosystem Services in India and abroad, Study on Environmental Impact Analysis. Visits to the ecosystem areas (Agro ecosystem, Forest Ecosystem and Aquatic ecosystem).

Suggested Readings

1. Baskaran, R., Cullen, R., and Takatsuka, y. (2009). Estimating the value of agricultural ecosystem services: A case study of New Zealand pastoral farming. Australasian Journal of Environmental Management 16 (2): 103-112.

2. Costanza, R., Cumberland, J., Daily, H., Goodland, R., and Norgard, R. (1997a): An Introduction to Ecological Economics. ISEE, Florida, 275 pp.
3. Costanza, R., d'Arge, R., De groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., o'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., and van den Belt, M. (1997b). The value of the world's ecosystem services and natural capital. Nature 387:253-260.
4. https://teebweb.org/our-work/nca/understanding-nca/
5. NAAS. 2020. Payment for Ecosystem Services in Agriculture. http://naas.org.in/ Policy%20 Papers/policy%2094.pd

Agricultural Marketing and Trade **3 (2+1)**

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions –NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L., 2006, Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chinna, S.S., 2005, Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore, Micro Economic Theory
4. Kohls Richard, L. and Uhl Josheph, N., 2002, Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong, 2005, Principles of Marketing, Pearson Prentice-Hall.
6. Lekhi, R. K. and Joginder Singh, 2006, Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I., 2003, Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
8. Pandey Mukesh and Tewari, Deepali. 2004, Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi. Sharma, R., 2005, Export Management, Laxmi Narain Agarwal, Agra.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objective

1. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
2. To provide basic knowledge of computer with applications in Agriculture
3. To make the students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Practical

Study of computer components, accessories, practice of important DOS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific document, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
2. Fundamentals of Computer by V. Rajaroman.
3. Introduction to Information Technology by Pearson.
4. Introduction to Database Management System by C. J. Date.
5. Introductory Agri Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication.

SEC-VI

Skill Enhancement Course **2 (0+2)**

One Course of (0+2) credits of skill enhancement courses will be offered from indicated list of skill enhancement courses.

Semester V

Post Harvest Management -I **3 (2+1)**

Objectives

1. To develop skills for primary and secondary processing, mechanical and biocontrol practices for storage of fruits and vegetables
2. To create awareness about natural preservation methods and hygiene and handling of fruits and vegetables.

Theory

Post-harvest management: Importance of fruits and vegetables, Introduction to post- harvest physiology of fruits and vegetables; Post-harvest losses, Maturity indices, Harvesting methods and collection devices, Unit operations in packaging with emphasis on use of natural products like bee wax, gum Arabic, shellac, xantham gum etc., Environment friendly and safe ripening methods, Post-harvest diseases, Disorders and their management.

Storage techniques: Traditional and modern storage structures: on farm and off farm storage, refrigerated storage, evaporative cool chambers, refrigerated vehicles, Storage techniques for local cultivars seeds.

Value addition: Principles and methods of preservation, natural preservatives, indigenous and traditional preservation techniques, phytochemicals for preservation, FSSAI, BIS, and Codex standards for major processed products from fruits and vegetables Value addition in fruits and vegetables through drying, pickling, jam, jelly, marmalade, preserve (murabba), candy, juice, ready-to-serve, squash, nectar, crystallized products, etc.; minimal processing, Eco-friendly handling and packaging: Use of essentials oils and ecofriendly phytochemicals in postharvest handling; Edible films and coating, eco or bio- based polymeric films used for packaging.

Modified atmosphere packaging, Vacuum packaging, Smart packaging, Active packaging using natural or bio-colours, ITKs for handling and packaging; neem- based products for fruit and vegetable handling.

Practical

Demonstration and use of different harvesting tools, Practical demonstration on packhouse operations, Study of different preservation methods for fruits, and vegetables, Study of weight loss of produce in eco-friendly packaging, Determination of TSS and acidity in fresh and processed products, Determination of ascorbic acid, Determination of sugars, Study of different types of dryers, Study of evaporative cooling system/low cost cooling system/Zero Energy Cool Chamber, Preparation of traditional value-added products from fruits and vegetables, Preparation of jam, Preparation of jelly, Preparation of fruit-based beverages, Preparation of pickles, Study of different packaging materials, Visit to industry/processing unit.

Suggested Readings

1. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation

and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.

2. De Freitas, S.T., and Pareek, S. 2019. Postharvest Physiological Disorders in Fruits and Disorders. CRC Press, US.
3. Kader, A.A. 2002. Postharvest Technology of Horticultural Crops. University of Davis, USA.
4. Pareek, S. 2016. Fresh-Cut Fruits and Vegetables: Technology, Physiology, and Safety. CRC Press, US.
5. Pareek, S. 2016. Postharvest Ripening Physiology of Crops. CRC Press, US.
6. Pareek, S. 2017. Novel Postharvest Treatments of Fruits and Vegetables. CRC Press, US.
7. Srivastava, R.P. and Kumar, S. 2002. Fruit and Vegetable Preservation: Principles and Practices, 3rd Ed. International Book Distribution Co., Delhi.
8. Verma, L. R. and Joshi, V. K. 2000. Post-Harvest Technology of Fruits and Vegetables.Vol. I and II. Indus Publishing Co., New Delhi
9. Wills, R. and Golding, J. 2016. Postharvest: An Introduction to the Physiology and Handling of Fruit and Vegetables. 6th edn, CABI.
10. Yahia, E.M. 2019. Postharvest Technology of Perishable Horticultural Commodities. United Kingdom: Elsevier.

Bio-resources and Agricultural Waste Management **3 (2+1)**

Objectives

1. To impart knowledge on various aspects of biowastes and agricultural wastes for managing as organic amendments in agricultural production system
2. To develop skills on various methods of conversion of decomposable wastes into organic manures

Theory

Introduction to bio-resources and agricultural biomass waste, Classification and characterization of agri and livestock biomass waste, Principles of agricultural waste management: 4R's approach, Potential of recyclable crop residues and its management, In-situ management of agricultural waste, Role of soil and plants in waste management, Impact of agro-waste on soil and plant quality and the environment, Pre-treatment of agricultural wastes, Pre-treatment methods: biological treatment, biological-processes of waste management, Bio- conversion/ bio-decomposition through native microflora biogas generation, operation and management of biogas plants, utilization of biogas and spent slurry, landfill, Farm waste management machinery, Environmental benefit of waste management, ITK information on waste management. Mission Life Style for Environment (LiFE) and Govt. schemes to promote agriculture waste into wealth.

Practical

Visit to various agri-farms, Collection and preparation of agricultural waste samples, Characterization of agricultural waste, Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash, Determination of pH, EC and CEC, Determination of BoD and CoD, Nutrient status (N, P, K, and micronutrients) analysis of agricultural waste, Survey of

different agri -waste from livestock, dairy, food processing, fruit and vegetable and agri-chemicals, Study of biogas production process and Study briquetting of agricultural residues and important commercial agri-waste management methods in public and private sector.

Suggested Readings

1. Agricultural Waste Diversity and Sustainability Issues. 2021. Ed(s): Peter Fonu, Charles Mbohwa. Academic Press. pp 187.
2. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.
3. Deepthi Reddy, M. Devender, Roja Mandapati. 2018. Agricultural Waste Management ICAR, New Delhi.
4. Shaktawat, M.S., N.C. Aery, M.K. Katewa Mohan Singh, B.N. Swami .2004. Phosphate Rich organic Manure (PRoM).
5. Waste water Management/ Garbage disposal and Management. In: Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 and 2); Document 3; Publ: ICAR, New Delhi.
6. Zainul Akmar Zakaria. 2019. Sustainable Technologies for the Management of Agricultural Wastes (Applied Environmental Science and Engineering for a Sustainable Future.

Medicinal and Aromatic Plants 2 (1+1)

Objectives

1. To impart knowledge on diversity of medicinal and aromatic plants and their utilities
2. To develop skilled manpower on cultivation practices of medicinal and aromatic plants under natural farming system

Theory

General aspects of Medicinal Plants: Definition, history, present and future needs, Introduction of plant parts (fruit, leaves, roots, stem, seeds and their modification), Cultivation and harvesting practices, Processing and storage practices, Marketing of medicinal products, Important Indian medicinal plants, Plant parts used as powder: Identification and utilization of Amla (*Embelica officinalis*), Behra (*Terminalia bellerica*), Harad (*Terminalia chebula*), Turmeric (*Curcuma longa*), Garlic (*Allium sativum*), Bitter guard (*Momordica charantia*), Black plum (*Syzygium cumini*), Fenugreek (*Trigonella foenumgraecum*), Cinnamon (*Cinnamomum verum*), Sarpgandha (*Rauvolfia serpentina*), Black pepper (*Piper nigrum*), Ashwagandha (*Withania somnifera*), Psyllium husk (*Plantego ovata*). Plant parts used as juice/ decoction: Identification and utilization of Amla (*Embelica officinalis*), Ginger (*Gingiber officinalis*), onion (*Alium cepa*), Bottle guard (*Lagenaria siceraria*), Basil (*Oscimum santum*), Arjun (*Terminalia arjuna*), Neem (*Azadirecta indica*), Gwarpatha (*Aloe vera*), Brahmi (*Bacopa monnieri*), Giloy (*Tinospora cordifolia*), Shankhpushpi (*Convolvulus prostrate*), Bael (*Aegle marmelos*). Plant parts used as Lotion and Ointments: Identification and utilization of Gwarpatha (*Aloe vera*), Fenugreek (*Trigonella foenumgraecum*), Pot marigold (*Calendula officinalis*), Neem (*Azadirecta indica*) Plant Parts Used as oil: Clove (*Syzygium*

aromaticum), Neem (*Azadirecta indica*), Coconut (*Coccus nucifera*), Nilgiri (*Eucalyptus* sp.). Plant parts used as Surgical Fibres, Sutures and Dressings: Identification and utilization of cotton (*Gossipium* sp.), Jute (*Corchorus capsularis*), Banana (*Musa sp.*). Plant parts used as Poultice: Identification and utilization of Turmeric (*Curcuma longa*), Nilgiri (*Eucalyptus sp.*), Ginger (*Gingiber officinalis*), Garlic (*Allium sativum*), onion (*Alium cepa*), Dhatura (*Dhatura* sp.), Aak (*Calotropis* sp.), Arandi (*Ricinus communis*).

