Academic Programme

4 Years B.Sc. (Hons.) Natural Farming

Eligibility Criteria: The minimum eligibility requirement for admission in undergraduate programme on Natural Farming will be the same as in case of B.Sc.(Hons.) Agriculture and allied subject

Semester Wise Course Distribution

Course Number	Course Title	Credit Hours
First Year		
Semester I		
FCC-111	**Vidyarambh**[#]	CNC
NF-111	Indian Heritage of Natural Farming	3(2+1)
NF-112	Principles and Practices of Natural Farming	4(2+2)
NF-113	Bhumi Suposhan (Soil Nutrition)	3(2+1)
NF-114	Biodiversity Conservation	3(2+1)
AGRON 113	Farming based Livelihood System	3(2+1)
SEC-I	Skill Enhancement Course	2(0+2)
SEC-II	Skill Enhancement Course	2(0+2)
	National Services Scheme/NCC/NSO	1(0+1)
	Physical Education, First Aid and Yoga Practice[#]	CNC
	Total	**21(10+11)**
Semester II		
NF-121	Cow- based Natural Farming	3(1+2)
NF-122	Soil Biology in Natural Farming	3(2+1)
NF-123	Integration of Horticulture Crops under Natural Farming	2(1+1)
NF-124	Insect Ecology, Nematodes and Pest Management	3(2+1)
EE- 122 (A)	Introductory English, Communication Skills and Personality Development	2(1+1)
Ag Met- 123	Environmental Studies and Disaster Management	3(2+1)
SEC-III	Skill Enhancement Course	2(0+2)
SEC-IV	Skill Enhancement Course	2(0+2)
	National Services Scheme/NCC/NSO	1(0+1)
	Total	**21(9+12)**
Second Year		
Semester III		
NF-211	Crop Management in Natural farming	3(2+1)
NF-212	Production of Bio-inputs	2(1+1)
NF-213	Farm Power and Machinery	3(1+2)
NF-214	Livestock and Poultry Production	3(2+1)
NF-215	Management of Plant Diseases	2(1+1)

Course Number	Course Title	Credit Hours
Ag. Stat-213	Agri- Informatics and Database Management	3(2+1)
SEC-V	Skill Enhancement Course	2(0+2)
SEC-VI	Skill Enhancement Course	2(0+2)
	Total	**20(9+11)**
Semester IV		
NF-221	Elements, Characteristics and Design of Natural Farming Systems	3(2+1)
NF-222	Improvement of Traditional and Under-utilized Crops	3(2+1)
NF-223	Agro-Ecosystem Analysis for Natural Farming	2(1+1)
NF-224	Beneficial Insects	3(2+1)
NF-225	Quantification and Valuation of Ecosystem Services	3(2+1)
EE -222	Entrepreneurship Development and Business Communication	3(2+1)
SEC-VII	Skill Enhancement Course	2(0+2)
SEC-VIII	Skill Enhancement Course	2(0+2)
	Seminar-I	1(0+1)
	Total	**22(11+11)**
Third Year		
Semester V		
NF-311	Post-Harvest Management –I	3(2+1)
NF-312	Bio- resources and Agricultural Waste Management	3(2+1)
NF-313	Medicinal and Aromatic Plants	2(1+1)
NF-314	Seed Production Technology	3(2+1)
NF-315	Value Chain Management in Natural Farming	2(1+1)
NF-316	Renewable Energy Sources	2(1+1)
NF-317	Natural Farming and Human Health	2(1+1)
ENTO	Fundamentals of Entomology	3(2+1)
	Educational Tour	CNC
	Total	**20(12+8)**
Semester VI		
NF-321	Indian Traditional Knowledge	3(2+1)
NF-322	Post-harvest Management-II	3(2+1)
NF-323	Standards and Certification for Natural Farming	2(2+0)
NF-324	Aqua-based Natural Farming	3(2+1)
NF-325	Marketing of Natural Farming Produce	3(2+1)
NF-326	Agronomic Practices	2(1+1)
Ag IPR-	Intellectual Property Rights	1(1+0)

Course Number	Course Title	Credit Hours
ECON	Principles of Agricultural Economics and Farm Management	2(2+0)
	Seminar-II (Case studies)	1(0+1)
	Total	**20(14+6)**
Fourth Year		
Semester VII		
NF-411	Community Mobilization for Natural Farming	2(1+1)
NF-412	Water Management	2(1+1)
NF-413	Research Methodology and Ethics	2(1+1)
NF-414	Weather Forecasting	3(2+1)
STAT	Basic and Applied Agricultural Statistics	3(2+1)
	Elective Course-I	3(2+1)
	Elective Course-II	3(2+1)
	Elective Course-III	3(2+1)
	Total	**21(13+8)**
Semester VIII		
Project Work/Experiential Learning/Internship	**For Student opting for 4 Year B.Sc. (Hons.) Natural Farmar Degree** Student READY (RAWE/Industrial Attachment/Experiential Learning/Hands on Training/Project Work)/ Internship **For Student opting for 4 Year B.Sc. Natural Farming (Research)** Research work	20 credits (Minimum 20 weeks) 20 credits
	Total	**20(0+20)**

Vidyaramh: At the start of 1st Semester, there will be a three weeks Foundation Course (FC) with 0+4 credits (Non-gradial), common to all the students

* Educational (Study) Tour: It will be compulsory non-gradial of 2 credit for 10-12 days during after 5th semester.

CNC – Compulsory Non-Credit Course.

Summary of credit distributions among different categories of courses

Semester	Total Credits	Skill Enhancement Courses	Basic Courses (Major, Minor)	Common Course	NCC/NSS/ NSO/ Seminar/ Education Tour	Student READY/ Internship	Elective Courses	Online Course
1st Semester	21+ FC*	4	13 Theory+ practical	#3 Farming based livelihood systems	1	-	-	20 credits Student plans and executes
2nd Semester	21	4	11 Theory + practical	#2+3 Introductory English, Communication skills & personality development (2 credits) Environmental Studies and Disaster management (3 credits)	1	**10 credits (10 weeks)	-	-
3rd Semester	20	4	13 Theory+ practical	#3 Agri informatics and database management	-	-	-	-
4th Semester	22	4	14	#3 Entrepreneurship Development and Business Management	1 Seminar	**10 credits (2 months extra time period after second year)	-	

Semester	Total Credits	Skill Enhancement Courses	Basic Courses (Major, Minor)	Common Course	NCC/NSS/ NSO/ Seminar/ Education Tour	Student READY/ Internship	Elective Courses	Online Course
5th Semester	20	-	20		2 credits Educational tour (NCC)	-	-	
6th Semester	20	-	18	#1 (Intellectual Property Rights (1 Credit)	1 Seminar	-	-	
7th Semester	21	-	21	-	-	-	credits: Student may selectthree courses each of 3 credits from a basket of elective courses	
8th Semester	20	-	-		-	20		
All semesters	**165+20**	**16**	**101**	**15**	**4**	**20**	**9**	**20**

- Vidhyarambh FC* = **Foundation Course**; At the start of 1st semester, there will be a **three weeks** non-gradial foundation course, common to all students entering certificate course of all degree programs.
- # Common courses
- **Internship**** of 10 weeks with 10 credits, after the course works of 2nd and 4th semesters. These Internships will be done by the student after completion of the respective semester and before award of the certificate/ diploma in additional period of 2 weeks.
- A student will make his own planning and execution of online courses with intimation to the Dean.
- Education (Study) Tour: Compulsory non-credit course for 10-12 days.(why mention credits ??)

ABSTRACT

Core courses	:	101 credits
Skill Enhancement courses	:	16 credits
Common courses	:	15 credits
NCC/NSS/ Yoga/Educational Tour/Seminar	:	4 credits
Elective courses	:	9 credits
Project work and Internship work	:	20 credits
MOOC courses (non-gradial)	:	20 credits
Grand Total	:	**185 credits**

Abstract of Credit Hours

Semester	Credit hours	Contact hours
1st Semester	10+11=21	32
2nd Semester	9+12=21	33
3rd Semester	9+11=20	31
4th Semester	11+11=22	33
5th Semester	12+8=20	28
6th Semester	14+6=20	26
7th Semester	13+8=21	29
8th Semester	0+20=20	40
Total Credit hours	**78+87=165**	**252**
*Online MOOC courses (Non-Gradial)	20*	Choice based
Grand Total	**165+20*=185**	

Break Up of Category of Courses

Year	Semester	Credits	Breakup of categories of courses				
			Core courses (Major/ Minor/ Common)	Skill Enhancement Courses/ Elective courses**	NSS/ NCC/Yoga/Seminar/ Physical Education	Internship and Project work	#Online course (MOOC)
I	1st	21	16	**4	1	-	Flexibility/ choice in selecting courses and completing in whole duration of the degree Program
	2nd	21	16	4	1	-	
II	3rd	20	16	4	-	-	
	4th	22	17	4	1		
III	5th	20	20	-	-		
	6th	20	19	-	1		
IV	7th	21	12	9	-		
	8th	20*	-	-	-	20	
	TOTAL	**165**	**116**	**25**	**4**	**20**	**20# (Non-Gradial)**
	Grand Total	**165+20#=185**					

Student will take in online mode with approval from Dean/Competent Authority.

* Student READY/Internship of 20 credits in 8th Semester

** In Natural Farming discipline, the skill component need to be strengthened

Natural Farming is a multi-disciplinary subject and have perfect amalgamation of many disciplines. Hence, choice of skill based & Elective courses will be offered to student from basket of Skill Enhancement Course modules to develop required skill competency in both first year and second year for UG Certificate in Natural Farming or Student READY/ Diploma in Natural Farming at the first exit or second exit respectively.

List of Basic Supporting Courses

S. No.	Course Tittle	Credit Hours
1.	Vidyarambh (Foundation Course) Physical Education, First Aid and Yoga Practice	CNC(0+4) CNC(0+1)
2.	NCC/NSS/NSO/Yoga/Educational Tour/Seminar (Offered in first IV semesters)	2(0+2)
3.	Farming Based Livelihood Systems	3(2+1)
4.	Agri- Informatics and Data base management	(2+1)
5.	Environmental Studies and Disaster Management	3(2+1)
6.	Entrepreneurship Development and Business Communication	3(2+1)
7.	Research methodology and Ethics	2(1+1)
8.	Intellectual Property Rights	1(1+0)

List of Courses with Credits as per Categories

B.Sc. (Hons.) Natural Farming

Course Category	Course Title	Credit Hours
Foundation course	Vidyarambh (3 weeks)	0+4 (NC)
Common courses	Farming based Livelihood System	3(2+1)
	Introductory English, Communication Skills and Personality Development	2(1+1)
	Environmental Studies and Disaster Management	3(2+1)
	Agri- Informatics and Database Management	3(2+1)
	Entrepreneurship Development and Business Communication	3(2+1)
	Intellectual Property Rights	1(1+0)
	Total credits	**15(10+5)**
Core courses	Indian Heritage of Natural Farming	3(2+1)
	Principles and Practices of Natural Farming	4(2+2)
	Bhumi Suposhan (Soil Nutrition)	3(2+1)
	Biodiversity and Conservation	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)

Course Category	Course Title	Credit Hours
Core courses	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)
	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)
	Indian Traditional Knowledge	3(2+1)
	Post-harvest Management-II	3(2+1)
	Standards and Certification for Natural Farming	2(2+0)
	Aqua-based Natural Farming	3(2+1)
	Marketing of Natural Farming Produce	3(2+1)
	Agronomic Practices	2(1+1)
	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)
	Fundamentals of Entomology	3(2+1)
	Principles of Agricultural Economics and Farm Management	2(2+0)
	Basic and Applied Agricultural Statistics	3(2+1)
	Total credits	**101 (62+39)**
Elective courses	Elective Course-I	3(2+1)
	Elective Course-II	3(2+1)
	Elective Course-III	3(2+1)
	Total credits	**9 (6+3)**
	Skill Enhancement Course I	2(0+2)

Course Category	Course Title	Credit Hours
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)
	Skill Enhancement Course VII	2(0+2)
	Skill Enhancement Course VIII	2(0+2)
	Total credits	**16 (0+16)**
Project Work/ Internship	Student READY (RAWE/Industrial Attachment/Experiential Learning/Hand on Training/Project Work)/ Internship	20 (0+20)
	Experiential Learning	8
	RAWE	6
	IPT/Industrial Attachment	4
	Student Project	2
	Total credits	**20 (0+20)**
Other courses	NSS/NCC/NSO/Phy Edn./ Yoga - I	1 (0+1)
	NSS/NCC/NSO/Phy Edn./ Yoga - II	1 (0+1)
	Educational Tour	NG
	Seminar-I	1 (0+1)
	Seminar-II (Case studies)	1 (0+1)
	Total credits	**6 (0+6)**
	Total for offline courses	**165 (78+87)**
On-line courses	Online course	20 (0+20)
	Total for online courses	**20 (0+20)**
	GRAND TOTAL	**185 (78+107)**

***NG - Non-Gradial**

Details of the Course

SEMESTER-I

S. No.	Course Title	Course No.	Credit load
1.	Vidyarambh	FCC-111	CNC
2.	Skill Enhancement Course	-	2(0+2)
3.	Skill Enhancement Course	-	2(0+2)
4.	Indian Heritage of Natural Farming	NF 111	3(2+1)
5.	Natural Farming: Principles and Practices	NF 112	3(2+1)
6.	Soil Nutrition (Bhumi Suposhan)	NF 116	2(1+1)
7.	Biodiversity Conservation	NF 117	3(2+1)
8.	Farming based Livelihood System	AGRON 113A	3(2+1)
9.	National Services Scheme/NCC/NSO	FCC-111(B)	1(0+1)
10.	#Physical Education, First Aid and Yoga Practice		CNC
	Total		**20 (9+11)**

* Course work credit requirements of I and II semesters

** Internship extra 2 months for those students who wish to exit after one year and get eligible for Certificate

CNC-Compulsory Non-credit Course

*** From Basket of Skill Development course modules available

Semester I

Course Title : Vidyarambh
Course Code : FC-111
Credit Hours : CNC 4(0+4)

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 & 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 student's 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

Course Title: Indian Heritage of Natural Farming
Course Code : NF-111
Credits Hours: 3(2+1)

General objective: To acquaint the students about the ancient *Vedic* Krishi, Indian heritage, principle and importance of natural farming.

Specific objectives:

i) To impart knowledge on the heritage of natural farming in ancient India and various techniques of *Vedic Krishi.*

ii) To develop skills on *Vedic Krishi* practices for practicing natural farming.

Theory

The heritage of natural farming, pPioneers 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 onimportant 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* (15^{th} 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 other indigenous liquid concoctions.

Practicals

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.

Learning Outcomes

1. Awareness and ease in adoption of natural farming
2. Competent human resource in Indian heritage with skills
3. Scientific basis of evaluation of benefits of Indian heritage in natural farming

Teaching Methods/Activities

- Lectures
- Assignment (writing/ reading)
- Students' presentation

- Group activities
- Hands on experience

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 Versus) 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. 2012A. Potential of some methods described in Vrikshayurveda in crop yield increase and disease management. *Asian Agri-History* **1**: 45-54p.
15. Nene YL. 2012B. 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. 2004a. Herbal kunapa. Asian Agri-History **8**:315–17.
18. Sreenivasa, AV. 2004b. 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

Lecture Schedule

Theory

Topic	No. of Classes
The Indian heritage of natural farming in India	1
Pioneers and scholars of natural farming and their contribution	1
Ancient Indian Methods of livestock management, health and nutrition	1
Ancient Indian Methods of management of soil fertility	1
Ancient Indian Methods of management of plant protection	1
Inventory of Indigenous Technical Knowledge (ITK) in agriculture	1
Description on ancient methods of rainfall prediction and seed sowing strategy	1
Ancient Indian methods about seed collection, storage, removal of weed seeds and seed uniformity	1
Knowledge demonstrated by Krishi-Parashar and Sitadhyaksha: chapter in Kautilya Arthashastra (Acharya Kautilya -321 BC)	1
Knowledge demonstrated by Kashyapiya Krishi Sukti (Sage Kashyap-c.800 CE) and Vrikshayurveda (by Vaidya Surapala),	1
Knowledge demonstrated by Upavanavinod (Nalini, 2011) and Vishwavallabha (Chakrapani Mishra -1577 CE)	1

Topic	No. of Classes
Knowledge demonstrated by Brihat Samhita (Varahamihi-600 AD) and Lokopakara (1000-year-old manuscript)	1
Knowledge demonstrated by Nuskha Dar Fanni-Falahat -The Art of Agriculture (Prince Dara Shikoh)	1
Knowledge demonstrated by Krishi Gita -Agricultural Versus (15^{th} century by Vidwan C Govinda Warrior)	1
Measurement of wealth on natural resources through '*Gau-dhan*' *'Ashwa-dhan*' '*Gaj-dhan*'	1
Concept of the most important wealth 'Dhanya' or rice/crops	1
Mode of the transactions in the society through '*dhanya*'	1
Concept of the Rishi Krishi, Panchgavya Krishi, Natural Ecological Farming (Natueco farming), Homa Farming and Biodynamic agriculture	1
Tradition of natural farming propounded by Dr. YL Nene (Asian Agri History Foundation)	1
Tradition of natural farming propounded by Narayana Reddy and Broad tradition of natural farming propounded by Shripad Dabholkar	1
Tradition of natural farming propounded by G Nammalvar, and Partap C Aggarwal	1
Tradition of natural farming propounded by Bhaskar Save	1
Principles for selection of crops and varieties for cultivation under natural farming	1
Crop disease management practices in ancient, medieval, and pre-modern India	1
Rich heritage of plant protection in natural farming	1
Fortification of nutrient resources in natural farming	1
Identification of plant diseases through Surapala's Vrikshayurveda based on Tridosha (Vata, Pitta, Kapha)	1
Identification of plant diseases through Siddhanta of Ayurveda along with symptoms and remedial measures	1
Concept of Kunapajala	1
Concept of Herbal kunapajala for plant protection	1
Concept of INDSAFARI – a commonly used pesticide for plant protection in tea	1
Total	**32**

Practicals

Topic	No. of Classes
Visit of natural farms to understand the concept, components and management practices	2
Identification of plant and animal-based products used in Vrikshayurveda for plant nutrition and crop protection	1
Preparation of Vrikshayurveda based on-farm inputs for nutrient, pest and disease management	2
Documentation of Vrikshayurveda technology knowledge-base for resource conservation, soil health and plant protection	2
Identification of products used in Kunapajala for plant nutrition and crop protection	1
Preparation of Kunapajala based on-farm inputs for plant protection purpose	1
Preparation of INDSAFARI for plant protection purposes	1
Identification of symptoms and treatments of important diseases of some crops based on principles of Ayurveda	1
Treatment of seeds of important crops based on principles of Vrikshayurveda	1
Case studies of pioneer farmers in natural farming	2
Identification and preparation of inputs for herbal kunapajala for plant protection	1
Ancient techniques of seed storage	1
Total	**16**

Course Title : Principles and Practices of Natural Farming

Course Code : NF-112

Credits Hours : 4 (2+2)

General Objectives

i) To impart knowledge on natural farming principles and practices in order to develop natural farming models.

Specific Objectives

i) To make the students aware about the agro-ecology, concept and principles.

ii) To impart knowledge on various principles and practices in natural farming.

iii) 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, and 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.

Practicals

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 & 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.

Learning Outcomes

1. Awareness of principles of natural farming.
2. Competent human resources with skills for implementation of natural farming.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students' presentation

- Group activities
- Hands on Experience

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 Prayog Pariwar 2021. Plenty For All: Natural Farming A To Z PRAYOG PARIWAR METHODOLOGY.