Practical

Identification of locally available common medicinal plants, Basic preparation of herbal products as kadha, powder (Ex. Neem leaf, moringa leaf, tulsi leaf, giloy, arandana), Juice (Ex. Amla, Aloe vera), Trifala, Chyavanprash, Amla candy, herbal tea, etc. Study and documentation of commercial production of at least five medicinal plants, (Using website/ you Tube). Submission of digital photo album of at least ten medicinal plants with brief description, Cultivation maintenance and reporting of at least five medicinal plants within college campus.

Suggested Readings

1. Atal and Kapoor, Cultivation and Utilization of Medicinal Plants, RRL Jammu Tavi.1982.
2. Brahmvarchas, Ayurved Ka Pran: Vanoshadhivigyan, Vedmata Gayatri Trust, Shaktikunj Haridwar.
3. Chaudhry R. D., Herbal Drug Industry, Eastern Publication.
4. CSIR – Cultivation and Utilization of Medicinal Plants.
5. Dutt Ashwin. An Introduction to Medicinal Plants, Adhyayan Publishers and distributers, 200.
6. Panda H., Hand Book of Ayurvedic Medicines, National Institute of Industrial Research, Delhi.
7. Raphael Ikan, Natural Products: A Lab Guide, Academic Press, 1991, 2nd edition.

Seed Production Technology 3 (2+1)

Objectives

1. To make the students aware about concept of seed and quality of seed
2. Principles of seed production of important cereals, pulses, oilseeds, fodder crops vegetables
3. To make aware about seed legislation, seed certification standards and seed processing.

Theory

Seed quality: Definition and concept of seed quality, Classification of seeds, Use of biodiversity for seed production, Formal and informal seed production systems. Principles of seed production of important cereals, pulses, oilseeds, fodder crops vegetables, Seed Physiology: Seed germination, viability, seed dormancy, types and requirements of seed germination, Seed health, quality seed collection from natural farming, Seed legislation, Seed testing, Varietal identification through Grow Out Test and electrophoresis, Biochemical tests and molecular tools, Minimum Seed Certification standards, field standards and seed standards, Seed drying and processing, Orthodox seed and recalcitrant seeds, General principles, stages and factors affecting seed longevity during storage and handling, Seed Village Concepts (seed self

reliance), types and significance of indigenous seed conservation, community seed banks, Seed marketing, Role of WTO and OECD in seed marketing, Seed production, collection, storage and quality control in context with Natural farming, Technology of Seed Health during ancient time, Materials recommended (plant based, animal based) in ancient time for seed treatments, Sample case study of a few farmers initiative on conservation of seed in different states of India, PPVFR Act (2001) and Suo generis plant variety law approach, ITKs in seed storage and seed health as compiled by ICAR.

Practical

Seed production in major self-pollinated crops, Seed production in major cross pollinated crops, Seed production in selected vegetable crops, Seed sampling procedures, Seed testing: Physical purity, moisture test, varietal purity. RPL, germination, viability, Grow out test and electrophoresis, etc. Seedling vigour tests, Seed health tests, Genetic purity test: moisture tests, heterogeneity, Seed certification: Procedure, field inspection, taking of field counts, Preparation of field inspection and seed testing reports, Seed collection and rural improved storages, Visits to seed production farms, seed testing laboratories and seed processing plants.

Suggested Readings

1. Andersen MM, Landes X, Xiang W, Anyshchenko A, Falhof J, Osterberg JT, et al.2015. Feasibility of new breeding techniques for organic farming. Trends Plant Sci. 20:426–434.
2. Borgen A. 2009. Present and future system organization of organic plant breeding, In 1 IFOAM Int. Conference on organic Animal and Plant Breeding, Ed. A Zschoke pp 253- 255. IFOAM, Santa Fe, New Mexico, USA.
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4. Dawson JC, Murphy KM, Jones SS. 2008. Decentralized selection and participatory approaches in plant breeding for low-input systems. Euphytica. 160:143–54.
5. Fess TL, Kotcon JB, Benedito AV. 2011. Crop breeding for low input agriculture: A sustainable response to feed a growing world population. Sustainability. 3:1742–72.
6. Mone, S. 2016. A source book on India's organic seeds. The organic Farming Association of India. pp 104.
7. Nene YL. 2007. Seed Health in Ancient and Medieval History and its Relevance to Present Day Agriculture. In. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 533-553.
8. Phillips SL, Wolfe MS. 2005. Evolutionary plant breeding for low input systems. J Agric Sci. 143:245.
9. Singh, B.D. 2018. Plant Breeding-Principles and Methods. Kalyani. Publishers, Ludhiana.

Value Chain Management in Natural Farming **2 (1+1)**

Objectives

1. Role and importance of value chains, value chain models
2. Role of Farmer Producer organization in value chains of natural farming

Theory

Concept of agriculture value chain, characteristics of value chain management in natural farming, types of value chains, role and importance of value chains; dynamics of renewable and non-renewable resources, resource scarcity, pricing and valuation of natural resources; good agriculture practices, good manufacturing and good processing practices, Value chain models- Producer driven, buyer driven, facilitated models.

Role of farmer producer organizations in value chains of natural farming products; Market initiation and strategies, organization of value chains, roles and responsibilities of stakeholders of value chain, transportation, logistics and infrastructure, cold chain components, dispute resolutions and arbitration, physical asset collateralization, Quality certification like HACCP and FSSAI standards, Postharvest, quality, and value-added aspects for domestic and export market special economic zones, Theory of storage and Warehouses – Types, classification, advantages and disadvantages.

Practical

Case studies and success stories on natural farming or chemical free farming value chains in India and abroad, environmental resource accounting techniques, visit to special economic zones, identification of value chains for commodities, identification of niche markets for natural farming produces; post-harvest loss assessment.

Suggested Readings

1. Carlson, G.A., Miranowski, J., and Zilberman, D. 1998. Agricultural and Environmental Resource Economics. oxford University Press.
2. Faires, Nicole. 2022. The Ultimate Guide to Natural Farming and Sustainable Living, Skyhorse Publishing, ISBN- 9781634502818.
3. Gulati, A., Ganguly, K. and Harshwardhan. 2022. Agriculture Value Chains in India.Springer open Access Book, India Studies in Business and Economics.
4. Prato, T. 1998. Natural Resource and Environmental Economics. Iowa State University Press.
5. Singh, R., Naik, D. and Feroze, S. M. 2014. Agri-Business potentials in India: Experiences from Hill states. EBH Publishers India136, M.L. Nehru Road, Pan Bazaar, Guwahati-781001.
6. Singh, R., Yumnam, A., Roy, A. and Choudhury, A. 2018. Agriculture Development: Technical and Policy options. Biotech Books 4762-63/23 Ansari Road, Darya Ganj, New Delhi, 110002
7. Sterner, T. 2003. Policy Instruments for Environmental and Natural Resource Management. Resources for the Future, Washington DC.

Renewable Energy Sources 2 (1+1)

Objectives

1. To gain the knowledge on different types of renewable energy sources
2. To understand the importance of renewable energy technology and its applications

Theory

Introduction to energy, Forms of energy, Conservation of energy, Sources of energy and their classification, Energy consumption patterns in India, Concept of renewable energy sources,

Potential of renewable energy sources, Classification of renewable energy sources, Ecological footprint, Carbon footprint. Role of renewable energy in natural farming and its impact on food system, Environment and economy, Solar Energy: Introduction of solar energy, solar thermal energy systems: solar cooker, solar distillation, solar water heater, solar dryer, solar photovoltaic systems and their different types and uses, soil solarization, Biomass Energy: Introduction of biomass, biogas–biogas generation process, types of biogas plants, application of biogas, usage of biogas spent slurry, Biomass Gasification- types of gasifiers, producer gas production and utilization, Introduction to ethanol, biodiesel and hydrogen production process. Wind Energy: Introduction, Traditional practices of wind energy, Wind mills and their applications, Role of renewable energy in carbon mitigation, Energy balance in natural farming, Programs and policies for promotion of renewable energy in India.

Practical

Visit to farms to study different source of energy and their consumption, Study of solar cooker, Study of solar dryer, Study of solar water heater, Study of solar distillation, Study of solar photovoltaic system, Study of biogas plant, Study of biomass gasifier, Study the production process of biodiesel, Study of improved biomass cookstove, Traditional practices of wind energy, Determination of energy balance in natural farming.

Suggested Readings

1. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.
2. Kothari DP, Singal KC and Ranjan R (2008) Renewable Energy Sources and Emerging Technologies, PHI Learning Pvt. Ltd., New Delhi
3. Rai GD (2013). Non-Conventional Energy Sources, Khanna Publishers, Delhi.
4. Rai GD (2013). Solar Energy Utilization, Khanna Publishers, New Delhi.
5. Rathore NS and Panwar NL (2021). Biomass Production and Efficient Utilization for Energy Generation. New India Publishing Agency, New Delhi.
6. Rathore NS and Panwar NL (2021). Fundamentals of Renewable Energy, New India Publishing Agency, New Delhi.
7. Seveda MS, Narale PD and Kharpude SN (2021). Bioenergy Engineering, CRC Press, Taylor and Francis Group, UK.
8. Seveda MS, Narale P and Kharpude SN (2021). Advances in Renewable Energy Engineering, Narendra Publishing House, New Delhi.
9. Solanki CS (2008). Renewal Energy Technologies: A Practical Guide for Beginners, PHI Learning.

Natural Farming and Human Health **2(1+1)**

Objectives

1. To make the students aware about concept of healthy food, Nutritional garden, Homestead kitchen garden and Nutri smart village
2. To understand the beneficial effects of medicinal crops on health

Theory

Changing lifestyles and food habits of the people over the years, Health and disease statistics of world and India, Food production and requirement vis-à-vis growth in human population in India and World, Need of healthy food, Concept of healthy food, safe food, organic food, green food, pesticide free food, fast food, slow food, Dietary guidelines, Traditional food vis-a-vis modern food and its potential health impact, Food Chain contamination and human health hazards, Deficiency in micro-nutrients by the human and livestock population, Malnutrition, Concept of one health, Traditional food of Indian population: Food and its nutrient content, Traditional diets in Indian and their adequacy- Nutritional value of traditional food, Concept of nutrition and health per acre, Interrelationship between natural farming and human health, Health and nutrition disconnect in the agriculture policy of India, Effect of natural farming on animal reproduction, Nutrients, taste, safety, immune system, antibiotic resistance, antioxidant value and protection of environment, Dietary requirement for Indian population: Current diet and nutrition scenario, Recommended Dietary Allowances (RDA): Food exchange list, food composition database, food composition and food groups, bio- fortification of crops, Criteria for classification of quality and safe food, Human health – Definition and philosophy, concept of health- biomedical, ecological, psychological and holistic, Criteria and qualities of organic and natural food, Comparison of natural and conventionally grown foods: Nutritional and non-nutritional components, bioactive components, their impact on human health, effect of processing on nutritional components, conservation of nutrients in processed foods, Food standards, food laws and labelling of natural foods, Concept of nutritional garden, homestead kitchen garden and nutri smart village. ITKs in human food and nutrition and health, Mission Life Style for Environment (LiFE).

Practical

Physical examination of food, determination of gluten, bulk density, hydration capacity and index, oil absorption capacity, Sensory evaluation and organoleptic evaluation of natural and conventional foods, Analysis of proximate composition in conventional foods and natural farming produce/foods based on available secondary data.

Determination of pesticide residues and heavy metal contamination in foods, Market survey and listing of natural farming foods available in the market, Preparation of nutri- thali, Composition of nutrient in different crop plants, Effect of processing on nutritive value of food, Determination of pesticides load in the food stuffs, Glycemic index of common food, Macro – nutrient and micro – nutrient and their sources, Calorie requirement among different class of population, Balance diet for different class of people, Drinking water standard - Limits of heavy metal content

Suggested Readings

1. Agarwal A and Udipi S (2014). Text Book of Human Nutrition. Jaypee Medical Publication, Delhi.
2. AOAC International (2016) AOAC Official Methods of Analysis. 20th Edition, Association of Official Analytical Chemists. Washington DC.
3. Bamji S M, Rao P N and Reddy V (2003). Textbook of Human Nutrition. oxford and IBH Publishing Co Pvt Ltd.

4. Lamuela- Raventós (2019). organic food and the impact on human health, Critical Reviews in Food Science and Nutrition, 59:4, 704-714, DoI: 10.1080/10408398.2017.1394815
5. Sawhney SK and Singh R (2000). Introductory Practical Biochemistry. Narosa Publishing House, New Delhi. Kalia M (2002) Food Analysis and Quality Control. Kalyani Publishers, New Delhi.
6. Shiva V and Singh V (2011). Health per Acre- organic Solutions to Hunger and Malnutrition. Navdanya Research Foundation for Science, Technology and Ecology.
7. Shiva V, Shiva M and Singh V (2013). Poisons in our Food- Links between Pesticides and Diseases, Natraj Publishers, Dehradun.

Fundamentals of Entomology **3 (2+1)**

Objectives

1. To teach the students on external morphology and anatomy of different systems of insects
2. To teach the students on classification and identification of insects upto family level

Theory

Entomology in ancient India, Historical classics of modern entomology, Classification of phylum Arthropoda up to classes, Relationship of class Insecta with other classes of Arthropoda, Major points related to dominance of Insecta in animal kingdom. Morphology: Structure and functions of insect cuticle and moulting, Body segmentation; Structure of head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts, legs, wing venation, modifications and wing coupling apparatus, Structure and modifications of abdominal appendages, Anatomy of insect systems - Digestive, excretory, respiratory, circulatory, nervous, reproductive and glandular systems, sense organs and tropism and bio-communication in insects, Metamorphosis in insects, Taxonomy – Importance, history and development and binomial nomenclature, Definitions of Bio-types, Sub-species, Species, Genus, Family and Order, Classification of class Insecta up to Orders, basic groups of present days insects with special emphasis to orders and families of economic importance and their distinguishing characters.

Practical

External features of Grasshopper/Blister beetle, Methods of collection and preservation of insects including immature stages, Types of insect antennae, mouthparts, legs, wings, wing venation and wing coupling apparatus, Types of insect larvae and pupae, Dissection of digestive system in insects, Dissection of male and female reproductive systems in insects, Study on characters of orders orthoptera, Dictyoptera, odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Coleoptera, Diptera, Hymenoptera, Neuroptera, and their families of agricultural importance, Identification of major pests of crops.

Suggested Readings

1. Chapman RF. The Insects Structure and Function. Cambridge University Press, The Edinburgh Building Press, Cambridge CB2 @RU, UK.
2. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation

and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.

3. Dhaliwal GS, Singh R, and Jindal V.A .2013. Text book of Integrated Pest Management. Kalyani Publishers.
4. Gillott C. 2005. Entomology, Third Edition, Springer University of Saskatchenam- Saskatoon, Saskatchewam, Canada Springer. P.O. Box 17, 3300 AA Dordrecht, The Netherlands.
5. Kapoor VC.2019. Theory and Practice of Animal Taxonomy and Biodiversity. oxford and IBH Publishing 8th Edition.
6. Richard J. Elzinga.2003 Sixth Edition. Fundamentals of Entomology, Printice Hall of India, New Delhi.
7. South Wood TRE. Henderson PA.2000. Ecological Methods. Black Well Science.

Semester VI

Indian Traditional Knowledge 3 (2+1)

Objectives

1. To equip the students with importance of Indian Traditional Knowledge
2. To develop skill for integration of traditional practices for the benefit of farming community

Theory

Introduction and importance of Indian Traditional Knowledge in agriculture and allied sciences: Definition, Difference between Traditional Knowledge System and Western Science System, Protection of Traditional Knowledge, IPR and other provisions, Indian Traditional Knowledge in Agriculture covering Veterinary and Animal Husbandry, Pest and Disease Management, Grain/ Seed storage, Horticultural Crops, Crops and Cropping systems, Farm implements, Weather forecasting, Soil and water conservation, Soil fertility management, Rain water management, Tillage practices, Fisheries, Post-Harvest Technology, Garbage disposal and management, Wind erosion, Waste water management.

Practical

Case studies on validation of ITKs, Need to revive traditional technologies relevant to the contemporary agricultural scenario, Geographical indications of plant species involved in various ITK's (Pest and disease management, Grain/ Seed Storage, Veterinary and Animal Husbandry and Weather forecasting).

Suggested Readings

1. Cross-sectoral Validation of Indigenous Technical Knowledge in Agriculture Document 4. 2004. Published by ICAR, New Delhi. Pp 230.
2. Indigenous Technical Knowledge in Agriculture- Geographical Indications of Plant Species. Document 5. 2004. Published by ICAR, New Delhi. Pp 284.
3. Inventory of Indigenous Technical Knowledge in Agriculture. Document 1. 2002.Published by ICAR, New Delhi. Pp 411.