Theory

Topic	No. of Classes
Natural farming: Concept and importance	2
Modern industrial agriculture and need for new alternative strategies	1
Origin of concept of natural farming	2
Agro ecology: Concept and principles, and history of development in agro-ecology	2
Natural farming: principles, philosophy and components	2
Merits and demerits of natural farming	2
Principles of Fukuoka and other methods of natural farming	3
Practices of Natural Farming - Case studies	2
Types of natural farming systems community based natural farming Indian Ancient Natural Farming Masanuba natural farming, Palekar natural farming (Bio-dynamic, homa farming, natu-eco farming, rishi Krishi, panchagavvya Krishi, Yogic farming etc.)	2
Scope of natural farming in modern time, laws of nature	1
Indian philosophy /Bhartiya Chintan of panchamahabhut and their role in human life and development	2
Important management practices for crops, fruits, vegetables and animals in natural farming, comparison of conventional, organic and natural farming production systems	3
Scientific aspects of ecological and natural farming for supporting food, nutritional and livelihood security - Food sovereignty, Livelihood of farmers and rural communities	2
Biodiversity and its conservation	2
Sustainable soil health and clean water, ecological pest protection, climate resilient food production	2
Indigenous Farming Systems prevalent in India and other countries	1
Government schemes supporting natural farming (PKVY, BPKP, National Mission on Natural Farming), Digital India	1
Total	**32**

Practical

Topic	No. of Classes
Identification of indigenous crops and practices: Study of different farming systems and its characterization	4
Visit of natural farms to understand the concept, components and management practices and interpretation of the same in the class room after the visit	4
Development of natural farm inventory	2
Analysis of Bio-dynamic, homa farming, natu-eco farming, rishi Krishi, panchagavvya Krishi, Yogic farming and practical field application of these practices	8
Design of natural farm based on locally available resources	4
Preparation of on-farm inputs for nutrient, pest and disease management	4
Documentation of indigenous technology knowledge (ITK) for nutrient, insect, pest disease and weed management	2
Development of documentary on management of natural farm	4
Total	**32**

Course Title : Bhumi Suposhan (Soil Nutrition)

Course Code : NF-113

Credits Hours : 3 (2+1)

General objectives

i) To create awareness among students the importance of soils and maintenance of soil fertility through activating biological compartment of biogeochemical cycles without relying on external inputs

Specific objectives

i) To impart knowledge on various properties of soils, soil evaluation procedures, factors of soil fertility and management of biological processes through natural farming practices

ii) 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 sulfate 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 masure), *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.

Practicals

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-natural farming practices,

Learning Outcomes

1. Awareness on significance of soils under natural farming practices.
2. Competent human resources with skills.
3. Scientific basis of evaluating benefits of natural farming.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/Reading)
- Students' presentation
- Group activities
- Hands on experience

Suggested Readings

1. Akshay Krishi Parivar.2022. Bhumi Suposhan- Commemorative Publication of the Nationwide Bhumi Suposhan and Samrakshan Abhiyan. AKP Publication 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 Edition, 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 Edition, 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 Edition, 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, Brady NC,2021. The Nature and Properties of Soil. 15th Edition, ISBN 978-9356062719.
11. Yawalkar K.S., Agarwal J.P. and Bokde S. (2012) Manures and Fertilizers. Agri-Horticultural Publishing House. Pp. 288.

Lecture Schedule

Theory

Topic	No. of Classes
Holistic view on soil in the Indian context	1
Status and management of soil degradation in India	1
Characteristics of a healthy soil, soil quality and health – indicators and evaluation criteria	2
Weathering of rocks and minerals, soil genesis and classification	1
Importance of physical, chemical, and biological properties of soil	1
History of soil fertility and plant nutrition	1
Concept of essential, beneficial, functional and tracer elements in soil. Classification of essential nutrients and criteria of essentiality of plant nutrients	1
Role, deficiency and toxicity symptoms of essential plant nutrients and critical limits of nutrients in soil	1
Nutrient movement to plant roots by mass flow, diffusion and root interception	1
Mechanisms of nutrient uptake by plants: carrier hypothesis, Lundegardh theory and Mengel and Kirkby theory	1
Factors affecting nutrient availability to plants	1
Carbon, nitrogen, phosphorus and sulphur cycles and their role in recycling the nutrients	1
Chemical methods of soil fertility evaluation: soil testing, plant analysis-rapid tissue test, critical levels of nutrients in plants	1
Biological methods of soil fertility evaluation: field experimentation tests, use of indicator plants, microbiological tests	1
Various organic sources of nutrients in soil: naturally occurring minerals, organic (plant and animal based), crop residue incorporation, green manuring, crop rotation with leguminous crops	1
Origin, formation, characteristics and management of acid soil	1
Origin, formation, characteristics and management of saline soil	1
Origin, formation, characteristics and management of alkali soil	1
Sources of contamination in soil and reclamation by bioremediation: Phytoremediation, phytoextraction & phytostabilization	2
Methods of manure preparations (on-farm) for management of healthy soils.	1

Topic	No. of Classes
Preparation of biogas slurry, Ghan Jeevamrit, bio-cultures, etc. and their importance and role in soil health	1
Conservation agriculture practices for soil health	1
Causes of depletion of organic carbon pools in soils and assessment and management of soil carbon sequestration	1
Role of soil microbes in nutrient supplementation	1
Microbial associations with plants, microbes and soil structure and nutrient storage in soil.	1
Best management practices (BMPs) for promoting soil health: Low tillage, cover crops, crop rotation, conducive environment for beneficial microbes, mixed cropping, intercropping, mulching, green manuring, biochar, Jeevamrit, Beejamrit, Sing Khad, Kunap Jal, Samadhi Khada, acerated and non-aerated liquid manures	2
Ancient classification of soil based on soil fertility, irrigation, physical characteristics, and crop suitability	1
Ancient practices for carbon natural farming and traditional festivals of the region in respect to soil health.	1
Soil carbon and nitrogen indices: nitrogen management index and carbon management index. Importance of carbon and nitrogen foot prints in natural farming	1
Total	**32**

Practicals

Topic	No. of Classes
Study of soil sampling tools, collection of representative soil sample, its processing and storage	1
Determination of soil texture by feel method	1
Determination of soil texture by hydrometer method and international pipette method	1
Determination of bulk density, particle density, porosity, and water holding capacity of soil	1
Determination of pH and EC of soil	1
Determination of organic carbon content of soil	1

Topic	No. of Classes
Determination of available nitrogen, phosphorus and potassium in soil	1
Determination of exchangeable calcium, magnesium and available sulphur content in soil	1
Determination of available micronutrients (Zn, Fe, Cu, Mn, B, Mo) in soil	2
Digestion of plant sample – di-acid digestion, tri-acid digestion and dry ashing	1
Determination of macro-nutrient (N, P, K & S) and micronutrient (Fe, Mn, Cu, Zn) contents in plant sample	2
Studies on important ITKs for selection of Soil	1
Quantification of important carbon natural farming practices	2
Total	16

Course Title : Biodiversity Conservation

Course Code : NF-114

Credits Hours : 3 (2+1)

General objective

i) To introduce students with the elements of biodiversity and their distribution, significance of biodiversity in ecosystem processes and functions, conservation and valuation of biodiversity.

Specific objectives

i) To impart knowledge on biodiversity in different agro-ecological zones

ii) 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 and mission life style environment (Life)

Practicals

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 & non-tangible benefit of biodiversity conservation, Orientation about biodiversity register and its activities.

Learning Outcomes

1. Awareness
2. Skill development
3. Increase acreage and production

Teaching Methods/Activities

- Lectures
- Assignment (Writing/Reading)
- Students' presentation
- Group activities
- Hand on experience

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 & 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.

Lecture Schedule

Theory

Topic	No. of Classes
Definition, concept and importance of biodiversity	1
Types of biodiversity: alpha diversity, beta diversity and gamma diversity and their implication in the environment	1

Topic	No. of Classes
Levels of diversity: genetic, species and ecological diversity and their structural and functional aspects	1
Agro-ecological zones in India with a brief understanding of diversity in soil types, temperature and rainfall	1
Watershed atlas of India, festivals, seasons and season cycle in India	1
Natural resources: forest, wildlife, energy and food resources	1
Wild life management and conservation	1
Importance and value of local biodiversity and conservation	1
Bio-geographic classification of India	1
India as a Mega Diversity Nation	1
The mega diversity regions across the world and their importance for the build up of modern agriculture and allied business	1
Hotspots of Biodiversity: Criteria for determining hot spots	1
Threats to Biodiversity- Habitat loss, pollution, species introduction, global climate change, developmental pressure	1
Threats to Biodiversity- overexploitation, poaching, human induced disasters, management of human resources and political and policy issues	1
Classification of threats to biodiversity: endangered, vulnerable, rare and threatened	1
Status of endangered and endemic species of plants and animals	1
Social, economical and political factors for mass extinction of rare species	1
Strategies for conservation of biodiversity – In-situ and ex-situ conservation	1
Important government policies for biodiversity conservation in India	1
Conservation practices in India and world - Organizations involved in resource conservation such as IUCN, WWF, UNEP and UNESCO	1
Conservation Practices in India and world - Organizations involved in resource conservation such as Biodiversity International, IPGRI, FAO, BSI and ZSI	1
Biosphere reserves, national parks and wild life sanctuaries of India	1
Structure, classification and functions of an ecosystem	1
Positive and negative interactions among living organisms in an ecosystem	1
Energy flow models and photosynthesis in an ecosystem	1
Succession: types and causes in an ecosystem	1
General account on activities of DBT, BSI and NBPGR for biodiversity conservation in India	1
General account on activities of ZSI, FSI NBAGR and NFPTCR for biodiversity conservation in India	1
Concept of sacred groves and biodiversity register	1

Topic	No. of Classes
Salient Provisions of Biological Diversity Act, 2002, role of Gramsabha in biodiversity conservation	1
Ancient Indian culture in biodiversity conservation, creation of public awareness on biodiversity conservation by state and central government agencies	1
Role of biodiversity conservation in SDGs, ecological economics and mission life style for Environment (LiFE)	
Total	**32**

Practicals

Topic	No. of Classes
Determination of biodiversity indices, (Shannon-Weiner index, Simpson's index, Margalef's richness, Pielu's Evenness, etc.), Bray-Curtis similarity matrix, Euclidean distance matrix, etc.	2
Field Survey for studying agro-biodiversity in a village/locality	2
Soil faunal biodiversity and methodologies for its estimation	2
Preparation of media, sterilization, principles of isolation and pure culturing	1
Methods in molecular microbial ecology and soil microbial community composition analysis	3
Procedures of monitoring natural enemies and pest and diseases incidences in agroecosystems.	2
Collection, identification and submission of non-wood forest products	1
Visit to forest to study genus/species distribution	1
Orientation about biodiversity register and its activities	1
Visit to ZSI and NBPGR (Regional branches) for knowledge on activities of biodiversity conservation.	1
Total	**16**

Course Title : Farming based Livelihood Systems

Course Code : AGRON 113

Credits Hours : 3 (2+1)

General Objective:

i) To make the students aware about farming systems in agriculture.

Specific Objectives:

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

ii)

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.

Practicals

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 manure in IFS, Study of crops and cropping systems for diversification in IFS, Visit to farmers

field for feasibility study for scientific intervention in IFS, Study of Integrated Organic Farming Systems

Learning Outcomes

1. Knowledge and skill about types of farming systems, their role and use of farming for livelihood.
2. Skills to use resources efficiently in management of farming systems to generate income scientifically.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested readings

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

Lecture Schedule

Theory

Topic	No. of Classes
Concept of farming system and integrated farming system- Definition, goal and advantages	1
Classification of farming systems, Components of farming systems	2
Crops and cropping systems, Livestock and poultry, Fishery and Secondary enterprises	2

Topic	No. of Classes
Integration of components in farming system , Factors affecting integration of components in IFS	3
Selection of crops and cropping systems for various enterprises, Feasibility of different cropping systems for different agro-climatic zones	3
Horticultural crops and cropping systems feasible for different farming systems, Livestock and poultry as a component of integrated farming systems	3
Study of different livestock components feasible for IFS (Dairy, Piggery, goatry, poultry, duckry etc.), Aquaculture as a component of IFS, duck/poultry cum fish, dairy cum fish, piggery cum fish etc.	4
Problems, profitability and prospects, Sericulture as a component of IFS, Scope and potentiality of sericulture for small and marginal farmers.	3
Some suitable module of IFS for different agro-ecological situations	3
Commercial livestock production- problems and prospects. Design for livestock shed and their maintenance.	3
Importance of feed processing unit for livestock production	2
Silage and hay production and marketing.	2
Concept of sustainable farming systems and their indicators	1
Total	**32**

Practical

Topic	No. of Classes
Study of IFS models	3
Preparation of IFS model in groups, preparation of organic manure in IFS	3
Recycling of organic waste in IFS, study of production and profitability of IFS,	3
Market survey for IFS products, study of crops and cropping systems for diversification in IFS, Study of Integrated Organic Farming Systems	4
Visit to farmers field for feasibility study for scientific intervention in IFS,	3
Total	**16**

Semester II

Course Title : Cow Based Natural Farming

Course Code : NF-121

Credits Hours : 3 (1+2)

General Objective

i) To develop a comprehensive knowledge and skill to students in cow based natural farming as a sustainable farming.

Specific Objectives

i) To acquaint the students about practicing natural farming involving cow and its relationship with farming activities.

ii) 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.

Practicals

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.

Learning Outcomes

1. Knowledge and skill development in cow based natural farming.
2. Adoption of cow based natural farming as a result of educational efforts

Teaching Methods/Activities

- Lectures
- Interaction
- Field visits
- Hand on experience
- Group activities such as brainstorming and group discussion
- Assignment (Writing/Reading)
- Student's presentation

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, 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. 1962. 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., & Thomas, C.K. (2019). Livestock Production Management. Kalyani Publishers, New Delhi.
9. Sastry, NSR & 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. & Sastry, NSR. 2013. Livestock Production Management. Kalyani Publishers.

Lecture Schedule

Theory

Topic	No. of Classes
Sociology of natural farming, Indian livestock scenario, indigenous breeds of cattle	1
Differentiating features of indigenous, crossbred and exotic cattle	1
Traditional livestock farming practices	1
Draft animal power in natural farming/ feeding cattle at various phases	1
Indian dairy cattle breeds and their suitability/ forage production, hay making	1
Indigenous, crossbred and exotic cattle and their products/ preventive health care practices	1
Physico-chemical properties and uses of cow dung and urine/ 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	1
Biogas and slurry management/ cow based rearing systems: land, feed and water requirement of traditional farming method, advantage of cow based natural farming methods	1
Fertilizers and pesticides from cow wastes	1

Topic	No. of Classes
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 in cow based natural farming	1
Draft animal power for 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	1
Indigenous traditional practices in cow based natural farming/ sustainable agriculture and fodder business, natural farming business and entrepreneurship development, supply chain management	1
Natural farming business, entrepreneurship development and extension techniques in cow based natural farming/ application of bio gas in agriculture/ preparation of inputs for cow based natural farming	1
Cow based budgeting and marketing cow dung and cow urinebased fertilizers, pesticides and other products	1
National Mission on Natural Farming (NMNF) and initiatives such as *Paramparagat Krishi Vikas Yojana* (PKVY) and BPKP	1
Role of institutions such as National Institute of Agricultural Extension Management (MANAGE), National Centre of Organic and Natural Farming (NCONF), NGOs and other organizations in cow based natural farming	1
Total	**16**

Practical

Topic	No. of Classes
Identification and characteristics of various cattle breeds, fodder varieties and feed ingredients	2
Visit to cow based dairy farm to study the various components and their utilization	2
Visit to Gau-shala and documentation of cow-based farming practices	2
Visit to an institute involved in cow based natural farming	2
Design and development of cow based natural farm	2
Identification of herbal plants ayurvedic & other methods used for livestock treatment	2
Ethno veterinary medicines & their use	1
Feed and fodder conservation practices-silage and hay making	2

Topic	No. of Classes
Concentrate making techniques including ration balancing for cow based farms	2
Calf management under Natural Farm	1
Value addition of milk from dairy	2
Grassland management- Identification of grases, their cultivation practices use & storage	2
Value addition of by-products from cow based natural farm	2
Inputs preparation for supplementary & complementary use at farm	2
Traditional practices followed in cow-based natural farms	2
Record keeping and economics of cow based natural farming	2
Demonstration of renewable energy sources in cow based natural farms	2
Total	**32**

Course Title : Soil Biology in Natural Farming

Course Code : NF-122

Credits Hours : 3 (2+1)

General objective

i) To introduce students with numerous life forms within soil matrix and their roles in crop growth and development, and management of soil quality and productivity.

Specific objectives

i) To impart knowledge on various aspects of soil biology, biological interactions and their roles in management of soil quality and productivity.

ii) 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 & 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.

Practicals

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.

Learning Outcomes

1. Awareness and knowledge dissemination
2. Competent human resources with skills on soil biology
3. Increased scientific database on soil biology under natural farming

Teaching Methods/Activities

- Lectures
- Assignment (Writing/Reading)

- Students' presentation
- Group activities
- Hands on experience

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. Second Edition. CRC Press. Boca Raton.
4. Indian Society of Soil Science. 2015. Introduction to Soil Science. ISSS, New Delhi.
5. Kannaiyan S, Kumar K & Govindarajan K. 2004. Biofertilizers Technology. Scientific Publ.
6. Lal R & Shukla MK. 2004. Principles of Soil Physics. Marcel Dekker.
7. Mengel K &Kirkby EA. 1982. Principles of Plant Nutrition. International Potash Institute, Switzerland. Mortvedt JJ, Shuman LM, Cox FR & 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 (Fourth Edition of Soil Microorganisms and Plant Growth), Oxford and IBH Publishing Co. Pvt. Ltd. pp. 387.

Lecture Schedule

Theory

Topic	No. of Classes
Soil as a habitat for life, concept of soil biome & its components	1
Soil organic matter: definition of soil organic matter and its characterization, Biochemical processes of formation of soil organic matter, SOM as carbon source for soil biota.	2

Topic	No. of Classes
Decomposition processes, reaction order and its dynamics	2
Soil biodiversity and its evaluation methods	2
Soil microbiota: its distribution and abundance, metabolism and physiology, classification of soil microorganisms and their importance in soil processes	3
Soil fauna (microfauna, mesofauna, macrofauna and megafauna): Distribution, abundance, diversity and interactions,	2
Factors affecting soil biodiversity, Significance of biota in soil development, Soil biological interactions: Functions and processes. Above-ground and below-ground biotic linkages,	1
Rhizosphere, spermosphere, phyllosphere and their use in crop growth and development	2
Habitat adaptive fitness benefits to host crops in terms of tolerance to abiotic and biotic stresses	1
Biological nitrogen fixation: Symbiotic (*Rhizobium*-legume, Actinorhizal, *Azolla-Anabaena*), Associative (*Azotobacter*, *Azospirillum*, *Gluconacetobacter*, etc.), Free-living (BGA, *Klebsiella*, etc.)	2
Microbiological methods of composting: various composting techniques, biofortification of various organic manures. *In-situ* decomposition techniques of crop residues using decomposers	3
In-situ decomposition techniques of crop residues using decomposers	1
Microbial mediated nutrient availability and exchange in soil	1
Nutrient mobilization, Arbuscular mycorrhizal symbiosis: its types, biochemical basis of interactions and benefits to host crops	2
Soil enzymes -characterization and mode of action, agricultural management impacts on soil enzyme activities	2
Use of microbes in soil bioremediation and various bioremediation pathways	2
Soil health, soil sickness, soil resistance concept, indicators and evaluation criteria	2
ITKs on soil health management through enriching soil microbiome	1
Total	**32**

Practicals

Topic	No. of Classes
Hands on microscopy and examination of microbes	1
Preparation of microbiological media and methods of sterilization	1
Enumeration of microbial population (bacteria, fungi, actinomycetes) in soil	1
Population counts of phosphate solubilizing bacteria in soil and their purification	1
Isolation and purification of *Azospirillum* from rice roots	1
Isolation and purification of *Azotobacter* from vegetable root/ or rhizosphere soil	1
Isolation, purification and mass production of Blue Green Algae (BGA)	1
Isolation and purification of *Rhizobium* from legume root nodules	1
Determination of biological nitrogen fixation in legume plants by Acetylene Reduction Assay (ARA)	1
Determination of plant growth promoting traits (IAA production, dissolution of insoluble P, K, Zn and Si complexes, etc.)	1
Determination of microbial biomass C, N and P in soil	1
Microscopic observation of AMF spores in soil and enumeration of AMF infection in plant roots	
Quantification of glomalin production in soil	1
Determination of dehydrogenase, phosphatase and β-glucosidase activity in soil	2
Determination of earthworm population and biomass	1
Assay for carbon substrate utilization	1
Total	**16**

Course Title : Integration of Horticultural Crops under Natural Farming

Course Code : NF-123

Credits Hours : 2(1+1)

General objective

i) To develop knowledge and skill on horticulture crops under natural farming**.**

Specific objectives

i) To acquaint the students with package and practices for horticultural crops under natural farming.

ii) 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,

Practicals

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 – defination 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.