4. Inventory of Indigenous Technical Knowledge in Agriculture. Document 2. 2003. Published by ICAR, New Delhi. Pp 680.
5. Inventory of Indigenous Technical Knowledge in Agriculture. Document 1 (Supplement1). 2002. Published by ICAR, New Delhi. Pp 226.
6. Inventory of Indigenous Technical Knowledge in Agriculture. Document 1 (Supplement2). 2004. Published by ICAR, New Delhi. Pp 321.
7. Validation of Indigenous Technical Knowledge in Agriculture. Document 3. 2004.Published by ICAR, New Delhi. Pp 505 Details of the Course

Post-Harvest Management -II **3 (2+1)**

Objectives

1. To develop skills for primary and secondary processing, mechanical and biocontrol practices for storage pest management in cereals, pulses and oil seeds
2. To create awareness about natural preservation methods and hygiene and handling of fish and meat

Theory

Physico-chemical and nutritive properties of cereals, pulses and oilseeds, causes of post-harvest losses, traditional and modern storage structures, on farm and off farm storage, bulk and bag storage (especially eco/bio-based bags), Primary processing of cereals, pulses and oilseeds: Cleaning, grading, curing/tempering/conditioning, pretreatments including parboiling, Secondary processing: Drying, size reduction (milling), Oil seed milling: Ghanis, hydraulic presses, expellers, extrusion processing and different types of extruded products (snack, breakfast cereals and weaning foods), bakery and confectionary products, Traditional value-added products (regional products like nuggets/wadi/badi, papad, vermicelli/sevai, etc.), Storage Pest Management: Use of ITKs like oil treatment, ash treatment, bio- control practices for storage pest control of cereals, pulses and oilseeds, Primary processing operations in poultry: Pre-slaughter operations and slaughtering operations for poultry: stunning, icing, grading, blanching, washing, evisceration, beheading, scaling, cutting off fins and belly flaps, steaking, filleting, skinning, deboning (meat-bone separator), mincing of skinned fillets, peeling, deveining, shucking, knobbing, Preservation methods for fish: Preservation of meat and fish by canning, chilling, freezing, marination (pickling), curing, cooking and smoking, dehydration, and biological preservatives (fermentation), etc. Value- added products from fish and meat, Hygienic handling and storage of fish: chilling or icing, refrigeration, pest infestations in stored fishery products, natural means to control pests infestation, Food-grade coatings as processing aids, Integrated pest management.

Practical

Study of physico-chemical properties of cereals, pulses and oils seeds, Determination of gluten content in wheat flour, Study of conditioning of wheat, Milling of wheat and rice by laboratory mill, Study of pre-treatment and milling of pulses, Study of oil expression equipment, Manufacture of value- added products, millets, guar gum and other minor crops, Study of primary processing of fish or meat, Study of preservation methods for fish/meat, Preparation of traditional value-added products from fish/meat, Preservation of meat/fish by freezing, Preservation of meat/fish by curing

and pickling, Preservation of meat/fish by dehydration, Preparation of value-added poultry meat products, Quality evaluation and grading of eggs, Visit to processing facilities.

Suggested Readings

1. Alan H. Varnam and Jane P. Sutherland. 1995. Meat and Meat Products: Technology, Chemistry and Microbiology. Chapman and Hall, London.
2. Amalendu Chakraverty, Arun S. Mujumdar, G.S. Vijaya Raghavan and Hosahalli S. Ramaswamy. 2003. Handbook of Post-Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
3. B.D. Sharma. 1999. Meat and Meat Products Technology Including Poultry Products Technology. Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi.
4. Chakraverty, A.K., 2008. Post-Harvest Technology of Cereals, Pulses and Oilseeds, 3rd Ed. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
5. Cutting, C. L. 2002 Processing and Preservation of Fish. Agro Bios, New Delhi.
6. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.
7. Mishra, R. (2022). Handbook on Fish Processing and Preservation. Taylor and Francis.
8. N.L. Kent and A.D. Evers. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th Ed. Elsevier Science Ltd., Oxford, UK.
9. Sahay, K.M. and Singh, K.K. 2001. Unit Operations of Agricultural Processing, 2nd edn. Vikas Publishing House Pvt. Ltd., Noida.
10. Samuel A. Matz. 1991. The Chemistry and Technology of Cereals as Food and Feed, 2nd edn. Springer Science + Business Media, NY, USA.
11. William J. Stadelman and Owen J. Cotterill. 1995. Egg Science and Technology, 4th edn. Food Products Press, NY, USA.

Standards and Certification for Natural Farming 3 (2+1)

Objectives

1. To learn the natural farming standards and certification processes vis a vis other standards and certification in vogue.
2. To impart the methods of certification in natural farming based set of standard practices.
3. To understand the process of quality control of inputs and products in natural farming.

Theory

Scope and procedure of Natural Farming Certification System (NFCS), definitions, Crop production, habitat care, conversion, landscape, seeds and planting materials, diversity in crop production, inputs for soil and fertility management, Insect, pest and weed management, Contamination control, Transition / conversion Period and requirements for transition, Soil and water conservation, collection of non-cultivated material of plant origin forest produces, Livestock production, General requirements, Feed and fodder, Health care, Processing and handling, General

requirement: Ingredients, Processing Methods, Packaging, Labelling, *Processed Products,* Storage and Transport, Marketing, Practices for use in soil preparation, Soil enrichment, practices for seed treatment, pest and disease management, procedure to evaluate natural farming input, Ethical Aspects — Animal welfare and socio-economic aspects, practices to be followed for livestock reared in natural farm, International and national regulations on quality assurance and certification for non-chemical farming systems, ICT enabled certification process.

Practical

Visit to natural farm, formulation of natural farm plan, characterization of farm sources (Investigation) and filling up of application forms for certification, exposure of students with the team certification agency, group discussion on natural farm conversion period and standards requirements, quality assurance and labelling requirement for certification of farm under natural farming standards. Visit of certification agency and learning about management of records and inspections.

Suggested Reading

1. APEDA.2018. National Program for Organic Production- A Training Manual, Ministry of Commerce and Industry, GoI, New Delhi.
2. Natural Farming Standards and Certification, Bureau of Indian Standards, Government of India.

Aqua-based Natural Farming 3 (2+1)

Objectives

1. To acquaint students about natural farming and technologies pertaining to aquaculture and their relationship with farming activities
2. Basic understanding and knowledge on the overall view of the aquaculture sector, how to start aquaculture venture, opportunities and challenges

Theory

Physical, biological and components of aquatic ecosystem, Ecological structure and function of aquatic ecosystem, Organic matter recycling and nutrient cycles, Food web and food chain, Heterotrophic activities, Energy and matter flow in the ecosystem, Eutrophication and pollution. Definition and scope of aquaculture, Global and national scenario, Trends and constraints, Different aquaculture systems and utilization of natural food, pond, pen, enhanced fisheries, Pre- stocking, stocking and post-stocking interventions for primary fish survival and growth, Aquaculture and climate change, Natural productivity and carrying capacity, Secondary and tertiary production, Carrying capacity of aquaculture system and associated factors, Natural food and feeding behavior of fishes and shellfishes: Concept of ecosystem based aquaculture, Integration of crop, live- stock, horticulture and fish farming as complimentary activities, Comparative nutritional value and decomposition of different types of organic wastes on organic productivity, Nutrient values of common animal waste and agro residues as potential manures and biofertilizers, Definition of reservoirs in India: nature and extent of reservoirs, pen and cage culture in reservoir, Health management in aquaculture, Traditional techniques for curing fish diseases and pond management, Probiotics

and bioremediation, Renewable and eco-friendly bio- inputs in aquaculture, Management and conservation natural aquatic ecosystems.

Practical

Identification of important cultivable species, Estimation of carrying capacity, Practices on pre-stocking, Stocking and post stocking management, Growth studies in aquaculture system, Study on waste accumulation in aquaculture system (NH , Organic matter, CO_2), Analysis of certified manure/natural aquaculture inputs, Measurement of important soil and water quality parameters and their correction measures with certified standard materials/inputs, Preparation of artificial feeds using locally available permitted feed ingredients, Identification of different live food organisms and their rearing/culture with standard methods, Case studies on cage and pen culture.

Suggested Readings

1. Adhikari, S. and Chatterjee, D. K. (2008) Management of Tropical Freshwater Ponds. Daya Publishing House.
2. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to7, Indian Council of Agricultural Research, New Delhi
3. Fisheries: In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement1& 2); Document 3; Publ: ICAR New Delhi.
4. Khanna SS, and Singh HR (2014) A textbook on Fish Biology and Fisheries, Narendra Publishing House, New Delhi
5. Martin O (2016) Aquaculture: Farming Aquatic Animals, Latest Edition, Syrawood Publication, USAA
6. Pillay TVR and Kutty MN (2011) Aquaculture: Principles and Practices, Blackwell Publishing, UK
7. Veeranjaneyulu K, Krishnaveni G. and Veerabhadra Rao N (2016). Recent Technologies in Fish and Fisheries, RIGI Publication, Punjab, India
8. Zaman, A. Integrated farming system and agricultural sustainability. New India Publishing Agency- NIPA.

Marketing of Natural Farming Produce **3 (2+1)**

Objectives

1. To study about the specific concepts of marketing channels, price spread market segmentation and market margin
2. To develop skill on calculating market margin and farmers share in consumer's rupee in natural farming

Theory

Concepts and definition of market, Agricultural marketing, Marketing of natural farming products, Market structure, Marketing mix and market segmentation, Demand, supply and

producer's surplus of agricultural commodities marketable and marketed surplus, Pricing consideration and approaches cost based and competition based pricing, Market promotion and publicity, Marketing management-segmentation, Targeting and positioning, Marketing function-physical function, facilitating functions, Market functionaries and marketing channels, Marketing efficiency, Marketing costs, Market margin and price spread, Role of government in marketing of natural farming products, Public sector institutions – CWC, SWC, FCI,CACP, APEDA, Risks in marketing-types of risks involved speculation and hedging, Forward markets and Future markets.

Practical

Study of relationship between market arrival and prices, Demand and supply curves, Calculation of marketable and marketed surplus, Identification of market channels for selected commodities, Computation of market margin, Price spread, visit to marketing institutions to study their organization and functioning.

Suggested Readings

1. Acharya S.S. and Agarwal N.L. (1994). Agricultural Price Analysis and Policy, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Acharya, S.S. and Agarwal, N.L. (2000). Agricultural Marketing in India, Oxford and IBH Publishing Co. New Delhi.
3. Kahlon, A.S. and George, M.V. (1985). Agricultural Marketing and Price Policy, Allied Publication Pvt. Ltd. New Delhi.
4. Kohls, Richard L. and Uhl, Joseph, N. (1980). Marketing of Agricultural Products, Macmillan Publishing Co. Inc. New York.
5. Mamoria, C.B. and Joshi, R.L. (1971). Principles and Practices of Marketing in India, Kitabmahal, Prayagraj.
6. Meena G.L. Burak SS, Pant DC, and Sharma R. (2017). Fundamentals of Agribusiness Management, Agrotech Publishing Academy, Udaipur, ISBN: 978-81-8321-418-6. First Edition.

Agronomic Practices 2 (1+1)

Objectives

To acquaint students with management aspects of crops, weeds, water in natural farm fields

To develop skills among students in practicing crop husbandry based natural farming

Theory

Classification of crops, Field crops – Origin, distribution, economic importance, soil and climatic requirements, varieties, cropping systems: definition, principles and its importance, physical resources, soil and water management in cropping systems, Importance of mixed cropping in natural farming, multiple cropping, alley cropping, sequential cropping and intercropping, cropping system indices - mechanism of yield advantage in intercropping systems, Complementary and competition relations, multi-storied cropping and yield stability in intercropping, Types of crops - Trap, cover, catch and restorative crops, ITK related to crops

and cropping systems, Seeds- Traditional and recent varieties, classification of seeds, seed dormancy, nursery management, main field preparation, types of tillage, Seasons of India, Pre-monsoon sowing, Sowing techniques, Optimum time of sowing for different crops-ITK for seed treatment and seed selection, Methods of planting of crops,Time of planting of different crops and intercrops, Row spacing for different crops, Irrigation– Definition, irrigation types, water saving techniques and management, ITKs in irrigation and water management, Green manures and green leaf manures – Types of green manures, Ideal plant types for green manures, Nutrient content and biomass contribution, time and method of incorporation, decomposition pattern, Advantages and limitations, Weeds- Classification, habitat management of weeds, crop weed interaction, critical periods of weed competition, non-chemical weed management, weed mulch, trap crop, biological and herbal measures, Mulching – Types, cover crops – advantages and disadvantages, Soil moisture conservation approaches and water harvesting, ITKs on soil and water conservation. Alternate land use system – Definitions and types.

Practical

Identification of different growth stages in crops, manures and seeds, agriculture tools and implements, nursery and main field preparation, animal drawn, seed treatment and seed dormancy, methods of sowing, input requirement, water requirement and water use efficiency (WUE), weeds in wetland, irrigated up land, dryland system, low cost technology, indices for cropping systems, mulching practices, green manuring practices, alternate land use system, wind break and shelter belt, ITKs in crops and agronomic practices.

Suggested Readings

1. Chandsrasekaran B. and E. Somasundram (2018). A Text book of Agronomy, New Age International Publication, New Delhi.
2. Choudhary, S.L., G.S. Sharma and Y.L. Nene (eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the Summer School held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.
3. Crops and Cropping Systems/ Soil and Water Management/ Rain water management. In: Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1& 2); Document 3; Publ: ICAR, New Delhi.
4. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission Mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.
5. Dwivedi A. P. (2019). Agroforestry Principles and Practices, Oxford and IBH Publication.
6. Reddy S. R. (2020). Principles of Agronomy, Kalyani Publications. New Delhi.
7. Reddy T. Yellamanda and G. H. Shankara Reddy (2016). Principles of Agronomy, Kalyani Publications, New Delhi.
8. Somasundaram E. and M Mohamed Amanullah (2017). Agronomy: Principles and Practices, New India Publishing Agency, New Delhi.

Intellectual Property Rights **1 (1+0)**

Objectives

1. To acquaint the students about filing of patent, patent specification, patent claims, Patent opposition and revocation
2. To create awareness in the students about infringement, compulsory licensing, patent search and patent database

Theory

Introduction, importance and meaning of intellectual property, changing scenario of agriculture in India, brief introduction to GATT, WTO,TRIPs and WIPO, Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc.; Types of Intellectual Property and legislations covering IPR in India: Patents, Copyrights, Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets, Patents Act, 1970 and patent system in India, patentability, process and product patent, filing of patent, patent specification, patent claims, Patent opposition and revocation, infringement, Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database: Origin and history including a brief introduction to UPOV for protection of plant varieties, Protection of plant varieties under UPOV and PPV&FR Act of India, Plant Breeders rights, Registration of plant varieties under PPV&FR Act 2001, breeders, researchers and farmers rights, Traditional knowledge-Meaning and rights of TK holders. Convention on biological diversity, International treaty on plant genetic resources for food and agriculture (ITPGRFA), Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing. Understanding Intellectual Property Rights in ancient India.

Suggested Readings

1. Chawla H.S. 2020.Introduction to Intellectual Property Rights. Oxford and IBH Publ. pp312. 4. P.C. Sinha. 2007.
2. Encyclopedia of Intellectual Property Rights. Anmol Publications Pvt. Ltd.
3. Sridevan Prabha. 2015. Intellectual Property in the Ancient Indian Texts. In: Diversity in Intellectual Property.pp.232-246. Publ: Cambridge University Press.
4. Verma Deepak and Madhu Bala. 2020. National Intellectual Property Rights Policy of India - A Review. In: Sensitizing and Imparting Awareness about Intellectual Property Rights among Students (pp.125-132). Publisher: National Press Associates.

Principles of Agricultural Economics and Farm Management **2 (2+0)**

Objectives

1. To impart knowledge on judicious use of resources for optimum production
2. To impart knowledge about basic theories of demand, supply, production and exchange.

Theory

Economics: Meaning, scope and subject matter, definitions, activities, approaches to economic analysis: micro and macroeconomics, positive and normative analysis, Nature of economic theory: rationality assumption, concept of equilibrium, economic laws as generalization of human behavior,

Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare, Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development, Agricultural planning and development in the country, Demand: Meaning, law of demand, demand schedule and demand curve, determinants, utility theory; law of diminishing marginal utility, equi-marginal utility principle, Consumer's equilibrium and derivation of demand curve, concept of consumer surplus, Elasticity of demand: Concept and measurement of price elasticity, income elasticity and cross elasticity, Production: process, creation of utility, factors of production, input output relationship, Laws of returns: Law of variable proportions and law of returns to scale, Cost: Cost concepts, short run and long run cost curves, Supply: Stock v/s supply, law of supply, supply schedule, supply curve, determinants of supply, elasticity of supply, Distribution theory: meaning, factor market and pricing of factors of production, Concepts of rent, wage, interest and profit, National income: Meaning and importance, circular flow, concepts of national income accounting and approaches to measurement, difficulties in measurement, Population: Importance, Malthusian and Optimum population theories, natural and socio-economic determinants, current policies and program s on population control, Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification of money, money supply, general price index, inflation and deflation, Economic systems: Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning, Forms of business organizations, international trade and balance of payments, GST and its implication on Indian economy.

Suggested Readings:

1. Ahuja H.L. (2011). Principles of Microeconomics by. S. Chand and Company Ltd., New Delhi
2. Johl, S.S and T.R Kapur. (2009) Fundamentals of Farm Business Management. Kalyani Publishers, New Delhi
3. Meena G. L. (2022). Fundamentals of Agricultural Economics. Lucky Publishing House, Udaipur
4. Reddy S. Subha, P. Raghu Ram, T.V. Neelakanta and I. Bhvani Devi (2004) Agricultural Economics. Oxford and IBH publishing Co. Pvt. Ltd
5. Sharma L., Acharya S. K. and Somani S. S. (2015). Principles of Agricultural Economics. Agrotech Publishing House, Udaipur.