Learning Outcomes

1. Trained human resource for promotion of horti-based natural farms
2. Knowledge sharing among different stakeholders

Teaching Methods/Activities

- Lectures
- Assignment (Writing/Reading)
- Students' presentation
- Group activities
- Hands on experience
- Visit to horti-based natural farms

Suggested Reading

1. Horticultural Crops. 2004. Inventory of Indigenous Technical Knowledge in Agriculture. ICAR. Document 2, Supplement 1. 84-100 pp.
2. Horticultural Crops. 2004. Inventory of Indigenous Technical Knowledge in Agriculture. ICAR. Document 2, Supplement 2. 111-136 pp.
3. K. K. Sharma and N.P. Singh. (2021). Soil and Orchard Management. Daya Publishing House.
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 & 2); Document 3; Publ: ICAR New Delhi.
5. 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.

Lecture Schedule

Theory

Topic	No. of Classes
Importance and scope of horticulture crops in natural farming	1
Soil management in relation to nutrient and water uptake and their effect on soil environment	1

Topic	No. of Classes
Intercrops - types and its role in nutrient management. Biological efficiency of cropping systems in horticulture	1
Planting of fruit plants in combination with annual crops – principles and strategies. Types of planting system for fruit plants in natural farming	1
Competitive and complimentary effect of root and shoot systems. Type of mulches - sod mulch and organic mulches for soil moisture and nutrients management	1
Soil microbes and their role for sustainable horticultural crop production system	1
Canopy management, Training and pruning. Methods of training and training of important fruit trees	1
High density planting (HDP) and meadow orchards and their management, Rejuvenation of old orchards - top working and frame working	1
Integrated pest and disease management (IPDM) in horticultural crops	1
Integrated nutrient management (INM) in horticultural crops	1
Management of resource constraints in existing horticultural systems	1
Climate aberrations and mitigation measures of horticultural crops	1
Management of fruit plants of important tropical, sub-tropical and temperate fruit crops under natural farming	2
Mulching of fruit crops and whapasa management.	1
ITK for management of fruit plants under natural farming systems	1
Total	**16**

Practicals

Topic	No. of Classes
Selection of site for farm system design for establishment of natural farming of horticulture crops	1
Different planting systems and its layout – triangular system, contour lines, double row system, rectangular and square	2
Preparation of pit and procedures for filling, Soil depth and slope for fruit tree plantation	1
Irrigation methods and application of water to fruit crops	1
Growing of intercrops ginger, turmeric, colocasia, cowpea, cabbage and green manuring	2
Filler crops – defination and their use in young orchard	1
Training and pruning methods of important tropical, sub-tropical and temperate fruit crops	2

Topic	No. of Classes
Weed management in orchards	1
Use of plant-based products and microbes for plant protection of tropical, sub-tropical and temperate fruit crops	3
Mulching of fruit crops and Whapasa management	2
Total	**16**

Course Title : Insect Ecology, Nematodes and Pest Management

Course Code : NF-124

Credits Hours : 3 (2+1)

General objective

i) To give a comprehensive knowledge to the students on insect ecology, nematodes and different pest management options available under natural farming.

Specific objectives

i) To teach students the insect ecology and effect of biotic and abiotic factors on pests.

ii) To impart practical knowledge on various plant protection options under natural farming.

iii) 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 of biotic 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 & 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.

Practicals

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.

Learning Outcomes

The students will acquire comprehensive knowledge on insect ecology, plant parasitic nematodes and different pest management options to be practiced under natural farming system

Teaching Methods/Activities

- Lectures
- Assignment (Writing/Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested Readings

1. Pest and Disease Management. In: Inventory of Indigenous Technical Knowledge in Agriculture. Document 1; Document 2; Document 2 (Supplement1& 2); Document 3; Publication: ICAR New Delhi.
2. DeBach, P. (1973) Biological control of Insect Pests and Weeds. Chapman and Hall, New York. 844p.
3. Panwar, V.P.S. 2014. Agricultural Insect Pests of Crops and Their Control. Kalyani Publishers, New Delhi
4. Walia, R.K. and Bajaj, H.K. 2014. Textbook of Introductory Plant Nematology (2nd Edition), Kalyani Publishers, New Delhi
5. Dhaliwal. G.S., Ram Singh and Vikas Jindal. 2013. A Textbook of Integrated Pest Management. Kalyani Publishers, Ludhiana, pp. 617.

6. Southwood, T.R.E. and Henderson, P.A. (2000) Ecological Methods. Third Edition, Blackwell Science, USA, 575p

Lecture Schedule

Theory

Topic	No. of Classes
Introduction to insect ecology	1
Role of environment and its components on pest population	1
Effect of abiotic factors on pest abundance - temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents	1
Effect of biotic factors on pest abundance - food, competition, natural enemies and host plants	1
Pest - definition - classification of insect pests - categories of pests	1
Types of injury, symptoms of damage caused by insects	1
Assessment of insect population and damage	1
Major pests of agricultural crops (Cereals and millets) - I	1
Major pests of agricultural crops (Pulses and oilseeds) - II	1
Major pests of agricultural crops (Cotton and sugarcane) - III	1
Major pests of horticultural crops (Fruit crops) - I	1
Major pests of horticultural crops (Vegetable crops) - II	1
Major pests of horticultural crops (Spices and plantation crops) - III	1
Major pests of horticultural crops (Flowers and medicinal crops) - IV	1
Stored product pests of agricultural and horticultural crops	1
Pest management in Natural Farming: Pest surveillance and monitoring	1
Pest management in Natural Farming: Perimeter weeding, conventional land preparation, crop rotation, planting practices, inter-cropping/ mixed cropping, trap crops, border crops, sanitation	1
Pest management in Natural Farming: Physical, mechanical and behavioral control	1
Pest management in Natural Farming: Host plant resistance - interaction of plant resistance traits and biocontrol agents	1
Pest management in Natural Farming: Biological control (Importation, Conservation, Augmentation; Parasitoids, Predators and Pathogens)	1

Topic	No. of Classes
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) - Conserving natural enemies via habitat enrichment	1
Role of botanicals in pest management - agniaster, brahmaster, neemaster, dasparni ark, neem oil, neem seed kernel extract and neem cake	1
Non-chemical management of stored product pests	1
History and economic importance of nematodes	1
General characters and morphology of plant parasitic nematodes	1
Symptomatology of important plant parasitic nematodes	1
Important plant parasitic nematodes of major field crops and management	1
Important plant parasitic nematodes of major horticultural crops and management	1
Cropping system approach in the management of plant parasitic nematodes	1
Role of neem formulations in the management of nematode	1
Role of biocontrol agents in the management of nematodes	1
Role of bio-formulations *viz.*, agniaster, brahmaster, neemaster, dasparni ark in the management of pests and nematodes, Integrated approach in the management of plant parasitic nematodes	1
Total	**32**

Practicals

Topic	No. of Classes
Types of injury and symptoms of damage caused by pests	1
Sampling techniques for the assessment of pest population and damage and calculation of diversity indices	1
Major insect pests of agricultural crops (Cereals and millets) - I	1
Major pests of agricultural crops (Pulses and oilseeds) - II	1
Major pests of agricultural crops (Cotton and sugarcane) - III	1
Major pests of horticultural crops (Fruit crops) - I	1
Major pests of horticultural crops (Vegetable crops) - II	1
Major pests of horticultural crops (Spices and plantation crops) - III	1
Major pests of horticultural crops (Flowers and medicinal crops) - IV	1

Topic	No. of Classes
Stored product pests of agricultural and horticultural crops	1
Sampling techniques for the estimation of nematodes populations	1
Important plant parasitic nematodes of major field crops	1
Important plant parasitic nematodes of major horticultural crops	1
Preparation of different bioformulations (agniaster, brahmaster)	1
Preparation of different bioformulations (neemaster, dasparni ark)	1
Methods of application of various bio-formulations in the management of insect-pests and nematodes	1
Total	**16**

Course Title : Introductory English, Communication Skills and Personality Development

Course Code : EE- 122(A)

Credit Hours : 2 (1 + 1)

General Objective

i) To enable the students to express themselves confidently in English by improving their vocabulary and grammar through appropriate exercises.

Specific Objectives

i) Improve their reading, writing, listening and speaking ability in English and thus gain confidence by enhancing their ability to articulate their ideas.

ii) Develop personality with regard to the different behavioural dimensions that have far reaching significance in the direction of organisational effectiveness.

Theory

Grammar-Parts of speech, Subject/verb agreement, Tenses; Sentence construction-Transformation of sentences, Synthesis of sentences, Direct and Indirect speech; Vocabulary-Homophones/ Homonyms, Commonly confused words; Paragraph Writing-Principles of paragraph construction, Orders of paragraph development (chronological, spatial, compare and contrast), Inductive and deductive paragraphs,**;** Introduction to communication skills-Communication and its types, Communication barriers, Effective communication, Speaking skills-Public speaking, Presentation skills, Reading skills- Skimming and Scanning, Local comprehension (Factual comprehension, Inferential comprehension, Evaluative comprehension), Understanding discourse markers**,** Writing skills: Introduction to

technical writing, Letter writing, Summarizing and Abstracting, Note-taking, Listening skills-Hearing, Understanding, Remembering, Evaluating, Responding, Introduction to personality development- Personality and its determinants, Developing positive attitude, Raising self-esteem, Etiquettes and Manners, Ethics and Values, Stress management, Time management, Group dynamics, Body language-Components of body language, Importance of body language, Body language in specific situations, Career and interviews-Attending interviews, Self-introduction, Preparing resume, SWOT Analysis-Elements of SWOT Analysis, Analysing strengths, weaknesses, opportunities and threats, Usage of SWOT analysis, Importance of SWOT Analysis

Practicals

Grammar- Function of different parts of speech, Subject/verb agreement, Correct usage of tenses; Sentence construction-Transformation of sentences, Synthesis of sentences, Direct and Indirect speech, Vocabulary-Correct usage of different Homophones/ Homonyms, Correct usage of commonly confused words, Paragraph Writing- Application of principles of paragraph construction, Chronological, Spatial, Compare and contrast paragraphs, Inductive and deductive paragraphs; Speaking skills-Public speaking, Presentation skills, Reading skills-Skimming and Scanning, Local comprehension (Factual comprehension, Inferential comprehension, Evaluative comprehension), Understanding discourse markers, Writing skills-Letter writing, Summarizing and Abstracting, Note-taking, Listening skills Hearing, Understanding, Remembering, Evaluating, Responding, Career and interviews: Self-introduction, Preparing resume, SWOT Analysis-Analysing strengths, weaknesses, opportunities and threats

Learning Outcomes

1. Students will improve their speaking and writing ability in English both in terms of fluency and comprehensibility.
2. Students will develop knowledge, skills, and judgment around human communication facilitating their ability to work in collaboration. Such skills could include communication competencies such as managing conflict, understanding small group processes, active listening, appropriate self-disclosure, etc.
3. The student will be able to understand, analyse, develop and exhibit accurate sense of self.

Teaching Methods/Activities

- Lecture

- Discussion
- Classwork
- Assignment
- Student presentation
- Group activities

Suggested Readings

1. Balasubrmanyam M. 1985. *Business Communication*. Vani Educational Books, New Delhi.
2. Naterop, Jean, B. and Rod Revell. 1997. *Telephoning in English*. Cambridge University Press.
3. Spitzberg B, Barge K & Morreale, Sherwyn P. 2006. *Human Communication: Motivation, Knowledge & Skills*. Wadsworth.
4. Narayanaswamy V R. 1979. *Strengthen Your Writing*. Orient Longman, New Delhi

Lecture Schedule

Theory

Topic	No. of Classes
Grammar: Parts of speech, Subject-Verb Agreement	1
Tenses	1
(i) Transformation of sentences: types of sentences, transformation of sentences (ii) Synthesis of sentences: Types of sentences, Conjunctions, Synthesis of sentences	1
Direct and Indirect speech	1
Vocabulary enhancement: Homophones/ Homonyms, Commonly confused words	1
Paragraph Writing: Principles of paragraph construction, Orders of paragraph development (Chronological, Spatial, Compare and Contrast), Inductive and deductive paragraphs.	2
Introduction to communication skills: Communication and its types, Communication barriers, Effective communication	1
(i) Speaking skills: Public speaking, Presentation skills (ii) Listening skills: Hearing, Understanding, Remembering, Evaluating, Responding	1

Topic	No. of Classes
Reading skills: Skimming and Scanning, Local comprehension (Factual comprehension, Inferential comprehension, Evaluative comprehension), Understanding discourse markers	1
Writing skills: Introduction to technical writing, Letter writing, Summarizing and Abstracting, Note-taking	1
Introduction to Personality Development: Personality and its determinants, Developing positive attitude, Raising self-esteem, Etiquettes and Manners, Ethics and Values, Stress management, Time management, Group dynamics	1
Body language: Components of body language, Importance of body language, Body language in specific situations	1
Career and interviews: Attending interviews, Self-introduction, Preparing resume	1
SWOT Analysis: Elements of SWOT Analysis, Analysing strengths, weaknesses, opportunities and threats, Usage of SWOT analysis, Importance of SWOT Analysis	1
Revision and doubt-solving session	1
Total	**16**

Practicals

Topic	No. of Classes
Grammar: Function of different parts of speech, Subject-Verb Agreement	1
Correct usage of tenses	1
Transformation of sentences: types of sentences, transformation of sentences	1
Synthesis of sentences: Types of sentences, Conjunctions, Synthesis of sentences	1
Direct and Indirect speech	1
Vocabulary enhancement: Homophones/ Homonyms, Commonly confused words	1
Paragraph Writing: Application of principles of paragraph construction, Chronological, Spatial, Compare and contrast paragraphs, Inductive and deductive paragraphs	2
Speaking skills: Public speaking, Presentation skills	1
Listening skills: Hearing, Understanding, Remembering, Evaluating, Responding	1
Reading skills: Skimming and Scanning, Local comprehension (Factual comprehension, Inferential comprehension, Evaluative comprehension), Understanding discourse markers	1

Topic	No. of Classes
Writing skills: Letter writing, Summarizing and Abstracting, Note-taking	1
Career and interviews: Self-introduction, Preparing resume	1
SWOT Analysis: Analysing strengths, weaknesses, opportunities and threats	2
Revision and doubt-solving session	1
Total	**16**

Course Title : Environmental Studies and Disaster Management

Course Code : Ag Met-123

Credits Hours : 3(2+1)

General Objectives

i) To impart knowledge to students on various aspects environmental issues in relation to agricultural activities and preparedness on disaster management.

Specific Objectives

- To acquaint students with the significance of environmental principles and remediation procedures.
- 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 & 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 Programme, 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.

Learning Outcomes

After completion of this course, the students will be gaining knowledge about

1. Concept of environmental studies
2. Various types of natural resources, ecosystems and biodiversity
3. Conservation of biodiversity
4. Disaster and their management
5. Practical knowledge on environmental issues

Teaching Methods/Activities

- Lectures
- Assignment (Writing/Reading)
- Students' presentation
- Group activities
- Hand on experience

Suggested Readings

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

Lecture Schedule

Departments: Soil Science, Agronomy, Crop physiology, Agrometeorology

Theory

Topic	No. of Classes
Definition, scope and importance Need for public awareness	1
• Renewable and non-renewable resources • Forest resources: Use and over-exploitation, deforestation; case studies • Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams- benefits and problems • Water conservation, rain water harvesting, watershed management	3
• Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. Case studies	1
• Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. Case Studies	1
• Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification • Wasteland reclamation.	1
• Role of an individual in conservation of natural resources • Equitable use of resources for sustainable life styles	1
• Energy resources: Growing energy needs • Renewable and non-renewable energy sources • Use of alternate energy sources • Urban problems related to energy	1
• Case studies. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification	1
• Concept of an ecosystem • Structure and function of an ecosystem • Producers, consumers and decomposers	1
• Energy flow in the ecosystem • Ecological succession • Food chains, food webs and ecological pyramids	1
• Introduction, types, characteristic features, the following ecosystem :- a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, ocean, estuaries)	1
• Introduction - Definition: genetic, species and ecosystem diversity • Biogeographical classification of India	1
• Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values	1
• Biodiversity at global, national and local levels • India as a mega-diversity nation • Hot-sports of biodiversity	1

Topic	No. of Classes
• Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts • Endangered and endemic species of India • Conservation of biodiversity: *In-situ* and *Ex-situ* conservation of biodiversity	1
• 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 g. Nuclear hazards • Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution	4
• Form Unsustainable to Sustainable development, urban problem related to energy • Water conservation, rain water harvesting, watershed management • Wasteland reclamation • Consumerism and waste products	1
• Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust deaths	1
• 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	1
• Population growth, variation among nations • Population explosion • Family Welfare Programme • Human Rights • Value Education • HIV/AIDS • Women and Child Welfare • Role of Information Technology in Environment and human health	3
• Natural Disasters- Meaning and nature of natural disasters, their types and effects • Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves	1
• Climate change, global warming, acid rain, Sea level rise, ozone depletion, ozone layer, depletion, nuclear accidents and holocaust. Case Studies	1

Topic	No. of Classes
• 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	1
• 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 arrangements; role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response • Disaster response; Police and other organizations	2
Total	**32**

Practical

Topic	No. of Classes
Techniques for collecting effluents Sample	1
Determination of BOD by Winkler's' titration method	3
Determination of pH of effluents sample	1
Determination of hardness of water sample	1
Study on rain water harvesting ponds	1
Study on meteorological observatory	1
Study on meteorological instruments-I	1
Study on meteorological instruments-II	1
Effect of heavy metals on crop growth and development	2
Study on natural Resources Degradation	2
Study on industrial pollution site	1
Study on biodiversity- A visit to sanctuary/biodiversity park /eco-Site etc	1
Study on conservation measures- A visit to nearby ecological sites or environmental conservation programme site	1
Total	**16**

Semester III

Course Title : Crop Management in Natural Farming

Course Code : NF-211

Credits Hours : 3(2+1)

General Objective

i) To provide comprehensive understanding on criteria for selection of crops specific to agroecological zones and their package of practices for cultivation under natural farming.

Specific objectives

i) To acquaint students with the concepts of selection of crops and their cultivation practices under specific agroecological zones following natural farming principles.

ii) 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- d 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.

Practicals

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

Learning Outcomes

1. Knowledge enhancement in the field of crop production under natural farming.
2. Equipped with the knowledge and skills regarding natural farming technologies in different crops.
3. Enhance awareness about natural farming technological applications.