Semester VII

Community Mobilization for Natural Farming **2 (1+1)**

Objectives

1. To gain the knowledge about the fundamental concepts and principles of community mobilization, program planning and about groups
2. To develop an understanding of techniques and strategies for community mobilization in natural farming

Theory

Community mobilization – Meaning, historical background, types, strategies, steps, opportunities and challenges, Community mobilization process: community mobilization in

rural areas and different models, community entry, profiling, social mapping, Yoga for community mobilization - Purpose, concepts, importance, types, benefits; SWOT Analysis- Meaning, advantages and case study, Social core value systems - Ethical principles, purpose, benefits, Development of understanding about rural society, Behavioral change and attitude, Program planning - Introduction, need and interest, concept, objectives and principles, process, Organizational structure - Define, key elements, types, span of control, Centralization and decentralization, formalization. Diffusion and Adoption Process- Define, meaning and stages.

Group: Definition, types, stages of group formation, modes of group development, process for group formation - stages of SHG, FPO/FPC and FBO development, group decision making techniques, FPO - benefits, activities, implementing agencies to form and promote FPOs, procedure to form FPC and organizational structure, Conflict -Meaning, types, process, conflict resolution and management strategies.

Motivation: Definition, elements, individual and group needs, motivation process, Maslow's Hierarchy theory of needs and Adam's Equity theory, motivation cycle, classification of motives, types of motivation, techniques of motivation, role/importance/factors of motivation. Capacity building and institutionalizing mechanism, Counselling – Need, functions and types, Mentoring: Definition, process, philosophy and mentor-mentee relationship, Training - meaning, advantages, types and process, training methodologies for creating awareness about natural farming, Monitoring and Evaluation - Define, objectives, types, concept, difference, importance; Impact analysis on social, economic and environmental effects of natural farming.

Case studies on community mobilization in natural farming, Traditional and social media for promoting natural farming, Government schemes and role of public and private institutions in promoting community mobilization in natural farming.

Practical

Preparation of Community Resource Mapping in selected rural villages, Community needs assessment techniques – Participatory Rural Appraisal, Yoga, SWOT analysis, Organization involved in community mobilization, Program planning and organizing events, Formation and functioning of SHG, Establishment, organizational structure and promotion of FPO and FBO, Group decision making techniques - Conduct of focused group discussion, Conflict management techniques, Motivation – preparation of Maslow's hierarchy theory of needs assessment, Counselling and mentoring- conduct sessions among beneficiaries of natural farming community, Organizing, capacity building programs, Socio economic impact analysis on natural farming, Traditional and social media for promoting natural farming, Public and private institutions promoting community mobilization for natural farming.

Suggested Readings

1. Choudhary, S.L., G.S. Sharma and Y.L. Nene (2000). Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the Summer School held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.
2. Prasad R.R. Community Mobilization – Methods and Models. Discovery Publishing House Pvt. Ltd.

3. Rasheed Sulaiman. V, Onima. V.T, Nimisha Mittal, Athira. E (2019). Taking Stock and Shaping the Future: Conversations on Extension, AESA.
4. Sethuraman S P, Santakki BS, Sulaiman R, Saravanan V,R, Mittal N, 2017. Manual on Good Practices in Extension Research and Evaluation, AESA.

Water Management **2 (1+1)**

Objectives

1. To equip the students with the knowledge about the fundamental concepts and principles of water management
2. To develop an understanding of techniques and strategies for conserving water resources and improving water use efficiency both in rainfed and irrigated ecosystems

Theory

History of water management in ancient and medieval India, Rainfed and irrigated farming; Water management: Definition, scope and importance, Water resources: Use and over- utilization of surface and ground water, floods, drought, Dams-Benefits and problems, Region specific traditional water harvesting and management systems, Rainfed farming, Rainwater conservation technologies - In-situ and ex-situ storage, water harvesting and recycling, Rain water harvesting, Farm ponds, Ground water recharge, Contour and graded bunding, *Chalkhal*, Water budgeting, Irrigation water requirement, Micro irrigation: Sprinkler, Drip irrigation systems, pitcher irrigation system, maintenance of micro irrigation system, fertigation, advantages and limitations of fertigation, Watershed management - Concept, objectives, factors affecting and watershed planning, Reservoirs, Ground water harvesting and conservation (Tanka, Talai, Nadi, Nada, Talab, Khadin), Indian Traditional Knowledge in rain water management, soil and water conservation.

Practical

Measurement of soil moisture by different soil moisture measuring instruments, Measurement of irrigation water requirement, Determination of bulk density by field method, Determination of field capacity by field method, Determination of permanent wilting point, Case study on water budgeting, Study of different types of farm ponds, Estimation of farm pond storage capacity, Testing of irrigation water quality, EC, pH and TDS, Study of different components of sprinkler irrigation system, Study of different components of drip irrigation, Field visit to micro irrigation system, Maintenance of different components of micro irrigation systems, Survey of watershed resources, Field visit to watershed, Field visit to water harvesting structure.

Suggested Readings

1. Choudhary ML, Kadam US. 2006. Micro irrigation for Cash Crops, Westville Publishing House.
2. Jat, ML, Sharma SK, Balyan JK, Kothari A K and Jain LK. 2011. Rainfed Farming. Kalyani Publisher, Ludhiana. pp. 324.
3. Michael AM. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.
4. Michael AM and Ojha TP. 2014. Principles of Agricultural Engineering. Vol. II 5th edn. Jain Brothers Publication, New Delhi.

5. Mishra Anupam, 2021.Aaj Bhi Khara Hai Talab.
6. Murthy VVN. 2013. Land and Water Management Engineering. Kalyani Publishers, New Delhi.
7. Rajasthan Ki Rajat Bunde.
8. Sadhale Nalini. 2007. Water Harvesting and Conservation in Ancient Agricultural Texts. *In:* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri- History Foundation. pp.414-424.
9. Singh Harpal and Kavia ZD. 2007. Traditional Rainwater Harvesting Methods of Indian Thar Desert. *In:* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation.pp.432-440.
10. Singh, P.K. 2000. Watershed Management: Design and Practices. E-Media Publications, Udaipur.

Research Methodology and Ethics **2 (1+1)**

Objectives

1. To provide basic knowledge on research tools and techniques
2. To develop skills on on-farm research and ethics in general with specific reference to natural farming

Theory

Research Ethics: Introduction, Ethical ethos- Researcher's obligations and participant's rights, Research Ethics: Researcher-Participant, General Ethics, Ethical Issues in India, Ethics Committees. Experimental techniques: Research design, sampling, data collection, On-station experimentation, On-Farm experimentation, tabulation, Statistical tools and analysis, techniques for interpretation of data, Geo-referenced characterization: Questionnaire design principles, Questionnaire design for consumers of organic products, Questionnaire design for farmers and producers of organic products, Questionnaire design for processors/traders/exporters, Geo-spatial analysis and mapping of natural farms/ producers/traders/consumers.

Meta data analysis: Concepts, Niche area and crops for natural farming: Parameters for niche area and crop, Different scales of niche area, Tools and steps in niche area and crop identification, Parameterization and classification based on macro, regional and micro level.

Climate resilience of natural farming: Methodology for identification of climate resilient production systems, GHG's estimation using IPCC, GHG's measurement using instrumentation, Global warming potential, Energy and Carbon budgeting. Bio-chemical and molecular signature of natural produces, Commercial project formulation on natural farming: Internal rate of return, Pay Back period, B:C ratio, Net Present Value, Model project formulation for organic farming, Impact analysis tools and methods, Farming system model development: Practical synthesis of natural farming system model, Estimation of GHG emission from natural farm using IPCC tools, Identification of niche area and crops for a district or block, Identification of climate resilient production system using long term meteorological data, Commercial project formulation, Geo-spatial analysis using GIS platform, Comparative carbon and energy budgeting between organic and natural farms, Comparative food quality between natural and conventional produces by meta-analysis.

Suggested Readings

1. Kamat P.V. Research Ethics. Retrieved from https://www3.nd.edu/~pkamat/pdf/ ethics.pdf.
2. Parveen, Huma and Showkat, Nayeem. (2017). Research Ethics. https:// www. researchgate. net/publication

Weather Forecasting 3 (2+1)

Objectives

1. To provide the knowledge on different types of weather forecasting
2. To acquaint the importance of weather forecasting and its applications
3. To train the students on the ancient weather based agricultural practices

Theory

Ancient wisdom on weather forecasting: Rainfall prediction, analysis and forecast of winter monsoon based on ancient literature and simulated models, Rain forecasting in India Almanacs (Panchangs), Measurement of rainfall, Testing of traditional methods of weather forecast, Ancient astronomers, Indian Almanac (Nakshatras, Rashi, Months, Paksha, Seasons, Tithi, Var, Yog, Karn, Nadi,), Krishi Panchang, Effect of planets on weather, Ancients methods of weather forecast (Analytical methods, Observational methods). Principles of Astro- Meteorology, Rainfall predictions techniques (1) Parashara technique, (2) Varahamihira technique, (3) Predictions based on planets, (4) Bio-indicators, (5) Other ancient rainfall predictions, Sudden rainfall, Indications of famine, The method of ascertaining the type of cloud of the year, Folklore regarding weather forecasting (Ghagh and his wife Bhaddri), (6) ITKs with description and the practitioner for weather forecasting, Meaning and scope of agricultural meteorology, Earth atmosphere-Its composition, extent and structure, Atmospheric weather variables, Atmospheric pressure, its variation with height, Nature and properties of solar radiation, solar constant, depletion of solar radiation, shortwave, longwave and the normal radiation, net radiation, albedo, Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, Energy balance of earth, Atmospheric humidity, concept of saturation, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud, Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet and hail, cloud formation and classification, Artificial rain making. Wind: causes and types of wind, cyclone, anticyclone, land breeze and sea breeze, General circulation; Indian Monsoon - mechanism and importance in Indian agriculture, Weather forecasting - types of weather forecast and their uses, ITK in weather forecasting, Weather hazards- High winds, drought, floods, tornado, frost, tropical cyclones, thunderstorms, dust storm, lightning and hailstorms and extreme weather conditions such as heat-wave and cold-wave, Agriculture and weather relations, Modifications of crop microclimate, climatic normal for crop and livestock production, Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national agriculture, Types of climate models – GCM and RCM.

Practical

Visit of Agrometeorological Observatory, site selection, layout, exposure to instruments and data acquisition techniques, Study and use of different instruments for measuring air temperature, rainfall, Estimation of net short-wave radiation, net long wave radiation, total

global and net radiation, Measurement of albedo and sunshine duration, wind speed and direction, Measurement of evaporation rate using USWB Class A Open Pan Evaporimeter, Determination of relative humidity and vapour pressure, Study and use of Duvdevani Dew Gauge for measurement of Dew, Computation of climatic normal using historical weather data, Study of ancient methods of weather forecast, Preparation of Krishi Panchang, Testing local folklore for weather forecasting.

Suggested Readings

1. Balkundi HV. 2007. Measurement of Rainfall in Ancient India. *In:* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp.365-372.
2. Chandrasekaran, B., K. Annadurai and E. Somasundaram. 2010. A Textbook of Agronomy. New Age International (P) Limited Publishers. pp856.
3. Choudhary, S.L., G.S. Sharma and Y.L. Nene (eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the Summer School held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.
4. Inventory of Indigenous Technical Knowledge in Agriculture. Thematic area: Weather Forecasting. Document 1(2002); Document 2 (2003); Document 2- Supplement 1(2003); Document 2- Supplement 2(2004); Document 3 (2004); Document 4 (2004); Published by ICAR, New Delhi.
5. Kanani PR. 2007. Testing of Traditional Methods for Weather Forecast in Gujarat. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 373-388.
6. Mishra SK, Dubey VK and Pandey RC. 2007. Rain Forecasting in Indian Almanacs (Panchangs): A Case for Making Krishi – Panchang. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 354-364.
7. Murugan M, Miniraj N, Josephraj Kumar A, Pradeep K P and Yusuf L. 2007. Analysis and Forecast of Winter Monsoon Based on Pre-Vedic Literature and Simulated Model. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri- History Foundation. pp. 344-353.
8. Ram Niwas, Surinder Singh, Diwan Singh, M.L. Khichar and Raj Singh. 2006. A Text Book on Agricultural Meteorology. CSS HAU, Hisar.
9. Sharma BD. 2007. Ancient Indian Wisdom on Agriculture and Weather Forecasting. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 323-325.
10. Varshneya MC. 2007. Ancient and Recent Methods of Rainfall Prediction. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri- History Foundation. pp. 326-343.

Basic and Applied Agricultural Statistics **3 (2+1)**

Objectives

1. To provide an idea on Statistical concepts of both descriptive and inference Statistics
2. To impart knowledge about tests of significance, ANOVA and sampling theory

Theory

Introduction to Statistics and its applications in agriculture, Types of Data, Scales of measurements of Data, Summarization of Data, Classification of Data, Frequency Distribution, Methods of Classification, Definition of Grouped and Ungrouped Data, Definition of Class Interval (formula for determining the no. of class interval), Width of CI, Class Limits (Boundaries), Mid Points, Types of Frequency Distribution, Diagrammatic Presentation of Data, Bar Diagrams – Simple, Multiple, Sub-divided and Percentage Bar Diagrams, Pie-diagram, Graphical Presentation of Data – Histogram, Frequency Polygon and Ogives.

Measures of Central Tendency, Requisites for an Ideal Measure of Central Tendency, Different Types of Measure, Arithmetic Mean– Definition, Properties, Merits, Demerits and Uses, A.M. (examples) for Grouped and Ungrouped Data, Step-deviation Method, Weighted Mean, Definition of Geometric Mean and Harmonic Mean, Relationship between A.M., G.M. and H.M. Median- Definition, Merits, Demerits and Uses, Graphical Location of Median, Mode- Definition, Merits, Demerits and Uses, Graphical Location of Mode, Relationship between Mean, Median and Mode, Measures of Dispersion, Characteristics for an Ideal Measure of Dispersion, Different Types of Measures of Dispersions, Definition of Range, Interquartile Range, Quartile Deviation and Mean Deviation, Standard Deviation- Definition, Properties, S.D. and Variance for Grouped and Ungrouped Data, Variance of Combined Series, Coefficients of Dispersions. Co-efficient of Variation, Measures of Skewness and Kurtosis: Definition of Symmetrical Distribution, Definition of Skewness, Measures of Skewness, Definition of Kurtosis, Measure of Kurtosis, Relationship between Mean, Median and Mode for Symmetrical and Skewed Distribution.

Probability Theory and Normal Distribution, Introduction to Probability, Basic Terminologies, Classical Probability- Definition and Limitations, Empirical Probability- Definition and Limitations, Axiomatic Probability, Addition and Multiplication Theorem (without proof), Conditional Probability, Independent Events, Simple Problems based on Probability, Definition of Random Variable, Discrete and Continuous Random Variable, Normal Distribution- Definition, Prob. Distribution, Mean and Variance, Assumptions of Normal Distribution, Normal Probability Curve.

Correlation and Regression, Definition of Correlation, Scatter Diagram, Karl Pearson's Coefficient of Correlation, Types of Correlation Coefficient, Properties of Correlation Coefficient, Definition of Linear Regression, Regression Equations, Regression Coefficients, Properties of Regression Coefficients.

Tests of Significance, Definition, Null and Alternative Hypothesis, Type I and Type II Error, Critical Region and Level of Significance, One Tailed and Two Tailed Tests, Test Statistic, One Sample, Two Sample and Paired t-test with Examples. F-test for Variance.

ANOVA and Experimental Designs, Definition of ANOVA, Assignable and Non assignable Factors, Analysis of One-way Classified Data, Basic Examples of Experimental Designs, Terminologies, Completely Randomized Design (CRD).

Sampling Theory, Introduction, Definition of Population, Sample, Parameter and Statistic, Sampling Vs Complete Enumeration, Sampling Methods, Simple Random Sampling with Replacement and without Replacement, Use of Random Number Table.

Practical

Diagrammatic and Graphical representation of data, Calculation of A.M., Median and Mode (Ungrouped and Grouped data), Calculation of S.D. and C.V. (Ungrouped and Grouped data), Correlation and Regression analysis, Application of t-test (one sample, two sample independent and dependent), Analysis of variance one way classification, CRD, Selection of random sample using simple random sampling.

Suggested Readings

1. Agricultural Statistics by S.P. Singh and R.P.S. Verma, Rama Publishing House.
2. Agriculture and Applied Statistics-I by P.K. Sahu, Kalyani Publishers.
3. Agriculture and Applied Statistics-II by P. K. Sahu and A. K. Das, Kalyani Publishes.
4. Basic Statistics by B. L. Agarwal, New Age International Publishers.
5. Fundamentals of Applied Statistics by S.C. Gupta and V. K. Kapoor, Sultan Chand and Sons.
6. Fundamentals of Statistics by D. N. Elhance, Kitab Mahal Publishers.

Semester VIII

S. No.	Course Title	Credit Load
1.	For students opting for 4-year B. Sc. Ag. (Hons.) Natural Farming degree Based on the theme of Student READY Program, students may be allotted Experiential Learning/Hands on Training/Skill development/ RAWE/ Industrial attachment/IPT/ student project and Internship depending upon the resources and priorities. RAWE Experiential Learning IPT/Industrial Attachment Student Project/Internship	20 Credits (Minimum 20 weeks) 8 6 4 2

For B.Sc. Ag. (Hons.) Natural Farming

- Project work: Student Project will be either R&D based, field study based (RAWE) or entrepreneurship based (incubation/experiential learning). The project work will be of above mentioned credits (Minimum 20 weeks) during which they will be attached to projects to learn, field experience, laboratory and field research or incubation centres or experiential learning units for developing viable projects.
- Internship work: The students will be attached to industry/ research institute/ commercial farm/ NGO/ agribusiness entrepreneur for 10 weeks with 10 credits to complete internship work and to learn entrepreneurship skills.
- Each student will submit individual report for both project work and internship work which will be evaluated and given grades.