Teaching Methods/Activities

- Lectures
- Assignment (writing/reading)
- Students' presentation
- Exposure visits
- Hand on experience

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, E Somasundaram and M Mohamed Amanullah, 2017, 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 & 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
10. Scientific Pulse Production 2003 by P.S. Rathore and S.K. Sharma, Yash Publishing House, Bikaner, pp. 1-269.
11. The Ultimate Guide to Natural Farming and Sustainable Living: Permaculture for Beginners (Ultimate Guides) by Nicole Faires (2016).
12. Vrikshayurvedic Farming: The Traditional Indian Agriculture by C & Mujh R Nandhakumar Swaminathan (2017)

Lecture Schedule

Theory

Topic	No. of Classes
Agricultural classification of crops, selection of crops, importance of pulses & legumes	1
Weather management- Concept of weather and climate - Factors affecting crop production	1
Climatic factors, Edaphic, Biotic, Physiographic factors and its influence on crop production	1
Micro-climate definition- importance of micro-climate and influence on crop production	1
Management techniques of micro-climate	1
Windbreaks and shelter belts, Management of weather factors in natural farms.	1
ITKs in weather prediction and management methods	1
Seeds – Importance, characters of good quality seeds	1

Topic	No. of Classes
Dormancy and types of dormancy - concept of seed selection, seed treatment	1
Seed rate- calculation methods - Factors affecting seed rate and seed germination	1
Sowing- time, method and depth, indigenous methods and animal drawn techniques	1
ITKs in seed storage and sowing time and methods	1
Irrigation – importance – need for irrigation	1
Time and methods of irrigation, management of irrigation water	1
Modern concepts in irrigation – pressurized irrigation systems	1
Drainage and its importance in crop production	1
Water use efficiency – various efficiencies - methods of calculation – water saving and economics	1
Crop Geometry- Definition of crop geometry and population - crop density, types of crop geometry, importance of crop geometry	1
Maintenance of crop population - thinning, gap filling, optimum plant population, factor affecting plant population	1
Relation of crop geometry and growth, relation of crop geometry and yield	1
Weed: Definition, harmful and beneficial effects of weeds on crop production	1
Classification characters of weeds of different eco systems – wetland, garden and dryland, and their importance	1
Crop weed competitions and management of weeds	1
Different methods of weed management – physical, chemical, biological and cultural practices in weed management	1
Practices of weed management in natural farming. Cultural, Physical and mechanical	1
ITKs in weed management	1
Nutrient requirement – criteria of essentiality	1
Classification of nutrients- macro, secondary and micro nutrient for crop growth	1
Deficiency symptoms and its identification	
Management of nutrients - Sources of nutrient application and their management in traditional and modern agriculture	1

Topic	No. of Classes
Soil health – Need and Importance – Maintenance of soil health, Relation between soil health and plant health	1
ITKs in soil and health management	1
Total	**32**

Practical

Topic	No. of Classes
Selection of crops for natural farming according to agro-ecological zones.	1
Know how on agro-met observatory and data interpretations. Different weather elements and Time of observation	1
Preparation of weather calendar for various agricultural operations – sowing, pest incidence and harvest	1
Calculation of seed rate for sowing	1
Plant geometry and population calculation	1
Traditional seed treatment methods	1
Preparation of traditional nutrient supply concoctions and their uses	1
Traditional knowledge techniques in crop management	1
Study of methods of crop residue management	1
Study of important methods of plant protection	1
Irrigation efficiency	1
Preparation of crop calendar for different sowing seasons under various micro-climates	1
Preparation of contingency crop plan for natural farming	1
Yield estimation in naturally grown crops	1
Visits to natural farm	1
Documentation of sustainable natural farming practices	1
Total	**16**

Course Title : Production of Bio-inputs

Course Code : NF-212

Credits Hours : 2 (1+1)

General objective

i) To acquaint students with the various types of bio-inputs applicable in natural farming, their mode of benefits in soils and plants.

Specific objectives

i) To impart knowledge on types of bio-inputs, their functions, compositions, application doses and impacts on soil processes.

ii) 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 of bioinputs in natural farming.

Practicals

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,

Learning Outcomes

1. Awareness and knowledge dissemination
2. Competent human resources with skills on bioinputs production
3. Increased acreage under natural farming practices

Teaching Methods/Activities

- Lectures
- Assignment (writing/reading)
- Students' presentation
- Group activities
- Hands on experience

Suggested Readings

1. A.C. Gaur. 1999. Microbial Technology for Composting of Agricultural residues by improved methods. Indian Council of Agricultural Research, (New Delhi), Pp.78.
2. Arun Sharma. Biofertilizers. Agrotech Publishing Academy, Udaipur
3. Ayangarya Valmiki Sreenivasa. 2006. Organic Tea – A Vrikshayurveda Experience. Agri-History Report No. 1. Asian Agri-History Foundation. pp. 36.
4. Choudhary SL and Saxena RC. 2007. Plant Protection in Medieval and Modern Indian Agriculture. *In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 455-480.
5. 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.
6. Nene YL.2003. Crop Disease Management Practices in Ancient, Medieval, and Pre-modern India. Asian Agri-History. Vol. 7(3):185-201.

7. 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 & 2); Document 3; Publ: ICAR New Delhi.
8. Saharan, B. S., & Nehra, V. (2011). Plant growth promoting rhizobacteria: a critical review. *Life Sci Med Res*, *21*(1), 30.
9. Saharan, B. S., Parshad, J., Kumar, D., & Sharma, N. (2021). Plant-Microbial Interactions in Natural/Organic Cultivation of Horticultural Plants. In *Plant-Microbial Interactions and Smart Agricultural Biotechnology* (pp. 115-128). CRC Press.
10. Palaniappan, S.P. and Anandurai, K.1999. Organic Farming – Theory and Practice. Scientific Pub. Jodhpur
11. 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.

Lecture Schedule

Theory

Topic	No. of Classes
Bioinputs: definition, types and their importance	1
Present scenario and future prospects of bioinputs in India and world	1
Mechanism of action of bioinputs	1
Assessment of quality standards of bioinputs	1
Methods of production and application doses of bioinputs: Beejamrutha, Jeevamrutha, ghan Jeevamrutha	1
Methods of production other inputs (agniaster, brahmaster, neemaster, sonthaster, Khatti lassi dasparni ark and saptdhanyaankur) for pest, disease and nutrient management	1
Fortification of bioinputs for improving soil quality	1
Study of physical, chemical and biological characteristics of bio-inputs	1
Factors influencing the application of bioinputs in soil and crops	1
Effects of bioinputs on soil biological components	1
Effects of bioinputs on soil enzymatic activities and soil fertility	1

Topic	No. of Classes
Impact of bioinputs on plant physiological activities and physiological stress indicators	1
Influence of bioinputs on plant-microbe and plant-faunal interactions	1
Initiatives taken by government(central/state), NGOs and other organizations in India for Promotion of bioinputs under natural farming perspectives	1
Economic considerations, viability, marketing and export potential of different bio-inputs	1
Quality aspect, grading, packaging, handling, and establishment of internal control system for bioinputs	1
Total	**16**

Practical

Topic	No. of Classes
Preparation of animal manure based bioinputs and its uses	1
Preparation of soil microbe based improved bioinputs and its uses	1
Preparation of *Bramhaster* and its uses	1
Preparation of *Agniaster* and its uses	1
Preparation of *Neemaster* and its uses	1
Preparation of *Dashparni* ark and its uses	1
Preparation of Ginger- Garlic- Chilli extract and its uses	1
Preparation of Fermented butter milk and its uses	1
Preparation of *Beejamrutha, Jeevamrutha, Ghana Jeevamrutha* and its uses	2
Preparation of herbal *kunapajala* and its uses	1
Preparation of *Neem-based concoctions* and its uses in pest and disease management	1
Study of physical, chemical and biological characteristics of important bioinputs	2
Determination of plant physiological stresses upon application of bioinputs	1
Project formulation for bioinput preparation	1
Total	**16**

Course Title : Farm Power and Machinery

Course Code : NF-213

Credits Hours : 3 (1+2)

General Objective

i) To provide a comprehensive understanding of the principles, practices, and technologies related to the use of power and machinery in agricultural operations.

Specific Objectives

i) To enable the students to understand the basic of farm power and machinery use in natural farming.

ii) 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.

Practicals

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 andsecondary 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.

Learning Outcomes

1. Knowledge enhancement in the field of farm power and machinery.
2. Equipped with the necessary knowledge, skills, and attitudes to effectively manage farm power and machinery, make informed decisions, and contribute to efficient and sustainable agricultural practices in natural farming.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested Readings

1. Sahay J (2006). Elements of Agricultural Engineering, Standard Publishers Distributers, New Delhi.
2. Pimental D. (1980). Handbook of Energy Utilization in Agriculture, CRC
3. Rathore NS, Joshi S and Choudhary N (2022). Digital Technologies for Agriculture, NIPA Genx Electronic, Recourses and Solutions Pvt. Ltd.
4. Rahudkar WB (2007). Ancient Agricultural Implements. *In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 389-396.
5. Akshay Krishi Parivar (2022). Bhumi Suposhan-Commemorative Publication of the Nationwide Bhumi Suposhan and Samrakshan Abhiyan. AKP Publication No.11. pp 212.
6. Sangwan Satpal. 2007. Level of Agricultural Technology in India (1757-1857). *In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation.pp.397-413.
7. Tillage and Interculture Management/Farm Implements. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document2;

Document2 (Supplement1&2); Document 3; Publ: ICAR New Delhi.
8. 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.
9. Peshwe D.R., Ram Kumar Sing, K.A. Deshmukh and S. Chopra. 2018. Advances and Research in Agricultural Tools. Publ: MME Publishing House Nagpur.
10. 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.

Lecture Schedule

Theory

Topic	No. of Classes
Mechanization in Agriculture: its potential and prospects	1
Sources of Farm Power, Draught animal power and its relevance to Indian Agriculture	1
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	3
Familiarization with tractor	2
Introduction to primary and secondary tillage equipment	2
Energy efficient improved tools and equipments in natural farming: Introduction to rotavator, planter, vegetable transplanter, bed former, disk harrow, mulch laying equipment, ergonomically improved hand tools for intercultural operation: wheel hoe, long handle hoe, garden tools, labour saving/drudgery reducing tools	2
Plant protection equipment: knapsack sprayer, power sprayer	1
Harvesting and threshing machinery	2
Animal drawn farm equipment/tools: Animal drawn bund former, Seed drill, Planters, Cultivator, ITK in farm machinery, ITKs on farm tools,	2
Total	**16**

Practical

Topic	No. of Classes
Study of different engine systems	2
Study of the different components of IC engines	2
Familiarization with tractors	2
Familiarization with tools and equipments for input production in field	3
Familiarization with tractor drawn primary and secondary tillage implements	2
Familiarization with animal drawn primary and secondary tillage implements	2
Familiarization with tractor drawn seed-cum-fertilizer drills their seed metering mechanism and calibration	3
Familiarization with animal drawn seed-cum-fertilizer drills their seed metering mechanism and calibration	2
Familiarization with planters	2
Familiarization with transplanters	2
Familiarization with different inter-cultivation equipment	2
Familiarization with different types of sprayers	2
Familiarization with different types of dusters	2
Familiarization with harvesting machinery	2
Familiarization with threshing machinery	2
Total	**32**

Course Title : Livestock and Poultry Production

Course Code : NF 214

Credits Hours : 3 (2+1)

General Objective

i) To give an overview of livestock & poultry production to students.

Specific Objective

i) To impart knowledge and skill in rearing of livestock and poultry production.

ii) 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 foot prints, 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 programmes 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) & their characteristics, Housing and feeding. Management of sheep and goat for optimal production.

Principles of disease and pest prevention 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. Troubleshooting hatchery failures, Poultry waste management, pollution and environmental issues, mixed and integrated poultry farming under natural landscape. Vertical & horizontal integration in poultry production, Management of ducks, turkeys, Japanese quails and guinea fowls.

Practicals

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 pest 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.

Learning Outcomes

1. Knowledge and skill development rearing livestock and poultry production.
2. Enhanced livestock and poultry production

Teaching Methods/Activities

- Lectures
- Interaction
- Field visits
- Hand on experience
- Group activities such as brainstorming and group discussion
- Assignment (Writing/Reading)
- Student's presentation

Suggested Readings

1. Ghotge, N.S. 2004. Livestock and Livelihoods, the Indian Context. Foundation Books, New Delhi.
2. Dakshinkar, N.P. & 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.
3. 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.
4. I.C.A.R. Handbook of Animal Husbandry
5. Mahesh Chander and B. Subrahmanyeswari, Organic Livestock Farming, Published by Indian Council of Agricultural Research, 2017
6. Sreenivasaiah, P.V. 2006 Scientific Poultry Production – a unique

encyclopedia, 3rd Ed.

7. Veterinary and Animal Husbandry. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement1& 2); Document 3; Publ: ICAR New Delhi
8. Chatterjee, B.N., & Das, P.K. (1989). Forage Crop Production. Oxford & IBH Publishing Co.
9. Banerjee, G.C. (2019). A Textbook of Animal Husbandry. (8th Ed.). Oxford & IBH Publishing, New Delhi
10. 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 & 2) & Document 3). ICAR, New Delhi.

Lecture Schedule

Theory

Topic	No. of Classes
Historical account of livestock rearing in Vedic, medieval and modern era in India inclusive Free range, semi-intensive and intensive systems and major pastoral systems in India	1
Demographic distribution and characteristics of livestock (Cattle, buffalo, sheep, goat, and poultry) and economy	1
Common farm management practices of livestock and poultry including housing, feeding, watering, sanitation, pest and disease management	2
Common vices of animals (Cattle, Buffalo, Sheep, Goat), their prevention and care	1
General principles of sewage disposal and purification; solid and liquid manure management, compost making	1
Ventilation requirements, presumptive standards for permissible air pollution in buildings	1
Respiratory exchange of domestic animals, Importance and method of ventilation, Livestock and poultry rearing and carbon foot print	1
Breeding strategies and biotechnological tools for the improvement of dairy cattle, buffalo, sheep, goat, swine and poultry; Natural Breeding for livestock and poultry	1
Methods of conservation - livestock and poultry conservation programmes in the state and the country	1

Topic	No. of Classes
Fodder production and conservation: Importance of grasslands and fodder in livestock production and their management	1
Structures for storage of feeds and fodders, Scarcity fodders and preservation of green fodder	1
Recycling of animal shed washings and wastes in fodder production and use of recycle waste, disposal, utilization and recycling of waste, etc.	1
Sheep, goat, rabbit farming and swine farming: role and importance in natural farming	1
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	1
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	1
Scavenging system of management – Low input technology – Backyard and semi-intensive units; their management and economic achievements	1
Deep litter management – Control of litter-borne diseases and recycling of litter	1
Cage management – Different types, Advantages and disadvantages, Management of growers, layers, broilers and breeders. Stress management	1
General management and feeding practices of calves, heifers, pregnant, lactating and dry animals, bulls and working animals	1
Systems of feeding, restricted feeding, phase feeding, Unconventional feed ingredients -Herbal Bio enhancers	1
Protection and welfare of livestock, poultry and working animals	1
Draught ability of cattle and buffaloes, Routine animal farm operations and labour management, Animal farm accounts and records	1
Indigenous technical knowledge related to livestock rearing and veterinary practices, Indigenous technical knowledge pertaining to health and management of livestock	1
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	1
Brooding management – Types of brooders – preparation of shed – Importance of environmental factors; Housing – Types of poultry, houses – space requirements	1

Topic	No. of Classes
Feeding management– Classification of nutrients, Nutrient requirements and feed formulations, Feeding systems, Water management	1
Sheep and goat farming: Introduction and scope in the country, Important breeds (exotic and indigenous) & their characteristics, Housing and feeding, Management of sheep and goat for optimal production	1
Principles of disease and pest prevention management, Ayurvedic, Homeopathic, Ethno-medicines, General principles of medication for livestock and poultry in natural farming	1
Candling, sexing, grading, packing and disposal of hatchery waste	1
Troubleshooting hatchery failures, Poultry waste management, pollution and environmental issues, mixed and integrated poultry farming under natural landscape	1
Vertical & horizontal integration in poultry production, Management of ducks, turkeys, Japanese quails and guinea fowls	1
Total	**32**

Practicals

Topic	No. of Classes
Identification of indigenous breeds of livestock, small ruminants and poultry and other avians	1
Acquaintance with natural livestock farms (dairy and small ruminant), backyard poultry and other avians	
Layout plans for different livestock houses and poultry	1
Fodder production and conservation: Visit to the fodder farm, Familiarization with various types of fodders in the various states	1
Livestock waste utilization and recycling/ Familiarization with various fertilizers and manures	1
Humane handling and restraining of cattle, buffalo, sheep and Goat; Clipping, shearing, dipping, spraying and spotting sick animals; Determination of body weight using different measurement	1
Training of breeding males, Detection of heat, Identification and care of pregnant animals, care of neonatal and young stock	1
Diagnosis, prevention and treatment of important diseases and pest of livestock, small ruminants and poultry and other avians	2
Economic traits of broilers, egg-type chicken and breeders	2

Topic	No. of Classes
Poultry farm and hatchery equipment, Brooding arrangement in broiler farms	1
ITKs related to livestock management, Vaccination, Deworming and Medication of birds, Records and maintenance	2
Feed ingredients and its quality assessment	1
Fundamentals in poultry post-mortem examination for sample collection and dispatch	1
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	2
Total	**16**

Course Title : Management of Plant Diseases

Course Code : NF 215

Credits Hours : 2 (1+1)

General Objective

i) To give a comprehensive knowledge to the students on important plant diseases, plant pathogenic organisms and different management options available under natural farming.

Specific Objectives

i) To teach students the important plant diseases and plant pathogenic organisms.

ii) To impart practical knowledge on crop loss assessment and disease management methods under natural farming.

iii) 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.

Practicals

Acquaintance with various laboratory equipments 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.

Learning Outcomes

1. The students will acquire comprehensive knowledge on important plant diseases, plant pathogenic organisms and different management options available under natural farming.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/Reading)
- Students presentation
- Group activities
- Hand on experience through practical classes

Suggested Readings

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

Lecture schedule

Theory

Topic	No. of Classes
Plant disease management under natural farming - Concepts and principles, Classification of plant diseases, Factors affecting disease development, disease triangle and tetrahedron	1
Important plant pathogenic organisms: Fungi, bacteria, fastidious vesicular bacteria phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes.	1
Pathogenesis - Koch's postulates, Epidemiology, Factors affecting disease development, Defense mechanism in plants - Role of enzymes, toxins and growth regulators in disease development,	1
Principles and pre-requisites of forecasting of diseases: Survey, surveillance and vigilance, crop loss assessment and models	1

Topic	No. of Classes
Principles and methods of plant disease management: Cultural, physical and mechanical control, host plant resistance, botanicals, biological and legislative control	1
Role of soil microbiome in disease management, Ecological management of crop environment, Suppressive soils, Concepts and potentialities for managing soil borne pathogens	1
Symptoms, etiology, disease cycle and management of major diseases of field crops (Cereals and millets) – I	1
Symptoms, etiology, disease cycle and management of major diseases of field crops (Pulses and oilseeds) - II	1
Symptoms, etiology, disease cycle and management of major diseases of field crops (Cotton and sugarcane) - III	1
Symptoms, etiology, disease cycle and management of major diseases of horticultural crops (Fruit crops) - I	1
Symptoms, etiology, disease cycle and management of major diseases of horticultural crops (Vegetable crops) - II	1
Symptoms, etiology, disease cycle and management of major diseases of horticultural crops (Spices and plantation crops) - III	1
Symptoms, etiology, disease cycle and management of major diseases of horticultural crops (Flowers and medicinal crops) - IV	1
Application of Khatti lassi, Jungle ki Kandi, Sontha aster for the management of plant diseases	1
Plant growth promoting rhizobacteria (PGPR) and their use in plant protection	1
Heritage perspective of plant protection (Drumraksha) and ITKs related to the management of plant diseases	1
Total	**16**

Practicals

Topic	No. of Classes
Acquaintance with various laboratory equipments and microscopy	1
Preparation of media, isolation and Koch’s postulates	1
Study of structures of fungi and representative fungal genera	1
Staining and identification of plant pathogenic bacteria	1

Topic	No. of Classes
Study of plant viruses	1
Study of phanerogamic plant parasites	1
Major diseases of field crops (Cereals and millets) - I	1
Major diseases of field crops (Pulses and oilseeds) - II	1
Major diseases of field crops (Cotton and sugarcane) - III	1
Major diseases of horticultural crops (Fruit crops) - I	1
Major diseases of horticultural crops (Vegetable crops) - II	1
Major diseases of horticultural crops (Spices and plantation crops) - III	1
Major diseases of horticultural crops (Flowers and medicinal crops) - IV	1
Preparation of extracts of natural plant products as fungicides.	1
Preparation and methods of application of Khattilassi, Jungle ki Kandi, Sontha aster for disease management	1
Bio-surfactants and their use in plant disease management	1
Total	**16**

Course Title : Agri Informatics and Database Management

Course Code : Ag Stat- 213

Credits Hours : 3(2+1)

General Objectives

i) To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision-making processes, etc.

Specific Objectives

i) To provide basic knowledge of Computer with applications in Agriculture.

ii) 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 application 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.

Practicals

Study of Computer components, accessories, practice of important DOS Commands, Introduction of different operating systems such as windows, Unix/ Linux, creating files & folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific documents, 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/CropSyst/ 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)

Learning Outcomes

After studying this course the students will gather knowledge on

1. Basics of computers with application.
2. Basics of MS Office, database with application in agriculture.
3. Basic concepts of internet and programming languages.
4. Basic concepts of Agril-Informatics its components such as e-agriculture, ICT, DSS, Expert System, Geo-spatial technology etc.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested readings

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

Lecture Schedule

Theory

Topic	No. of Classes
Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Hardware and Software, Software types	3
Operating System, definition, types and function	2
Basic concept of MS-Office, MS-Word, MS-Excel, MS-Access and MS-Power Point	2
Data presentation, tabulation and graph creation, statistical analysis, mathematical expressions	2
Database, concepts and types, database languages and uses of DBMS in Agriculture	3
Internet, World Wide Web (WWW), Concepts and components	2

Topic	No. of Classes
General Concepts of computer programming with algorithm, flowchart	1
Introduction to Visual Basic, Java, Fortran, C/C++, etc., concepts and standard input/output operations	5
e-Agriculture, concepts, design, development, India Digital Ecosystem of Agriculture	2
Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer models in agriculture	2
IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management	2
Smartphone mobile apps in agriculture for farm advice, market price, postharvest management etc.	1
Geospatial technology: concepts, techniques, components and uses for generating agri-information.	2
Decision support systems, concepts, components and applications in agriculture	1
Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions, Preparation of contingent crop-planning and crop calendars using IT tools	2
Total	**32**

Practicals

Topic	No. of Classes
Study of Computer components, accessories.	1
Practice of important DOS commands	1
Introduction of different operating systems such as windows, Unix/ Linux, Creating, Files & Folders, File Management	1
Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific document	1
MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data, mathematical expressions	2
MS-Access, creating database, preparing queries and reports, demonstration of Agri-information system	2
Programming language Visual Basic/ Java/Fortran,/C/ C++ etc.	3
Introduction to World Wide Web (WWW) and its components	1
Hands on practice on Crop Simulation Models (CSM)	1

Topic	No. of Classes
computation of water and nutrient requirements of crop using CSM and IT tools	1
Introduction of Geospatial Technology for generating information for agriculture	1
Hands on Decision Support System, Preparation of contingent crop planning and learning about India Digital Ecosystem in Agriculture (IDEA)	1
Total	**16**

Semester IV

Course Title : Elements, Characteristics and Design of Natural Farming Systems

Course Code : NF-221

Credits Hours : 3 (2+1)

General Objective

i) To impart knowledge and understanding on natural farming systems.

Specific Objectives \:

i) To make students aware about concept, function and design of natural farming as a system approach.

ii) 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, prakritikshaswat 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.

Practicals

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 bio-diversity 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.

Learning Outcomes

1. The students will acquire comprehensive knowledge on elements, characteristics and design of natural farming systems

Teaching Methods/Activities

- Lectures
- Assignment (Writing/Reading)
- Students presentation
- Group activities
- Hand on experience through practical classes

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. Ikerd, J.E., Agriculture and Spirituality. In: Zsolnai, L. and Flanagan, B. (ed) The Routledge International Handbook of Spirituality in Society and the Professions, Routledge, 2019. 31. Agriculture: Spiritual Foundations for the Renewal of Agriculture by Rudolf Steiner
6. 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.
7. Minamino Y. 1994. Manifesto of Nature Farming. In the Front of Organic Agriculture. Fumin-Kyokai, Tokyo, 195pp.
8. Natural Farming: A Practical Guide by Pat Coleby (2004) Compendium of Success Stories of Natural Farming Publishing Agency: NITI Aayog (2022) ISBN: 978-81- 953811-4-2.
9. 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
10. 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 1-16.
11. The Philosophy of Spiritual Farming. Subash Paleker.
12. The Principles of Spiritual Farming - Volume II Subash Paleker.

Lecture Schedule

Theory

Topic	No. of Classes
Farming Systems: Concept, approaches, components and Characteristics. Strength and weakness of natural farming systems	2
System approach and concept for farming systems, Natural Farming Systems, Ecosystem services, Types of ecosystems: Natural ecosystems and Agri-ecosystems	2
The water cycle, nutrient cycle and energy cycle	2
Classification of farming types (Based on geographical condition, levels of technology and external input use, labour demand of produce, etc.)	2
Subsistence farming: Intensive subsistence and primitive subsistence, Traditional farming, intensive conventional farming, integrated farming, conservation agriculture, eco-agriculture, ecologically intensive agriculture (Sustainable intensifications)	3
Natural system models at the basis of mimicry (The rain forest model, The dry forest model, The prairie model	2
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	6
Comparison of natural ecosystems, traditional farming system and modern agriculture, Production syndrome in natural farming	2
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)	3
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	4
Optimization methodology: a potential approach for system, natural farming system and ecosystem analysis and design	4
Total	**32**

Practical

Topic	No. of Classes
Identification and characterization of different natural and agro-ecosystems in the rainfed, hill and mountain, arid, coastal and irrigated regions	2
Study on characterization of natural eco-systems and intensive farming system Preparation of survey questionnaire	1
Study on characteristics of elements of water cycle in natural ecosystem and farming system	2
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	1
Comparative biodiversity analysis in natural and conventional farming systems. Calculation of bio-diversity index for different farming systems	2
Designing of cropping/farming and natural farming systems	1
Study and representation of resource flow and recycling in different farming systems	1
Budgeting: Farm records and farm book keeping in natural farming system. Cost and profit analysis of different components and whole system	2
Designing of natural farming systems models in different Agro-ecosystems	2
Designing Farming systems/Natural farming systems using mathematical tools/optimization methodology	2
Total	**16**

Course Title : Improvement of Traditional and Underutilized Crops

Course Code : NF-222

Credits Hours : 3 (2+1)

General Objective

i) To provide comprehensive understanding of traditional and underutilized crops, and ways and means of their improvement under natural farming.

Specific objectives

i) To gain the knowledge on different types of traditional and underutilized crops

ii) 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 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.

Practicals

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 & their characteristics, Seed identification & 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 & IBH Publishing Co Pvt Ltd, New Delhi.
3. Dawson JC, Murphy KM, Jones SS. Decentralized selection and participatory approaches in plant breeding for low-input systems. Euphytica. 2008; 160:143–54.
4. 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.
5. Lammerts van Bueren ET, 2002. Organic plant breeding and propagation: concepts and strategies. Ph. D. Thesis, Wageningen University, the Netherlands.
6. 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.
7. Phillips SL, Wolfe MS. Evolutionary plant breeding for low input systems. J Agric Sci. 2005; 143:245.
8. 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.
9. Ranganathan Nithya. 2018. Druma Vichitrikaranam - The Ancient Approach to Plant Mutagenesis, Asian Agri-History, Vol. 22(3): 218-225.
10. Geographical Indications of Plant Species. In Inventory of Indigenous Technical Knowledge in Agriculture Document 5; Publ: ICAR New Delhi.
11. 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.

Learning Outcomes

1. The students will acquire comprehensive knowledge on cultivation of improved and underutilized crops under natural farming.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/Reading)
- Students presentation
- Group activities
- Hand on experience through practical classes

Lecture Schedule

Theory

Topic	No. of Classes
Importance of traditional and underutilized crops, Genetic basis of crop Improvement: Laws of inheritance; qualitative and quantitative traits	2
Multiple factor hypothesis and pureline theory	1
Components of phenotypic variance	1
GXE interaction and heritability	1
Breeder's equation	2
Populations/ landraces/ farmers' varieties/ cultivars	1
Hardy Weinberg equilibrium and factors effecting it	1
Assortative and disassortative mating	1
Difference between self-pollinated, cross pollinated and clonal populations	1
Important physiological parameters for crop improvement- photosynthesis, transpiration, water and mineral regulation	2
Breeding objectives under natural farming systems- Nutrient Use Efficiency; Tolerance to micronutrient, mineral deficiencies and toxicities	2
Weed competitiveness	1
Enhanced Interaction with rhizospheric microorganisms	2
Multiple disease and insect resistance and quality	1
Earliness/ crop duration to suit multiple cropping system and agro-ecologies; Wider adaptability and stability	1
Broad genetic base / population heterogeneity, high yield	1
Multipurpose crops- stay green, food, feed, fiber and fuel	1
Plant breeding techniques: Domestication, introduction, selection, hybridization	2
Breeding self-pollinated crops- Pureline selection, mass selection, pedigree selection, mass selection, SSD, backcross breeding	1
Breeding cross pollinated crops- Population improvement, recurrent selection, composite and synthetic varieties	2
Improving clonally propagated crops- clonal selection	2
Farmer participatory plant breeding	1

Topic	No. of Classes
Molecular markers, Marker Assisted Selection (MAS); Comparison of MAS vs. Phenotypic selection	2
Total	**32**

Practicals

Topic	No. of Classes
Study of floral biology of different crops	1
Hybridization techniques	2
DUS characterization important land races and traditional varieties of crops	1
Breeding methods for natural farming	2
Study of root characteristics of crops grown under natural and other production systems	2
Learning of techniques of participatory plant breeding	1
Techniques and procedures of conservation of plant genetic resources	2
PRA for mapping indigenous crops & their characteristics	1
Seed collection, identification & conservation for natural farming systems	1
Identification of important land races and traditional varieties of crops	2
Identifications of important land races and traditional varieties of fruit crops	1
Total	**16**

Course Title : Agro-Eco System Analysis for Natural Farming

Course Code : NF-223

Credits Hours : 2 (1+1)

General Objective

i) To enrich the knowledge on existing agricultural eco system and importance of local resources that complementing the natural farming will be explored.

Specific Objectives

i) To enhance the knowledge about the concepts, types and tools adopted in agro eco system.

ii) To study the techniques and strategies adopted in natural farming and as a tool in agro eco system 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 frame work, 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.

Learning Outcomes

1. To enrich the knowledge about agro eco system analysis for natural farming.
2. To develop the expertise in agro eco system and different models

Teaching Methods/Activities

- Lectures
- Assignment (Writing/Reading)
- Students' presentation
- Group activities
- Hand on experience

Suggested Readings

1. Adhikary. 2006. Participatory Planning and Project Management in Extension Science. Agrotech. Publ. Academy.
2. Singh B.K. 2008. PRA/PLA and Participatory training. Adhyayan Publ. & Distr.
3. Agro-ecosystem Analysis for Research and Development by Gordon R. Conway.

4. Handbook and agro ecosystem analysis and agro ecological zoning: a tool for district land use planning- NAFR Lao-Swedish Upland Agriculture and Forestry Research Programme.

Lecture Schedule

Theory

Topic	No. of Classes
Introduction to systems and system hierarchy - Definition of a system and its components - Overview of system hierarchy and its relevance to agro-ecosystem analysis	1
Introduction, definition, meaning, and concept of agro-ecosystem - Understanding the concept of agro-ecosystems -Key characteristics and components of agro-ecosystems	1
Properties of agro-ecosystems -Exploring the properties and attributes of agro-ecosystems -Understanding the dynamic nature of agro-ecosystems- Productivity¬, Stability, Sustainability, Equitability	1
Types of agro-ecosystem analysis -Overview of different approaches to agro-ecosystem analysis (quantitative, qualitative, etc.) -Comparative analysis of different types of agro-ecosystem studies	1
Agro-ecosystem analysis and sustainable agriculture -Linking agro-ecosystem analysis to the concept of sustainable agriculture -Examining the role of agro-ecosystem analysis in promoting sustainable farming practices	2
Steps involved in agro-ecosystem analysis -Detailed overview of the step-by-step process of conducting agro-ecosystem analysis -Planning, data collection, analysis, and interpretation stages	1
Methodology of agro-ecosystem analysis -Understanding the methodologies and approaches used in agro-ecosystem analysis - Experimental design, case study methods, and modeling techniques	1
Energy flow of agro-ecosystem analysis -Exploring the energy flow and nutrient cycling in agro-ecosystems -Quantifying energy inputs and outputs in agricultural systems	1
Participatory rural appraisal related terms - RRA, PRA, PLA, PLAM - Definitions and distinctions between RRA, PRA, PLA, and PLAM - Understanding the purpose and scope of participatory rural appraisal approaches	1

Topic	No. of Classes
Philosophy of PRM (Participatory Rural Management) -Exploring the underlying philosophy and principles of participatory rural management -Empowering communities and enhancing local decision-making processes	1
Participatory planning framework -Introduction to the participatory planning framework -Steps involved in facilitating participatory planning processes	1
Importance of participation -Understanding the significance of participation in development initiatives -Benefits of involving local communities in decision-making and planning	1
Principles of participatory extension -Key principles and approaches for implementing participatory extension programs -Enhancing farmer engagement and knowledge sharing	1
Participatory technology development process -Exploring the steps and stages of participatory technology development	1
Involvement of farmers in the design, testing, and dissemination of agricultural technologies	1
Total	**16**

Practical

Topic	No. of Classes
Concepts related to agro-eco system analysis for natural farming	1
Visit to nearest natural farm and understand the agro-eco system	1
Simulated exercise on space related methods	1
Documenting the energy flow of agro-eco system analysis	1
Arrange a debate on agro-eco system analysis and sustainable agriculture	1
Study the tools of PRA - Diagramming – Interviewing	1
Study the tools of PRA - Preference ranking - Mapping and Modeling	1
Conducting agro eco system analysis using PRA tools and techniques in village situation	1
Steps in participatory technology development process	1
Learn the techniques of action plan development	1
Tools and techniques used in agro eco system analysis – Space analysis	1

Topic	No. of Classes
Tools and techniques used in agro eco system analysis – Time analysis	1
Tools and techniques used in agro eco system analysis – Flow analysis	1
Tools and techniques used in agro eco system analysis – Decision analysis	1
Study the software related for agro eco system analysis	1
Develop a model related to agro eco system suitable to your area	1
Total	**16**

Course Title : Beneficial Insects

Course Code : NF-224

Credits Hours : 3 (2+1)

General Objective

i) To provide comprehensive knowledge to the students on beneficial insects of various kinds.

Specific Objectives

i) To teach students the role of beneficial insects *viz.*, pollinators, decomposers, predators and parasitoids, soil builders, productive insects.

ii) 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 & 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.

Practicals

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 & habitats of beneficial insects, crop wise applications of beneficial insects for pest control.

Learning Outcomes

1. The students will acquire comprehensive knowledge on the role of beneficial insects *viz.*, pollinators, decomposers, predators and parasitoids, soil builders, productive insects under natural farming

Teaching Methods/Activities

- Lectures
- Assignment (Writing/Reading)
- Students presentation
- Group activities
- Hand on experience through practical classes

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 Edition). New Vishal Publications
10. Reddy, A, Anusha, C., Ramprasad, B., Kumar, R & V. Daravath. 2022. Importance of Beneficial Insects in Agriculture. In Research Trends in Multidisciplinary Research and Development (pp.7-24). Wiser publications, Germany.

Lecture Schedule

Theory

Topic	No. of Classes
Ecological understanding of insects in natural farming	1
Economic classification of insects based on importance	1
Life cycle, population dynamics and interaction of insects with abiotic and biotic components in a natural farming ecosystem	1
Introduction to beneficial insects	1
Insects in ecological communities - Insects as food, soil builders and insects of aesthetic value	1
Insects as decomposers in natural farming system	1
Pollinators in natural farming systems, their kinds, types, diversity, conservation and profitable use for enhancing productivity in terms of quality and quantity	1
Natural enemies of insects - generalist predators, specific predators	1
Natural enemies of insects - parasitoids (egg, larval, pupal & intermediary)	1
Mass production and use of important natural enemies	1
Promotion of required habitat for friendly insects	1
Honey bee species, castes, social biology	1
Communication in honey bees	1

Topic	No. of Classes
Site selection for apiary, bee pasturage, crop pollination and seed production	1
Hive inspection and maintenance of hive records	1
General and seasonal management of honey bees and protecting bees from pesticide poisoning	1
Methods for mass rearing of queen bees	1
Insect, mite and bird enemies of honeybees	1
Brood and adult diseases of honey bees and their management	1
Bee products - specification and uses of honey, bees wax, bee pollen, propolis, bee venom, royal jelly	1
History, development and importance of sericulture	1
Silkworms - kinds and their hosts, systematic position, distribution, lifecycles	1
Moriculture - Mulberry varieties, package of practices and management of pests, diseases and nutritional disorders	1
Silkworm - races, morphological features, silk glands	1
Silkworm rearing house and equipments	1
Pests and diseases of silkworm, disinfection and hygiene	1
Grainge, packing and transportation of eggs, incubation, black boxing, hatching of eggs	1
Cocoon characters - colour, shape, hardiness and shell ratio. Defective cocoons and stifling of cocoons. Uses of silk and by-products	1
History of lac culture and lac growing areas in India, Lac insects, biology and behavior	1
Kinds of lac and lac products and enemies of lac insects	1
Knowledge and importance of beneficial insects in ancient India	1
Indigenous technical knowledge on management of insect pests	1
Total	**32**

Practicals

Topic	No. of Classes
Identification of useful and harmful insects based on economic classification	1
Identification of honey bee species, castes, and life stages in honey bees	1
Types of beehives, beekeeping equipments, specification and uses	1

Topic	No. of Classes
Site selection for apiary, hive inspection and maintenance of hive records and Identification of bee pasturage, pollen and nectar yielding plants	1
Visit to apiary - Dividing, uniting bee colonies, providing super and artificial feeding	1
Identification and management of pests and diseases of honey bees	1
Honey extraction, processing, purity testing, identification of bee products - bees wax, bee pollen, propolis, bee venom, royal jelly	1
Preparation of mulberry cuttings, planting methods under irrigated and rainfed conditions	1
Maintenance of mulberry garden-pruning, fertilization, irrigation, leaf and shoot harvest	1
Mulberry pests, diseases and nutritional disorders	1
Kinds of silkworms and morphology of mulberry silkworm	1
Equipments for silkworm rearing -. Rearing room requirements - Chawki rearing and late age silkworm rearing and types of mountages	1
Pests and diseases of silkworm and their management - Economics of silk production	1
Lac cultivation, food plants, pruning, inoculation, cropping	1
Kinds of lac and lac products and enemies of lac insects	1
Identification and mass production of predators and parasitoids	1
Total	**16**

Course Title : Quantification and Valuation of Ecosystem Services

Course Code : NF-225

Credits Hours : 3 (2+1)

General Objective

i) To familiarize the students understand with key concepts and processes in ecosystems, complexity, visible and invisible benefits

Specific Objectives

i) To orient the students with basic concepts of ecosystems services

ii) 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.

Practicals

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).