ELECTIVE COURSES

S. No.	Course Number	Title
1.	Ag Econ (E) 413	Agri-Business Management
2.	Agron (E) 413	Management of Natural Resources

S. No.	Course Number	Title
3.	EE (E) 413	Agricultural Journalism
4.	Hort (EA) 323	Landscaping
5.	GPB (E) 413	Commercial Plant Breeding
6.	Hort (EB) 323	Food Safety and Standards
7.	PP (EA) 322	Bio Formulation and Nano formulation
8.	PP (EB) 413	Biopesticides and Biofertilizers
9.	Ag Met (EA) 413	System Simulation and Agro-advisory
10.	Hort (EC) 413	Hi-tech Horticulture
11.	Hort (ED) 413	Protected Cultivation
12.	Ag Met (EB) 413	Climate Resilient Agriculture
13.	ABT(E) 413	Biotechnology of Crop Improvement
14.	Soil (E) 412	Geoinformatics and Remote Sensing, Precision Farming
15.	Hort (EE) 413	Micro-propagation Technologies
16.	SST-413	Commercial Seed Production

- More electives to be included by the universities / institutions, based on the facilities available, such as nano formulations, drones use in agriculture etc

Agri-Business Management **3 (2+1)**

Objective

To impart knowledge on understanding the concepts processes, significance and role of management and organizational behavior

Theory

Transformation of agriculture into agribusiness, various stakeholders and components of agribusiness systems, Importance of agribusiness in the Indian economy and New Undergraduate Degree Program in Natural Farming

Agricultural Policy, Distinctive features of Agribusiness Management: Importance and needs of agro-based industries, Classification of industries and types of agro-based industries, Institutional arrangement, procedures to set up agro-based industries, Constraints in establishing agro-based industries, Agri-value chain: Understanding primary and support activities and their linkages, Business environment: PEST and SWOT analysis, Management functions: Roles and activities, Organization culture, Planning, meaning, definition, types of plans, Purpose or mission, goals or objectives, strategies, polices procedures, rules, programs and budget, Components of a business plan, Steps in planning and implementation, Organization staffing, directing and motivation, Ordering, leading, supervision, communications, control, Capital management and Financial management of Agribusiness, Financial statements and their importance, Marketing Management: Segmentation, targeting and positioning, Marketing mix and marketing strategies, Consumer behavior analysis, Product Life Cycle (PLC), Sales and Distribution management, Pricing policy, various pricing methods, Project management: Definition, project cycle, identification, formulation, appraisal, implementation, monitoring and evaluation, Project appraisal and evaluation techniques.

Practical

Study of agri–input markets: Seed, fertilizers pesticides, Study of output markets: grains, fruits, vegetables, flowers, Study of product market, retails trade commodity trading, and value added products, Study of financing institutions- Cooperative, Commercial Bank, RRBs, Agribusiness Finance Limited, NABARD, Preparations of projects and Feasibility reports for agribusiness entrepreneur, Appraisal/ evaluation techniques of identifying viable project- Non-discounting techniques, Case study of agro- based industries, Trend and growth rate of price of agricultural commodities, Net present worth technique for selection of viable project, Internal rate of return,

Suggested Readings

1. Bairwa SL, 2016. Objective on Fundamentals of Agri-business Management. Kalyani Publishers.
2. Broadway AC, Broadway Arif A, 2002. A Textbook of Agri-Business Management. Kalyani Publishers.

Management of Natural Resources 3 (2+1)

Objective

1. To enlighten students about available natural resources and their relationship with crop production
2. To impart the knowledge of principles and practices of natural resource management

Theory

Introduction to Natural Resource Bases: Concept of resource, classification of natural resources, Factors influencing resource availability, distribution and uses, Interrelationships among different types of natural resources, Concern on productivity issues, Ecological, social and economic dimension of resource management, Land resources: Land as a resource, Dry land, land use classification, land degradation, man induced landslides, soil erosion and desertification, Landscape impact analysis, wetland ecology and management, Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems, Water ecology and management, Energy resources: Growing energy needs, renewable and non- renewable energy sources, use of alternate energy sources, Resource Management Paradigms: Resource management the evolution and history of resource management paradigms, Resource conflicts: Resource extraction, access and control system, Approaches in Resource Management: Ecological approach; economic approach; ethnological approach; implications of the approaches: integrated resource management strategies, Introduction to soil and water conservation and causes of soil erosion, Definition and agents of soil erosion, Water erosion: Forms of water erosion, gully classification and control measures, Soil loss estimation by universal soil loss equation: Soil loss measurement techniques. Principles of erosion control: Introduction to contouring, strip cropping, Contour bund: Graded bund and bench terracing, Wind erosion: Mechanics of wind erosion, types of soil movement, Principles of wind erosion control and its control measures, Water harvesting techniques: Lining of ponds, tanks and canal systems.

Practical

Identifying natural resources and their utility, Practicing survey: Principles and educating to use pacing technique for measurement, Area calculations through chain survey: GPS demo for tracking and area measurement, Estimation of soil loss and calculation of erosion index, Leveling concepts

and practical utility in agriculture, Preparation of contour maps, Concept of vegetative water ways and design of grassed water ways, Wind erosion and estimation process, Different irrigation pumps and their constructional differences, Farm pond construction and its design aspects, Visit to nearby farm pond, Visit to an erosion site, Exposure to strip cropping/contour bunding.

Suggested Readings

1. Management of Natural Resource for Sustainable Development by Vijay Singh Rathore and B S Rathor, Daya Publishing House.
2. Sustainable Natural Resource Management by Danill R. Lynch.

Agricultural Journalism 3 (2+1)

Objective

To acquaint the qualities and role of journalist /journalism in agricultural development and development of media

Theory

Journalism – Meaning, nature, importance and types of journalism, Agricultural Journalism – Meaning, definition, principle, objectives, types, and scope, Similarities and difference between agricultural journalism and other types of journalism, Role of agricultural journalist, Training of agricultural journalist, Qualities of journalist, Role of journalist /journalism in agricultural development and development of newspaper and magazines readers, Newspaper and magazines as communication media: Characteristics, kinds and functions of newspaper and magazines, Characteristics of newspaper and magazines readers, Form, content, style and language of newspaper and magazines, Standard part of newspaper and magazines, The agricultural story: Types of agriculture stories, subject matter of the agricultural story, structure of the agricultural story, Gathering farm information - Sources of farm information: abstracting from research and scientific materials, interviews, coverage of events, other sources: electronic media, field study. Success stories-definition, nature, components, guidelines of writing a success story, Writing a news story difference between news and feature story, the principle of writing a news story, Inverted pyramid structure, Organizing the material, treatment of the story, writing the news lead and the body Readability measure-readability ease score, automated readability index, gunning fog index, How to improve readability of articles and stories, Use of photograph in agricultural journalism- Basic principles of photography – composition, exposure, lens, light Use of artwork (Graphs, charts maps, etc), Writing the captions, Editorial mechanism: Copy reading, headline and title writing Proof reading: definition, signs and symbols of proofreading, level of proofreading, duties of a proof-reader, Layout– Meaning, principles of layout and design.

Practical

Practice in writing an agricultural news story, Practice in writing an agricultural feature story, Covering agricultural events for the information collection, Practice in interviewing for the information collection, Abstracting stories from research and scientific materials and wire services, Selecting pictures and artwork for the agricultural story, Practice in editing, copy reading, Practice in headline and title writing, Practicing proof reading,, Practice in lay outing of newspaper, Testing copy with a readability formula, Visit a publishing office.

Suggested Readings

1. Agricultural Extension and Farm Journalism, book by A K Singh,
2. Basic Journalism, Book by Rangaswami Parthasarathy
3. Farm Journalism – Jana and Mitra.
4. Farm Journalism and Media Management – Bhaskaran et al,
5. Introduction to Journalism, Book by Carole Fleming, Emma Hemmingway, and Gillian Moore
6. News Reporting and Editing, Book by K. M. Shrivastava
7. Prepared You Tube videos.
8. Professional Journalism, Book by MV Kamath
9. The Journalist's Handbook, Book by MV Kamath.
10. Web Materials

Landscaping **3 (2+1)**

Objectives

1. To educate the students on designing different styles and types of gardens
2. To enable the students to identify different ornamental plants and their utilization in landscaping design
3. To enable students to design landscapes in softwares like AUTOCAD, ARCHCADE etc.

Theory

Importance and scope of landscaping, Principles of landscaping, garden styles and types terrace gardening, vertical gardening, garden components, adornments, lawn making, rockery water garden, walk-paths, bridges, other constructed features etc. gardens for special purposes, Trees: Selection, propagation, planting schemes, canopy management, shrubs and herbaceous perennials: selection, propagation, planting schemes, architecture, Climber and creepers importance, selection, propagation, planting, Annuals: selection, propagation, planting scheme, Other garden plants: palms, ferns, grasses and cacti succulents, Pot plants: selection, arrangement, management, Bio-aesthetic planning: Definition, need, planning; landscaping of urban and rural areas, Peri-urban landscaping, Landscaping of schools, public places like bus station, railway station, townships, river banks, hospitals, play grounds, airports, industries, institutions, Bonsai principles and management, Lawn: establishment and maintenance. CAD application.

Practical

Identification of trees, shrubs, annuals, pot plants; Propagation of trees, shrubs and annuals, care and maintenance of plants, potting and repotting, identification of tools and implements used in landscape design, training and pruning of plants for special effects, lawn establishment and maintenance, layout of formal gardens, informal gardens, special type of gardens (sunken garden, terrace garden, rock garden) and designing of conservatory and lathe house. Use of computer software, visit to important gardens /parks /institutes.