Learning Outcomes

1. Understand the fundamental concepts of ecosystem services
2. List out the visible and invisible benefits of ecosystems
3. Gain expertise in quantification of ecosystems
4. Learn about valuation of ecosystems services

Teaching Methods/Activities

- Lectures/ Participatory Lecture
- Assignment (Writing/Reading)
- Students’ presentation
- Group/ Team activities
- Hands on experience

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%20Papers/policy%2094.pdf

Lecture Schedule

Theory

Topic	No. of Classes
The Economics of Ecosystems and Biodiversity (TEEB), United Nations Environmental Programme (UNEP), , United Nations Framework Convention on Climate Change (UNFCCCoPs), World Trade Organization (WTO) and ecosystem services	1
Definition, concepts, significance and objectives of ecosystem services (ES)	1
Kind of ecosystem services and their indicators	1
Functional categorization of ecosystem services	1
Definitions and concepts of Natural capital, produced capital, social capital and human capital	1
I-Provisioning ecosystem services and their indicators (eg. Food, Fiber, Fuel, Biochemical, Genetic resources etc.)	1
II-Provisioning ecosystem services and their indicators (eg. Food, Fiber, Fuel, Biochemical, Genetic resources etc.)	1
I-Regulating ecosystem services (eg. Climate regulation, Water regulation, Water purification, Disease regulation etc.)	1
II-Regulating ecosystem services (eg. Climate regulation, Water regulation, Water purification, Disease regulation etc.)	1
I-Cultural Services (Recreation and eco-tourism, Spiritual and Religious, Aesthetic, Educational etc.)	1

Topic	No. of Classes
II-Cultural Services (Recreation and eco-tourism, Spiritual and Religious, Aesthetic, Educational etc.)	1
Supporting ecosystem service (Soil formation, Nutrient recycling, Primary production, Supporting biodiversity etc.)	1
Definition, concepts of ecosystem dis-services	1
Differences between ecosystem services and ecosystem disservices	1
I-Framework and method for estimation and valuation of provisioning ecosystem services	1
II-Framework and method for estimation and valuation of provisioning ecosystem services	1
I-Framework and method for estimation and valuation of regulating ecosystem services	1
II-Framework and method for estimation and valuation of regulating ecosystem services	1
I-Framework and method for estimation and valuation of cultural ecosystem services	1
II-Framework and method for estimation and valuation of cultural ecosystem services	1
I-Framework and method for estimation and valuation of supporting ecosystem services	1
II-Framework and method for estimation and valuation of supporting ecosystem services	1
Valuing ecosystem services in the total economic value (TEV) framework	1
I-Payment of Agri-ecosystem services (PAES)	1
II- Payment of Agri-ecosystem services (PAES)	1
Sustainable livelihood security and their valuation	1
Indigenous agri-practices and ecosystem services	1
Modern agri-practices and ecosystem services	1
Good agricultural practices (GAP) for improving ecosystem services	1
Carbon trading and ecosystem services	1
Tangible benefits of the ecosystem services	1
Intangible benefits of the ecosystem services	1
Total	**32**

Practical

Topic	No. of Classes
Exposure visits on nature positive agri-practices	1
I- Concepts on tools used in estimation and valuation of ecosystem services eg. In Vest model	1
II- Concepts on tools used in estimation and valuation of ecosystem services eg. In Vest model	1
III- Concepts on tools used in estimation and valuation of ecosystem services eg. In Vest model	1
Methodology for calculation of provisioning ecosystem services valuation	1
Methodology for calculation of regulating ecosystem services valuation	1
Methodology for calculation of cultural ecosystem services valuation	1
Methodology for calculation of supporting ecosystem services valuation	1
I-Exposure visits of agri, agroforestry and forest systems and comparative estimation of carbon sequestration	1
II-Exposure visits of agri, agroforestry and forest systems and comparative estimation of carbon sequestration	1
Calculation of total economic value (TEV) of ESSs	1
I-Calculation and valuation of sustainable livelihood security index based on economic efficiency index (EEI), ecological security index (ESI) and social equity index (SEI)	1
I-Calculation and valuation of sustainable livelihood security index based on economic efficiency index (EEI), ecological security index (ESI) and social equity index (SEI)	1
Calculation of Agrobiodiversity index	1
Calculation and valuation of women empowerment	1
Payment of carbon credit in lieu of ecosystem services	1
Total	**16**

Course Title : Entrepreneurship Development and Business Communication

Course Code : EE-222

Credits Hours : 3 (2+1)

General Objective

i) To familiarize the students understand with key concepts and processes in entrepreneurship and business development

Specific Objectives

i) To orient the students with basic concepts of entrepreneurship ecosystem

ii) To impart knowledge and skill in business processes and project development

Theory

Concept of entrepreneur, Entrepreneurship development, Characteristics of entrepreneurs; SWOT Analysis & achievement motivation, Government policy and programs on MSMEs/SSI , export and import policy relevant in agriculture sector and institutions for entrepreneurship development, Impact of economic reforms on agribusiness/agri-enterprises, Entrepreneurial development process; Developing organizational skill (controlling, supervising, problem solving, monitoring & evaluation), Developing managerial skills, Business Leadership Skills (Communication, direction and motivation Skills), Problem solving skill, Supply chain management and Total quality management, Project planning, formulation and report preparation; Financing of enterprise, Opportunities for agri-entrepreneurship and rural enterprise.

Practicals

Assessing entrepreneurial traits, problem solving skills, managerial skills and achievement motivation, exercise in creativity, time audit through planning, monitoring and supervision, identification and selection of business idea, preparation of business plan and proposal writing, visit to entrepreneurship development institute and entrepreneurs.

Learning Outcomes

At the end of the course, students will be able to:

1. Understand the fundamental concepts of entrepreneur and enterprises.
2. List out the traits of an entrepreneur.
3. Gain expertise in business process and formulation of business project.
4. Learn about entrepreneurial schemes and entrepreneurship development institutes.

Teaching Methods/Activities

- Lectures/ Participatory Lecture

- Assignment (Writing/Reading)
- Students presentation
- Group/ Team activities
- Hands on experience

Suggested Readings

1. A Handbook of Agricultural Entrepreneurship by Lokesh Gupta, Rekha Vyas, S.K. Sharma, Suriti Gupta, Amit Kumar. ISBN: 978-93-90425-464, 2022. Pages 526, Publisher- International Books Periodicals Supply Service, New Delhi.
2. Bhaskaran, S. 2014. Entrepreneurship Development & Management. Aman Publishing House, Meerut.
3. Gupta, C.B. 2001. Management: Theory and Practice. Sultan Chand and Sons, New Delhi.
4. Indu Grover 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Publishing Academy, Udaipur.
5. Khanka, S.S. 1999. Entrepreneurship Development. S. Chand and Co., New Delhi.
6. Mary Coulter 2008. Entrepreneurship in Action. Prentice Hall of India Pvt. Ltd., New Delhi.
7. Mohanty, S.K. 2009. Fundamentals of Entrepreneurship. Prentice Hall of India Pvt. Ltd., New Delhi.
8. Sagar Mondal and Ray, G. L. 2003. Text Book of Entrepreneurship and Rural Development. Kalyani Publishers, Ludhiana.
9. Singh, D. 1995. Effective Managerial Leadership. Deep and Deep Publications, New Delhi.
10. Vasanta Desai. 2000. Dynamics of Entrepreneurial Development and Management. Himalaya Publishing House, New Delhi.

Lecture Schedule

Theory

Topic	No. of Classes
Concept and definition of entrepreneur and entrepreneurship	2
Characteristics, functions and types of entrepreneur	2
SWOT analysis	1
Achievement motivation	1
Government policy and programmes on MSME & SSI for ED	2

Topic	No. of Classes
Export and import polices relevant in agricultural sector	2
Institution for entrepreneurship development	1
Impact of economic reforms on agribusiness/ agri-enterprises	1
Entrepreneurial development process	2
Business leadership skills (Communication, direction and motivation skill)	2
Developing organizational skill (controlling supervises problem solving, monitoring and evaluation)	2
Developing managerial skills and business leadership skill	2
Problem solving skill	1
Supply chain management and Total Quantity or quality Management	2
Project Planning, formulation, and report preparation	3
Financing of enterprise	2
Opportunities for agri- entrepreneurship and rural enterprise	2
Review of the entire course	2
Total	**32**

Practicals

Topic	No. of Classes
Assessing entrepreneurial traits	2
Problem solving skill	1
Managerial Skill	1
Achievement motivation	1
Exercise in creativity	1
Time audit through planning, monitoring and supervision	1
Identification and selection of business idea	2
Preparation of business plan and proposal writing	2
Exercise on problem solving Skill	2
Field visit for SWOT analysis	1
Field visit to a successful farm/ enterprise	1
Visit to entrepreneurship development institute	1
Total	**16**

Semester V

Course Title : Post-Harvest Management -I

Course Code : NF-311

Credits Hours : 3 (2+1)

General Objective

i) To impart knowledge to the students about post harvest management practices of fruits and vegetables.

Specific Objectives

i) To develop skills for primary and secondary processing, mechanical and biocontrol practices for storage of fruits and vegetables.

ii) 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 postharvest 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.

Practicals

Demonstration and use of different harvesting tools, Practical demonstration on packhouse operations, Study of different preservation methods for fruits, and vegetable, 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.

Learning Outcomes

1. To develop trend manpower for post-harvest management of fruits and vegetables.

Teaching Methods/Activities

- Lectures/ Participatory Lecture
- Assignment (Writing/Reading)
- Students' presentation
- Group/ Team activities
- Hands on experience

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 & 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 & 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 Edition, CABI.
10. Yahia, E.M. 2019. Postharvest Technology of Perishable Horticultural Commodities. United Kingdom: Elsevier.

Lecture Schedule

Theory

Topic	No. of Classes
Post-harvest management: Importance of fruits and vegetables	1
Introduction to postharvest physiology of fruits and vegetables	1
Post-harvest losses and maturity indices	2
Harvesting methods and collection devices	1
Unit operations in packaging with emphasis on use of natural products like bee wax, gum Arabic, shellac, xantham gum etc.	2
Environment friendly and safe ripening methods	1
Post-harvest diseases, disorders and their management	2
Storage techniques: Traditional and modern storage structures, On farm and off farm storage	1
Refrigerated storage, refrigerated vehicles	1
Evaporative cool chambers	1
Storage techniques for local cultivars seeds	1
Value addition: Principles and methods of preservation	2
Natural preservatives, Phytochemicals for preservation	1
Indigenous and traditional preservation techniques	1

Topic	No. of Classes
FSSAI, BIS, and Codex standards for major processed products from fruits and vegetables	1
Value addition in fruits and vegetables through drying and pickling	1
Value addition in fruits and vegetables through and jam, jelly, marmalade	1
value addition in fruits and vegetables through preserve (murabba), candy, crystallized products	1
value addition in fruits and vegetables through juice, ready-to-serve, squash, nectar	1
Minimal processing	1
Eco-friendly handling and packaging	1
Use of essentials oils and ecofriendly phytochemicals in postharvest handling	2
Edible films and coating, eco or bio-based polymeric films used for packaging	1
Modified atmosphere packaging	1
Vacuum Packaging, Smart packaging, Active Packaging using natural or bio-colours	1
ITKs for handling and packaging	1
Neem-based products for fruit and vegetable handling	1
Total	**32**

Practicals

Topic	No. of Classes
Demonstration and use of different harvesting tools	1
Practical demonstration on packhouse operations	1
Study of different preservation methods for fruits, and vegetable	1
Study of weight loss of produce in eco-friendly packaging	1
Determination of TSS and acidity in fresh and processed products	1
Determination of ascorbic acid	1
Determination of sugars	1
Study of different types of dryers	1
Study of evaporative cooling system/low cost cooling system/Zero Energy Cool Chamber	1
Preparation of traditional value-added products from fruits and vegetables	1

Topic	No. of Classes
Preparation of jam	1
Preparation of jelly	1
Preparation of fruit-based beverages	1
Preparation of pickles	1
Study of different packaging materials	1
Visit to industry/processing unit	1
Total	**16**

Course Title : Bio-resources and Agricultural Waste Management

Course Code : NF-312

Credits Hours : 3 (2+1)

General Objective

i) To acquaint students with the knowledge and skills on management of bioresources and agricultural wastes into wealth for enhancing productivity and quality of agroecosystems.

Specific objectives

i) To impart knowledge on various aspects of biowastes and agricultural wastes for managing as organic amendments in agricultural production system.

ii) 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 (Jeevamrutha) 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,. Life style for Environment (LiFE) and Govt. schemes to promote agriculture waste into wealth.

Practicals

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 & 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.

Learning Outcomes

1. Awareness and knowledge dissemination.
2. Competent human resources with skills on wastes to wealth.
3. Increased acreage under natural farming practices.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students' presentation
- Group activities
- Hands on experience

Suggested Readings

1. Agricultural Waste Diversity and Sustainability Issues.2021. Ed(s): Peter Onu, Charles Mbohwa. Academic Press. pp 187.
2. D.C. Joshi and S.R. Choudhary B.N. Swami. 2006.Agricultural Organic Waste-Ii (Management for Crop Production).
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. Deepthi Reddy M. Devender, Roja Mandapati. 2018. Agricultural Waste Management ICAR, New Delhi
5. M.S. Shaktawat, N.C. Aery, M.K. Katewa Mohan Singh, B.N. Swami .2004. Phosphate Rich Organic Manure (Prom).
6. Waste water Management/ Garbage disposal and Management. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 & 2); Document 3; Publ: ICAR New Delhi.
7. Zainul Akmar Zakaria. 2019.Sustainable Technologies for the Management of Agricultural Wastes (Applied Environmental Science and Engineering for a Sustainable Future)

Lecture Schedule

Theory

Topic	No. of Classes
Introduction to bio-resources and agricultural biomass waste	1
Classification and characterization of agri and livestock, biomass waste	1
Annual production of different crops, quantum of biomass generated, rank in residue generation and residue to crop ratio in India	1
Extent of burning of biomass obtained from different sources in India	1
Negative consequences of biomass burning	1
Meta analysis on the health risk of biomass burning in India and World	1
Emission of greenhouse gases and air pollutants from biomass burning	1
Principles of agricultural waste management: 4R's approach, Potential of recyclable crop residues and its management	1
Crop residues as an important source of silicon, Development of green technologies for recovery of silica from crop residues	1
In-situ management of agricultural waste	1
Conservation agriculture-based crop residue management technologies	1
Analysis of the B:C ratio and socio-economic impacts of residue incorporation in conservation agriculture vis-à-vis residue burning for both short- and long-term scale	1
Bioenergy and biofuel production from crop residues – a probable renewable energy program	1
Effect of crop residues on soil health and carbon sequestration	1
Role of soil and plants in waste management	1

Topic	No. of Classes
Impact of agro-waste on soil and plant quality and the environment	1
Management of crop residues for improving input use efficiencies by regulating various soil biochemical properties	1
Impact of crop residue management in controlling soil degradation	1
Impact of management of crop residues on farmers livelihood	1
Constraints of effective crop residue management in India and possible solutions	1
Pre-treatment (Jeevamrutha) of agricultural wastes	1
Pre-treatment methods: biological treatment	1
Biological-processes of waste management	1
Bio-conversion/bio decomposition through native microflora biogas generation	1
Operation and management of biogas plants	1
Utilization of biogas and spent slurry	1
Utilization of landfill	1
Farm waste management machinery	1
Environmental benefit of waste management	1
ITK information on waste management as compiled by ICAR	1
Capacity building and awareness generation about impacts of crop residue burning	1
Laws and legislation to manage crop residue burning in India and World and financial resource mobilization for management of crop residues	1
Total	**32**

Practical

Topic	No. of Classes
Collection and preparation of agricultural waste sample	1
Characterization of agricultural waste	1
Determination of ash content of agricultural wastes	1
Determination of un-burnt carbon in ash	1
Determination of pH, EC and CEC	1
Determination of BOD and COD	2

Topic	No. of Classes
Nutrient status (N) analysis of agricultural waste	1
Nutrient status (P& K) analysis of agricultural waste	2
Nutrient status (micronutrients) analysis of agricultural waste	1
Survey of different agri waste from livestock and dairy	1
Survey of different agri waste from food processing, fruit & vegetable and agri-chemicals and methods of their management	2
Study of biogas production process and methods of briquetting of agricultural residues	1
Study of important commercial agriculture waste management methods in public and private sector	1
Total	**16**

Course Title : Medicinal and Aromatic Plants

Course Code : NF-313

Credits Hours : 2 (1+1)

General Objective

i) To acquaint students with the knowledge and skills on cultivation practices of medicinal and aromatic plant under natural farming norms.

Specific objectives

i) To impart knowledge on diversity of medicinal and aromatic plants, and their utilities.

ii) 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*).

Practicals

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. Panda H., Hand Book of Ayurvedic Medicines, National Institute of Industrial Research, Delhi.
2. CSIR – Cultivation and Utilization of Medicinal Plants.
3. Brahmvarchas, Ayurved ka Pran: Vanoshadhivigyan, Vedmata Gayatri Trust, Shaktikunj Haridwar.
4. Chaudhry R. D., Herbal Drug Industry, Eastern Publication.
5. Atal and Kapoor, Cultivation and Utilization of Medicinal Plants, RRL

Jammu Tavi. 1982.

6. Raphael Ikan, Natural Products: A Lab Guide, Academic Press, 1991, 2nd edition.
7. Dutt Ashwin. An Introduction to Medicinal Plants, Adhyayan Publishers and distributers, 2009.
8. Lecture Schedule awaited Practical and theory.

Lecture Schedule

Theory

Topic	No. of Classes
Introduction to medicinal plants-Definition, history, present and future needs	1
Introduction to botany of medicinal plants (fruit, leaves, roots, stem, seeds and their modification)	1
Important Indian Medicinal Plants	1
Cultivation and storage practices of amla, behra, harad and turmeric	1
Cultivation and storage practices of garlic, bitter gourd, black plum, fenugreek	1
Cultivation and storage practices of cinnamon, sarpagandha, black pepper	1
Cultivation and storage practices of ashwagandha, psyllium	1
Cultivation and storage practices of onion, basil, arjun, neem	1
Cultivation and storage practices of *Aloe vera*, brahmi, giloy	1
Cultivation and storage practices of shankhpushpi, bael, pot marigold	1
Important aromatic Plants, their identification and uses	1
Processing and value addition of medicinal plants	2
Processing and value addition of aromatic plants	2
Marketing of medicinal and aromatic plant products	1
Total	**16**

Practical

Topic	No. of Classes
Identification of locally available common medicinal plants	1
Basic preparation of herbal product: Kadha	1

Topic	No. of Classes
Basic preparation of herbal product: powder (Ex. Neem leaf, moringa leaf, tulsi leaf, giloy, arandana)	1
Basic preparation of herbal product: Juice (Ex. amla, *Aloe vera*)	1
Basic preparation of herbal product: Trifala	1
Basic preparation of herbal product: Chavanprash	1
Basic preparation of herbal product: Amla candy	1
Basic preparation of herbal product: Herbal tea	2
Study and documentation of commercial production of at least five medicinal plants	2
Submission of digital photo album of at least ten medicinal plants with brief description	2
Cultivation, maintenance and reporting of five regional medicinal plants within college campus	2
Total	**16**

Course Title : Seed Production Technology

Course Code : NF-314

Credits Hours : 3 (2+1)

General Objective

i) To develop knowledge and understanding on Seed Production Technology in the context of Natural Farming

Specific Objective

i) To make the students aware about concept of seed and quality of seed.

ii) Principles of seed production of important cereals, pulses, oilseeds, fodder crops vegetables.

iii) 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.

Practicals

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.

Learning Outcomes

1. Awareness and knowledge dissemination.
2. Competent human resources with skills on wastes to wealth.
3. Increased acreage under natural farming practices.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students' presentation

- Group activities
- Hands on experience

Suggested Readings

1. Andersen MM, Landes X, Xiang W, Anyshchenko A, Falhof J, Osterberg JT, et al. Feasibility of new breeding techniques for organic farming. Trends Plant Sci. 2015; 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.
3. Chahal, G.S. and S.S. Ghosal. 2019. Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches. Narosa Publishing House Pvt. Ltd. New Delhi.
4. Dawson JC, Murphy KM, Jones SS. Decentralized selection and participatory 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. 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. Evolutionary plant breeding for low input systems. J Agric Sci. 2005; 143:245.
9. Singh, B.D. 2018. Plant Breeding-Principles and Methods. Kalyani. Publishers, Ludhiana.

Lecture Schedule

Theory

Topic	No. of Classes
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	6
Seed Physiology: Seed germination, viability, seed dormancy, types and requirements of seed germination	3
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	7
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	5
Seed health, quality, seed collection from natural farming: 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	6
Sample case studies of a few farmer initiatives 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	5
Total	**32**

Practicals

Topic	No. of Classes
Seed production in major self-pollinated crops	2
Seed production in major cross pollinated crops	1
Seed production in selected vegetable crops	1
Seed sampling procedures: Seed testing: Steps, Physical purity, moisture test, varietal purity	2
RPL, germination, viability, Grow out test and electrophoresis, etc. Seedling vigour tests	2
Seed health tests, Genetic purity test: moisture tests, heterogeneity	2

Topic	No. of Classes
Seed certification: Procedure, Field inspection, Field counts Preparation of field inspection and seed testing reports	2
Seed collection and rural methods of improved storages	2
Visits to seed production farms, seed testing laboratories and seed processing plants	2
Total	**16**

Course Title : Value Chain Management in Natural Farming

Course Code : NF-315

Credits Hours : 2 (1+1)

General Objective

i) To study the value chain management in natural farming: value chains, pricing and valuation of natural resources; Market initiation and strategies, organization of value chains, roles and responsibilities of stakeholders of value chain.

Specific Objectives

i) Role and importance of value chains, value chain models

ii) 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 organization 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.

Practicals

Case studies and success stories on natural 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.

Learning Outcomes

1. Knowledge and skill development.
2. Practical knowledge about applied aspects of the subject.

Teaching Methods/Activities

- Lectures
- Interaction
- Field visits
- Hand on experience
- Group activities such as brainstorming and group discussion
- Assignment (Writing/Reading)
- Student's presentation

Suggested Readings

1. Carlson, G.A., Miranowski, J., & 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. & Harshwardhan. 2022. Agriculture value chains in India. Springer Open Access Book, India Studies in Business & 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.

Lecture Schedule

Theory

Topic	No. of Classes
Concept of agriculture value chain and characteristics	1
Types of value chains and their role and importance	1
Dynamics of renewable and non-renewable resources	1
Resource scarcity of natural resources	1
Pricing of natural resources	1
Valuation of natural resources	1
Good agriculture practices, manufacturing practices and processing practices	1
Value chain models- producer driven, buyer driven	1
Value chain models-facilitated driven models.	1
Role of farmer producer organization in value chains of natural farming products	1
Organization of value chains, Roles and responsibilities of stakeholders	1
Transportation logistics and infrastructure, Cold chain components	1
Dispute resolutions and arbitration and Physical asset collateralization	1
Quality certification like HACCP and FSSAI standards, Postharvest and quality aspects for domestic and export market	1
Value-added aspects for domestic and export market special economic zones	1
Theories of storage and warehouses, Classification, advantages and disadvantages of storage and warehouses	1
Total	**16**

Practical

Topic	No. of Classes
Case studies on natural farming value chains in India and abroad	2
Success stories on natural farming value chains in India and abroad	2
Environmental resource accounting techniques- Concept	1
Stages of Environmental Accounting techniques	2

Topic	No. of Classes
Environmental Management Accounting (EMA)	1
Environmental Financial Accounting (EFA)	2
Environmental National Accounting	1
visit of special economic zones	1
Identification of value chains for commodities	1
Identification of niche markets for natural farming produces	1
Post-harvest loss assessment	2
Total	**16**

Course Title : Renewable Energy Sources

Course Code : NF-316

Credits Hours : 2 (1+1)

General Objective

i) To provide a comprehensive understanding of renewable energy sources, their applications, and their role in natural farming.

Specific Objectives

i) To gain the knowledge on different types of renewable energy sources.

ii) 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 & 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, Programmes and policies for promotion of renewable energy in India.

Practicals

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.

Learning Outcomes

1. Knowledge enhancement in the field of renewable energy sources.
2. Equipped with the knowledge and skills regarding renewable energy technologies.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience

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 & 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.

Lecture Schedule

Theory

Topic	No. of Classes
Introduction to energy, Forms of energy, Conservation of Energy, Sources of energy and their classification	1
Energy consumption patterns in India, Concept of renewable energy sources, Potential of renewable energy sources	1
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	1
Introduction of solar energy, Solar thermal energy systems: solar cooker, solar distillation, solar water heater and solar dryer	3
Solar photovoltaic systems and their different types & uses, soil solarization	2
Introduction of biomass, Biogas generation process, Types of biogas plants, application of biogas, usage of biogas spent slurry	2
Biomass Gasification, types of gasifiers, producer gas production and utilization	2
Introduction to ethanol, biodiesel and hydrogen production process	1
Wind Energy: Introduction, Traditional practices of wind energy, Windmills and their applications.	2
Role of renewable energy in carbon mitigation. Energy balance in natural farming, Programmes and policies for promotion of renewable energy in India.	1
Total	**16**

Practicals

Topic	No. of Classes
Visit to farm/sto study different sources of energy and their consumption	1
Study of solar cooker	1
Study of solar dryer	2
Study of solar water heater	1
Study of solar distillation	1
Study of solar photovoltaic system	2
Study of biogas plant	2
Study of biomass gasifier	2
Study the production process of biodiesel	1
Study of improved biomass cookstove	1
Traditional practices of wind energy	1
Determination of energy balance in natural farming	1
Total	**16**

Course Title : Natural Farming and Human Health

Course Code : NF-317

Credits Hours : 2 (1+1)

General Objective

i) To develop knowledge and understanding the beneficial effect of Natural farming on human health.

Specific Objectives

i) To make the students aware about concept of healthy food concept of Nutritional Garden, Homestead kitchen garden and Nutri smart village.

ii) 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 & 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, Life Style for Environment (LiFE Mission)

Practicals

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.

Learning Outcomes

1. Students will understand the beneficial effect of Natural farming on human health.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Student's presentation
- Group activities
- Hand on experience

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 & Ecology.
7. Shiva V, Shiva M and Singh V (2013). Poisons in Our Food- Links between Pesticides and Diseases, Natraj Publishers, Dehradun

Lecture Schedule

Theory

Topic	No. of Classes
Changing lifestyles and food habits of the people over the years, Health and disease statistics of world and India	1

Topic	No. of Classes
Need of healthy food, Concept of healthy food, safe food, organic food, green food, pesticide free food, fast food	2
Dietary guidelines and Recommended Dietary Allowances (RDA), food exchange list, food composition database, food composition and food groups	1
Traditional food vis-a-vis modern food and its potential health impact	1
Food Chain Contamination and human health hazards, Deficiency in micro-nutrients by the human and livestock population, Malnutrition	1
Concept of one health	1
Traditional food of Indian population: Food and their nutrient content. Traditional diets in Indian and their adequacy- Nutritional value of traditional food	1
Interrelationship between natural farming and human health	1
Effect of Natural farming on animal health	1
Criteria for classification of quality food and safe food, Human health – definition and philosophy, concept of health- biomedical, ecological, psychological and holistic, Criteria & qualities of organic and natural food	1
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	2
Food standards, food laws and labelling of natural foods, FSSAI guidelines	1
Concept of Nutritional Garden, Homestead kitchen garden and Nutri smart village, ITKs in human food and nutrition and health. Bio-fortification of crops	1
Heavy metal contamination (As, Cd, Fl, Ni, Cr): associate diseases and health disorders	1
Total	**16**

Practical

Topic	No. of Classes
Physical examination of foods, determination of gluten, bulk density, hydration capacity and index, oil absorption capacity	2
Sensory evaluation and organoleptic evaluation of natural and conventional foods	1
Analysis of proximate composition in conventional foods and natural farming produce/foods based on available secondary data	2
Determination of pesticide residues and heavy metal contamination in foods	1

Topic	No. of Classes
Market survey and listing of natural farming foods available in the market, Preparation of nutri-thali	1
Composition of nutrient in different crop plants Effect of processing on nutritive value of food	2
Determination of pesticides load in the food stuffs Glycemic index of common food	1
Macro – nutrient and micro – nutrient and their sources, Minor millets and its micronutrient supply potential and meeting nutritional requirement	2
Calorie requirement among different class of population. Balance diet for different class of people	1
Drinking water standard - limits of heavy metals content	2
Medicinal crops, their identification and their diseases curing potential	1
Total	**16**

Course Title : Fundamentals of Entomology

Course Code : ENTO

Credits Hours : 3 (2+1)

General Objective

i) To impart comprehensive knowledge to the students on external morphology, anatomy of different systems, classification and identification of insects up to family level.

Specific Objectives

i) To teach the students on external morphology and anatomy of different systems of insects.

ii) To teach the students on classification and identification of insects up to 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.

Practicals

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.

Learning Outcomes

1. The students gain knowledge on external morphology of the insect along with knowledge on basic aspects of anatomy of different systems, classification and identification of insects up to family level with hands-on experience.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience through practical classes

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.

Lecture Schedule

Theory

Topic	No. of Classes
Entomology in ancient India, Historical classics of modern Entomology	1
Classification of phylum Arthropoda up to classes - Relationship of class Insecta with other classes of Arthropoda	1
Structural, morphological and physiological factors responsible for dominance of Insecta in animal kingdom	1
Structure and functions of insect cuticle and moulting	1
Structure of insect head and its appendages	1
Structure of insect thorax and its appendages	1
Structure of insect abdomen and its appendages	1
Structure of alimentary canal and its modifications	1
Excretory organs - malpighian tubules and accessory excretory organs	1
Respiratory system - structure and types of respiratory system - types of spiracles - respiration in aquatic and endoparasitic insects.	1
Circulatory system - circulation of blood - composition of haemolymph	1
Nervous system - structure of neuron - types of nervous systems	1
Axonic and synaptic transmissions of nerve impulses	1
Reproductive systems - male and female reproductive systems in insects	1
Types of reproduction - oviparous, viviparous, paedogenesis, polyembryony ovoviporous and parthenogenesis	1

Topic	No. of Classes
Types of metamorphosis - Immature stages of insects	1
Sense organs in insects	1
Glandular system in insects - exocrine and endocrine glands and their function	1
Tropism and biocommunication in insects	1
Systematics - principles and procedures of classification and nomenclature of insects	1
Distinguishing characters of insect orders - Apterygota (Thysanura, Diplura, Protura and Collembola), Exopterygota - (Ephemeroptera, Odonata and Phasmida)	1
Orthoptera (Ensifera - Tettigonidae, Gryllidae and Gryllotalpidae; Caelifera - Acrididae), Dictyoptera, Dermaptera and Embioptera	1
Isoptera - social life in termites, Thysanoptera, Pscoptera, Mallophaga and Siphunculata	1
Hemiptera – Homoptera (Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophidae, Aleurodidae, Pseudococcidae)	1
Hemiptera - Heteroptera (Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae)	1
Endopterygota - Classification of Lepidoptera – Butterfly families (NymphalidaePieridae, Papiloinidae and Hesperiidae)	1
Classification of Lepidoptera - Moth families (Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturnidae, Bombycidae)	1
Classification of Coleoptera – Suborder: Adephaga (Carabidae, Cicindellidae, Dytiscidae)	1
Classification of Coleoptera - Suborder: Polyphaga (Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae)	1
Diptera – (Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae)	1
Hymenoptera (Tenthridinidae, Apidae, Trichogrammatidae, lchneumonidae, Braconidae, Chalcididae)	1
Neuroptera (Chrysopidae); Siphonaptera	1
Total	**32**

Practical

Topic	No. of Classes
Observations on external features of grasshopper/cockroach and other members of phylum Arthropoda	1
Methods of insect collection, preservation, display and storage	1
Types of insect head and antenna	1
Mouth parts of cockroach, modifications in the mouth parts in plant bug, female mosquito, honeybee, thrips, antlion grub, house fly, moths and butterflies	1
Structure of thorax and abdomen and their appendages - modifications in insect legs and wings - wing venation, regions and angles - wing coupling.	1
Types of immature stages of insects	1
Study of digestive system.	1
Study of male and female reproductive systems	1
Observing the characters of Apterygota - Collembola and Thysanura and Exopterygota - Odonata and Ephemeroptera and Phasmida	1
Observing the characters of Dictyoptera, Dermaptera, Embioptera, Orthoptera (Ensifera - Tettigonidae, Gryllidae and Gryllotalpidae; Caelifera - Acrididae and Tetrigidae), Mallophaga and Siphunculata	1
Observing the characters of Exopterygota - Isoptera and Hemiptera - Homoptera (Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophidae, Aleurodidae, Pseudococcidae); Heteroptera (Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae)	1
Observing the characters of orders Thysanoptera and Diptera (Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae)	1
Observing the characters of Hymenoptera (Tenthridinidae, Apidae, Trichogrammatidae, lchneumonidae, Braconidae, Chalcididae)	1
Observing the characters of Coleoptera - Adephaga (Carabidae, Cicindellidae, Dytiscidae) Polyphaga (Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae)	1
Observing the characters of Lepidoptera - Butterfly families (Nymphalidae, Pieridae, Papilionidae and Hesperiidae), Moth families (Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturnidae, Bombycidae)	1
Observing the characters of Neuroptera (Chrysopidae) & Siphonoptera. Identification and naming of collected insects based on characters - order and family	1
Total	**16**

Semester VI

Course Title : Indian Traditional Knowledge

Course Code : NF-321

Credits Hours : 3 (2+1)

General Objective

i) To acquaint traditional knowledge in agriculture & allied sciences and its integration with modern science.

Specific Objectives

i) To equip the students with importance of Indian Traditional Knowledge.

ii) 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 system, 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.

Practicals

Case studies on validation of ITK's, 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).

Learning outcomes

1. Application of traditional knowledge for farm management
2. Enhanced research and use for improving conventional practices

Teaching methods

- Class room lectures
- Traditional Tools in practical
- Exposure visits

Suggested Readings

1. Indigenous Technical Knowledge in Agriculture- Geographical Indications of Plant Species. Document 5. 2004. Published by ICAR New Delhi. Pp 284.
2. Cross-sectoral Validation of Indigenous Technical Knowledge in Agriculture Document 4. 2004. Published by ICAR New Delhi. Pp 230.
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 (Supplement 1). 2002. Published by ICAR New Delhi. Pp 226.
6. Inventory of Indigenous Technical Knowledge in Agriculture. Document 1 (Supplement 2). 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

Lecture Schedule

Theory

Topic	No. of Classes
Traditional kKnowledge: Definition, Concepts and History, Difference between Traditional knowledge and Western Science	1
Vedic based Indian Traditional Knowledge: Strengths	1
Traditional knowledge on crop cultivation and its blending with modern science	1
Indian natural agricultural practices for crop production and livestock rearing	1
Traditional knowledge-based farming systems	1
Application and integration of traditional knowledge in farm machinery and implements	1

Topic	No. of Classes
Natueco farming, Permaculture, Rishi Krishi, homa farming, panchagavya Krishi applications and benefits	1
ITK based soil fertility management	1
Insect and disease management with traditional knowledge	1
Linkage between modern science and traditional knowledge	1
Significance of Intellectual Property Rights and protection of traditional knowledge and practices	1
Traditional water harvesting and irrigation systems	1
ITKs on processing and storage of grains	1
Traditional implements, advantages and need for its improvement	1
Need for Geo-spatial mapping of traditional knowledge and practices	1
Waste management practices in ancient era	1
Weather forecasting methods in ancient days	1
Case studies on ITK	1
Tribes in India and traditional tribal knowledge on agriculture	1
Characterization method for traditional practices	1
Biological interventions in improving traditional knowledge	1
Systemic transformation of Indian traditional knowledge	1
Need and ways for back to basics using traditional knowledge	1
Traditional marketing system	1
Ancient weed management practices	1
Ancient housing practices for livestock: Benefits and short comings	1
Native varieties and breed conservation system in ancient times	1
Global versus Indian literature on traditional knowledge	1
Aquaculture-Traditional knowledge	1
Properties of plants used in traditional practices	1
Ways and means to improve traditional knowledge systems	1
Need for preservation of traditional knowledge in agriculture	1
Total	**32**

Practical

Topic	No. of Classes
Identification of plants used in different traditional practices for soil health, test, disease and animal health management	1

Topic	No. of Classes
Biodynamic preparation	1
Preparation of Sashagavvya and Dasagavvya	1
Identification of traditional implements	1
Geo-tagging mechanism of traditional knowledge and practices	1
Passport data development for Indian traditional knowledge and practices	1
Traditional housing systems of livestock	1
Identification of pest and diseases and management with traditional knowledge	1
Storage pest management with traditional knowledge	1
Traditional farming systems: Exposure visit	1
Tribal knowledge and practices: Exposure visit	1
Traditional water storage and irrigation systems	1
Identification of native varieties of crops and breeds of livestock	1
Panchagavvya preparation	1
Livestock and human health management through ayurvedic preparations	1
Methodology for characterization of traditional inputs	1
Total	**16**

Course Title : Post-Harvest Management -II

Course Code : NF-322

Credits Hours : 3 (2+1)

General Objective

i) To impart knowledge to the students about post-harvest management practices of cereals, pulses and oil seeds.

Specific Objectives

i) To develop skills for primary and secondary processing, mechanical and biocontrol practices for storage pest management in cereals, pulses and oil seeds.

ii) 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 postharvest 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: Preslaughter 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.

Practicals

Study of physicochemical 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.

Learning outcomes

1. Development of trained manpower on eco-friendly post harvest management
2. Creation of skilled manpower in natural way of primary and secondary processing and preservation methods of natural farm produce.

Teaching methods

- Class room lectures
- Traditional Tools in practical
- Exposure visits

Suggested Readings

1. Sahay, K.M. and Singh, K.K. 2001. Unit Operations of Agricultural Processing, 2nd Ed. Vikas Publishing House Pvt. Ltd., Noida.
2. Chakraverty, A.K., 2008. Post-Harvest Technology of Cereals, Pulses and Oilseeds, 3rd Ed. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. 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.
4. Samuel A. Matz. 1991. The Chemistry and Technology of Cereals as Food and Feed, 2nd Ed. Springer Science + Business Media, NY, USA.
5. 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.
6. B.D. Sharma. 1999. Meat and Meat Products Technology Including Poultry Products Technology. Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi.
7. Alan H. Varnam and Jane P. Sutherland. 1995. Meat and Meat Products: Technology, Chemistry and Microbiology. Chapman & Hall, London.
8. William J. Stadelman and Owen J. Cotterill. 1995. Egg Science and Technology, 4th Ed. Food Products Press, NY, USA.
9. Cutting, C. L. 2002 Processing and Preservation of Fish. Agro Bios, New Delhi.
10. Mishra, R. (2022). Handbook on Fish Processing and Preservation. Taylor & Francis.

11. 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.

Lecture Schedule

Theory

Topic	No. of Classes
Physico-chemical and nutritive properties of cereals, pulses and oilseeds	2
Causes of postharvest losses in cereals, pulses and oilseeds	1
Traditional and modern storage structures for cereals, pulses & oilseeds	2
On farm and off farm storage of grain/seed of cereals, pulses & oilseeds	1
Bulk and bag storage (especially eco/bio-based bags)	1
Primary processing of cereals: Cleaning, grading, curing/tempering/ conditioning, pretreatments including parboiling	1
Primary processing of pulses: Cleaning, grading, curing/tempering/ conditioning, pretreatments including parboiling	1
Primary processing of oilseeds: Cleaning, grading, curing/tempering/ conditioning, pretreatments including parboiling	1
Secondary processing: Drying, size reduction (milling)	1
Oil seed milling: Ghanis, hydraulic presses, expellers	2
Extrusion processing and different types of extruded products (snack, breakfast cereals and weaning foods)	2
Bakery and confectionary products	2
Traditional value-added products (regional products like nuggets/wadi/badi, papad, vermicelli/sevai, etc.)	2
Storage Pest Management: Use of ITKs like oil treatment, ash treatment, bio-control practices for storage pest control of cereals, pulses and oilseeds	3
Primary processing operations in poultry: Preslaughter 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.	2
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.	2
Different value-added products from fish and meat	2
Hygienic handling and storage of fish: chilling or icing, refrigeration	1

Topic	No. of Classes
Pest infestations in stored fishery products, natural means to control pests infestation	1
Food-grade coatings as processing aids	1
Integrated pest management in post-harvest management of cereals, pulses and oilseeds	1
Total	**32**

Practicals

Topic	No. of Classes
Study of physicochemical properties of cereals, pulses and oils seeds	1
Determination of gluten content in wheat flour, Study of conditioning of wheat	1
Milling of wheat and rice by laboratory mill	1
Study of pre-treatment and milling of pulses	1
Study of oil expression equipment	1
Manufacture of value- added products; millets, guar gum and other minor crops	2
Study of primary processing of fish or meat	1
Study of preservation methods for fish/meat	1
Preparation of traditional value-added products from fish/meat	2
Preservation of meat/fish by freezing, curing, pickling and dehydration	2
Preparation of value-added poultry meat products	1
Quality evaluation and grading of eggs	1
Visit to processing facilities & documentation	1
Total	**16**

Course Title : Standards and Certification for Natural Farming

Course Code : NF-323

Credits Hours : 2 (2+0)

General Objective

i) To provide comprehensive understanding of standards and certification for natural farming systems and develop skills for certification of crop, livestock, aquaculture and other systems in natural farming.

Specific Objectives

i) To learn the natural farming standards and certification processes vis a vis other standards and certification in vogue.

ii) To impart the methods of certification in natural farming based set of standard practices.

iii) 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.

Learning Outcomes

1. Knowledge enhancement in the field of natural farming certification
2. Equipping knowledge on do's and dont's in natural farming system

Teaching methods/activities

- Lectures
- Assignment
- Student presentation

Suggested Reading

1. APEDA.2018. National Programme 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.

Lecture Schedule

Topic	No. of Classes
Scope and definitions for natural farming production system and labelling of naturally produced products, buffer zone, conversion period, compliance, habitat care, agrobiodiversity, parallel production, part conversion	2
Requirements for certification: crop production	3
Requirements for certification: Livestock production	2
Requirements for Certification: Aquaculture	2
Requirements for Processing and handling	2
Storage and transport requirements	2
Marketing requirements	2
Practices in soil preparation and enrichment	2
Practices for seed treatment	1
Practices for pest management	2
Practices for disease management	1
Procedures to evaluate additional inputs for natural farming	2
Ethical aspects for animal welfare and socio-economic aspects	1
Ingredients and processing aids	1
Packaging for naturally grown produces	1
International regulations on quality assurance and certification for non-chemical farming systems	2
National regulations for chemical free farming	2
ICT enabled documentation for certification and e-marketing	2
Total	**32**

Course Title : Aqua-based Natural Farming

Course Code : NF-324

Credits Hours : 3 (2+1)

General Objective

i) To develop a comprehensive knowledge among students on Aquaculture based Natural Farming.

Specific Objectives

i) To acquaint students about natural farming and technologies pertaining to aquaculture and their relationship with farming activities.

ii) 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, Biofertilizer, 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.

Practicals

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_3, 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,

Learning Outcomes

1. Knowledge and understanding of various aqua species and their production systems.
2. Knowledge of post harvest activities in aquaculture.
3. Knowledge about potential of aquaculture in rural development.

Teaching Methods/Activities

- Lectures
- Interaction
- Field visits
- Hand on experience
- Group activities such as brainstorming and group discussion
- Assignment (Writing/ Reading)
- Student's presentation

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 To 7, 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.

Lecture Schedule

Theory

Topic	No. of Classes
Definition and scope of aquaculture, Food web and food chain: Physical, biological components of aquatic ecosystem, Ecological structure and function of Aquatic ecosystem	2
An introduction to Genera: Biology and physiology of cultivable species	2
Organic matter recycling and nutrient cycles	3
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	2
Farm management and water qualities studies, Aquaculture techniques	3
Natural food and feeding behavior of fishes and shellfishes: Concept of ecosystem based aquaculture, Integration of crops, live-stock, horticulture and fish farming as complimentary activities	2
Marine aquaculture, Fishing Gears and crafts	2
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, Biofertilizer	3
Aquaculture and climate change, Natural productivity and carrying capacity, Secondary and tertiary production, Carrying capacity of aquaculture system and associated factors	2
Heterotrophic activities, energy and matter flow in the ecosystem, eutrophication and pollution	2
Potential of aquaculture development among fishing communities & entrepreneurship	1
Ornamental fish culture	2
Health management in aquaculture, Traditional techniques for curing fish diseases and pond management, Probiotics and bioremediation	2
Global aquaculture scenario, prospects of domestic & export markets	2

Topic	No. of Classes
Definition of reservoirs in India; nature and extent of reservoirs, pen and cage culture in reservoir	1
Renewable and eco-friendly bio-inputs in aquaculture, Management and conservation natural aquatic ecosystems	1
Total	**32**

Practicals

Topic	No. of Classes
Identification of important cultivable fish species.:Culture with standard methods	1
Estimation of carrying capacity	1
Practices on pre-stocking, stocking and post stocking management	1
Study on waste accumulation in aquaculture system (NH3, Organic matter, CO2)	1
Analysis of certified manure/natural aquaculture inputs	1
Measurement of important soil and water quality parameters and their correction measures with certified standard materials/inputs	1
Identification of different live food organisms and their rearing.	1
Case studies on cage and pen culture	1
Preparation of artificial feeds using locally available permitted feed ingredients	1
Case studies of aquaculture based entrepreneurs	1
Spotting various fishing equipments, exposure to various types of ornamental species	1
Post harvest, processing of aquaculture products	2
Diagnosis & management of infections & diseases in aquatic species	2
Water quality testing	1
Total	**16**

Course Title : Bio-resources and Agricultural Waste Management

Course Code : NF-325

Credits Hours : 3 (2+1)

General Objective

i) To relate the generalized concept of Agricultural marketing to Natural Farming produce.

Specific Objectives

i) To study about the specific concepts of marketing channels, price spread market segmentation and market margin.

ii) 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 & 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 market sand 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.

Learning Outcomes

1. Knowledge and skill development.
2. Practical Knowledge about applied aspects of the subject.

Teaching Methods/Activities

- Lectures
- Interaction
- Field visits
- Hand on experience
- Group activities such as brainstorming and group discussion
- Assignment (Writing/Reading)
- Student's presentation

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

Lecture Schedule

Theory

Topic	No. of Classes
Concepts and definition of market	1
Agricultural marketing- concepts and Types of Market	2
Marketing of natural farming products	1
Market structure, Marketing mix	1
Market segmentation, Demand and supply	1

Topic	No. of Classes
Producer's surplus of agricultural commodities- Concept	1
Marketable and Marketed surplus	1
Factors affecting the Marketable surplus	1
Pricing consideration	1
Approaches cost based and competition based pricing	2
Market promotion and publicity	1
Marketing management- Concept	1
Segmentation, targeting & positioning (STP)	1
Marketing function-physical function and facilitating functions	2
Market functionaries and their functions	1
Marketing channels and its types	1
Marketing efficiency and marketing costs	2
Concept of market margin and price spread	1
Role of government in marketing of natural farming products	1
Public sector institutions their role and functions-CWC	1
SWC- role and functions	1
Food Co-operation of India (FCI) - role and functions	1
CACP and APEDA	1
Digitalization in agricultural marketing	1
Risk in marketing-types of risks	1
Speculation and hedging	1
Forward markets and future markets	2
Total	**32**

Practical

Topic	No. of Classes
Study of relationship between market arrival and prices	2
Demand curves for natural farming produce	1
Supply curves for natural farming produce	1
Calculation of Elasticities of Demand	2
Calculation of Elasticity of Supply	1
Calculation of marketable and marketed surplus	1
Identification of market channels for selected commodities	2

Topic	No. of Classes
Computation of market margin and Price spread	2
Study of marketing institutions their organization and functioning.	2
Visit to marketing institutions- Local Mandi, Warehouse and Cold storage	2
Total	**16**

Course Title : Agronomic Practices

Course Code : NF-326

Credits Hours : 2 (1+1)

General Objective

i) To provide a comprehensive knowledge on agronomic practices relevant to agro-ecology specific natural farming.

Specific objectives

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

ii) 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 & 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.

Practicals

Identification 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.

Learning Outcomes

1. Awareness and knowledge dissemination
2. Competent human resources with skills on agronomic practices
3. Increased acreage under natural farming practices

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students' presentation
- Group activities
- Hands on experience

Suggested Readings

1. E Somasundaram and M Mohamed Amanullah (2017) Agronomy Principles and Practices, New India Publishing Agency, New Delhi.
2. B. Chandsrasekaran and E. Somasundram (2018) A Text book of Agronomy, New Age International Publication, New Delhi.

3. S. R. Reddy (2020) Principles of Agronomy, Kalyani publications. New Delhi
4. T. Yellamanda Reddy and G. H. Shankara Reddy (2016) Principles of Agronomy, Kalyani Publications, New Delhi.
5. A. P. Dwivedi (2019) Agroforestry principles and Practices, Oxford& IBH Publication.
6. 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.
7. 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.
8. 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.

Lecture Schedule

Theory

Topic	No. of Classes
Classification of crops- Field crops – Origin, distribution, economic importance, soil and climatic requirements, varieties	1
Cropping systems: definition, principles and its importance; physical resources, soil and water management in cropping systems	1
Importance of mixed cropping in natural farming: importance of multiple cropping, alley cropping, sequential cropping and intercropping	1
Cropping system indices -mechanism of yield advantage in intercropping systems: Complementary and competition relations	1
Multi storied cropping and yield stability in intercropping: Types of crops - trap, cover, catch and restorative crops, ITK related to crops and cropping systems	1

Topic	No. of Classes
Seeds- Traditional and recent varieties: classification of seeds, seed dormancy, nursery management, main field preparation	1
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	1
Methods of planting of crops, Time of planting of different crops & intercrops, Row spacing for different crops	1
Irrigation –Definition, irrigation types, water saving techniques and management	1
ITKs in irrigation and water management	1
Green manures and green leaf manures – Types of green manures, Ideal plant types for green manures.	1
Nutrient content and biomass contribution, time and method of incorporation, decomposition pattern, advantages and limitations	1
Weeds- Classification, habitat management of weeds, crop weed interaction, critical periods of weed competition, non-chemical weed management	2
Weed mulch, trap crop, biological and herbal measures Mulching – Types, cover crops – advantages and disadvantages	1
Soil moisture conservation approaches and water harvesting; ITKs on soil and water conservation, Alternate land use system – Definitions and types	1
Total	**16**

Practical

Topic	No. of Classes
Identification of various crops and their characteristic	1
Identification of various agronomical tools and implements in field preparation.	1
Identification of various seed and their characteristics	1
Study on different methods of seed treatment and seed dormancy	2
Study on different methods of seed sowing	1
Study on water requirement and water use efficiency of field crops	1
Identification of weeds in crops	1
Study on different agronomical practices of weed management	2
Study on different cropping system indices	2
Study on different mulching practices of field crops	2

Topic	No. of Classes
Study on different ITKs in crops and agronomic practices	2
Total	**16**

Course Title : Intellectual Property Rights

Course Code : Ag. IPR-210

Credits Hours : 1 (1+0)

General Objective

i) To develop a comprehensive knowledge and impart skills to students regarding meaning of intellectual property rights Types of Intellectual Property and legislations covering IPR in India.

Specific Objectives

i) To acquaint the students about filing of patent, patent specification, patent claims, Patent opposition and revocation

ii) 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.

Learning Outcomes

1. Knowledge about patenting system in India.
2. Inspiration towards innovation.

Teaching Methods/Activities

- Lectures
- Interaction
- Group activities such as brainstorming and group discussion
- Assignment (Writing/ Reading)
- Student's presentation

Suggested Readings

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

Lecture Schedule

Topic	No. of Classes
Introduction importance and meaning of intellectual property in changing agriculture scenario	1
brief introduction to GATT, WTO, TRIPs and WIPO, Treaties for IPR protection	1
Madrid protocol, Berne Convention, Budapest treaty, etc.;	1
Types of Intellectual Property and legislations covering IPR in India: - Patents, Copyrights, Trademark, Industrial design, Geographical indications, Integrated circuits	1

Topic	No. of Classes
Trade secrets. Patents Act 1970 and Patent system in India Patents, Copyrights, Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets	2
Patents Act 1970 and Patent system in India, Process and product patent, Filing of patent, Patent specification, Claims, Opposition, Revocation &infringement.	1
Origin and history including a brief introduction to UPOV for protection of plant varieties	1
Protection of plant varieties under UPOV and PPV&FR Act of India	1
Plant breeders rights	1
Registration of plant varieties under PPV&FR Act 2001, breeders, researcher and farmers rights	1
Traditional knowledge-meaning and rights of TK holders.	1
Convention on Biological Diversity	1
International treaty on plant genetic resources for food and agriculture (ITPGRFA)	1
Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing	1
Understanding Intellectual Property Rights in ancient India.	1
Total	**16**

Course Title : Principles of Agricultural Economics and Farm Management

Course Code : Ag. Econ. 212

Credits Hours : 2 (2+0)

General Objectives

i) To aware the students about broad areas covered under agricultural Economics and farm management.

Specific Objectives

i) To impart knowledge on judicious use of resources for optimum production.

ii) 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 macro economics, 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 programmes 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.

Learning Outcomes

1. An enhanced knowledge on least cost combination of inputs, national income, product diversification and demand for and supply of a particular commodity.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)

- Students presentation
- Group activities
- Hand on experience

Suggested readings:

1. Ahuja H.L. (2011). Principles of Microeconomics. 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 & IBH publishing Co. Pvt. Ltd
5. Sharma L., acharya S. K. and Somani S. S. (2015). Principles of Agricultural Economics. Agrotech Publishing House, Udaipur

Lecture Schedule

Topic	No. of Classes
Economics: Meaning, scope and subject matter, definitions, activities, approaches to economic analysis, micro and macro economics, positive and normative analysis	2
Nature of economic theory, rationality assumption, concept of equilibrium, economic laws as generalization of human behavior	2
Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare	2
Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development	1
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.	1
Consumer’s equilibrium and derivation of demand curve, concept of consumer surplus	2
Elasticity of demand: concept and measurement of price elasticity, income elasticity and cross elasticity	2

Topic	No. of Classes
Production: process, creation of utility, factors of production, input output relationship	2
Laws of returns: Law of variable proportions and law of returns to scale, Cost: Cost concepts, short run and long run cost curves	3
Supply: Stock v/s supply, law of supply, supply schedule, supply curve, determinants of supply, elasticity of supply	2
Distribution theory: meaning, factor market and pricing of factors of production, Concepts of rent, wage, interest and profit	2
National income: Meaning and importance, circular flow, concepts of national income accounting and approaches to measurement, difficulties in measurement	2
Population: Importance, Malthusian and Optimum population theories, natural and socio-economic determinants, current policies and programmes on population control	2
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	2
Economic systems: Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning	2
Forms of business organizations, international trade and balance of payments. GST and its implication on Indian economy	3
Total	**32**

Semester VII

Course Title : Community Mobilization for Natural Farming

Course Code : NF-411

Credits Hours : 2 (1+1)

General Objective

i) To provide complete understanding of community mobilization, including strategies, decision making techniques, motivation and mentoring.

Specific Objectives

i) To gain the knowledge about the fundamental concepts and principles of community mobilization, programme planning and about groups.

ii) 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, case study, Social core value systems - Ethical principles, purpose, benefits, Development of understanding about rural society, Behavioral change and attitude, Programme 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, Counseling – 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.

Practicals

Preparation of "Community Resource Mapping" in selected rural village, Community needs assessment techniques – Participatory Rural Appraisal, Yoga, SWOT analysis, Organization involved in community mobilization, Programme 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 programmes, 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.

Learning Outcomes

1. Understand the community mobilization and rural setting.
2. Strategies regarding know how on community mobilization for promoting natural farming.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students' presentation
- Group activities
- Case study and success stories

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 21stCentury. Proceedings of the summer school held from 28thMayto 17thJune 1999, Rajasthan College of Agriculture, Udaipur, India pp363.
2. Prasad R.R. Community Mobilization – Methods and Models. Publ: 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.

Lecture Schedule

Theory

Topic	No. of Classes
Community mobilization – Meaning, historical background, types, strategies, steps, opportunities and challenges, Community entry, profiling, social mapping- Yoga for community mobilization	1
SWOT Analysis- Meaning, advantages, case study- Social core value systems- Ethical principles, purpose, benefits	1
Development of understanding about rural society, Behavioral change and attitude	1
Programme Planning- Introduction, need and interest, concept, objectives and principles, processes	1
Diffusion and Adoption Process- Definition, meaning and Strategies	1
Group - Definition, types, stages of group formation, modes of group development Process for group formation - stages of SHG/ FPO/ FPC/ FBO development- Group decision making techniques	1
FPO- benefits, activities, implementing agencies to form and promote FPOs	1
Application procedure to form FPC, Organizational structure, Government schemes	1
Conflict-Meaning, types, process, Conflict resolution and management strategies	1

Topic	No. of Classes
Motivation–Definition, elements, individual and group needs, motivation process, Motivation cycle, classification of motives, Maslow's Hierarchy theory of needs and Adam's Equity theory	1
Types of motivation, techniques of motivation, role/importance/ factors of motivation	1
Capacity building and institutionalizing mechanism, Counseling – need, functions and types	1
Mentoring- definition, process, philosophy and mentor-mentee relationship, Training – meaning, advantages, types and process	1
Monitoring and Evaluation - Define, objectives, types, concept, difference, importance Impact analysis on social, economic and environmental effects of natural farming	1
Case studies on community mobilization in natural farming, Traditional and social media for promoting natural farming	1
Government schemes and role of public and private institutions in promoting community mobilization in natural farming	1
Total	**16**

Practical

Topic	No. of Classes
Exercise on preparation of "Community Resource Mapping" in selected rural village	1
Community needs assessment techniques – Participatory Rural Appraisal	1
Exercise on Yoga	1
Exercise on SWOT analysis	1
Exposure visits to organization involved in community mobilization	1
Exercise on programme planning and organizing events	1
Exercise on formation and functioning of SHG	1
Exercise on establishment, organizational structure and promotion of FPO and FBO	1
Exercise on Group decision making techniques - Conduct of focused group discussion	1
Exercise on conflict management techniques	1

Topic	No. of Classes
Exercise on motivation – preparation of Maslow's hierarchy theory of needs assessment	1
Exercise on counselling and mentoring- conduct sessions among beneficiaries of natural farming community	1
Exercise on organizing capacity building programmes	1
Exercise on socio economic impact analysis on natural farming	1
Exercise on traditional and social media for promoting natural farming	1
Exercise on public and private institutions promoting community mobilization for natural farming	1
Total	**16**

Course Title : Water Management

Course Code : NF-412

Credits Hours : 2 (1+1)

General Objective

i) To provide comprehensive understanding of water management principles, challenges, and strategies, and equip them with the necessary skills to contribute to sustainable water resource management in natural farming.

Specific Objectives

i) To gain the knowledge about the fundamental concepts and principles of water management.

ii) 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.

Practicals

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,

Learning Outcomes

1. Knowledge enhancement in the field of water management.
2. The ability developed to apply theoretical knowledge and skills to real-world water management scenarios.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested Readings

1. Choudhary ML, Kadam US, 2006. Micro irrigation for cash crops Westville Publishing House.
2. Jat, M.L.; Sharma, S.K.; Balyan, J.K.; Kothari, A.K. and Jain, L.K. 2011. Rainfed Farming. Kalyani Publisher, Ludhiana. pp. 324.

3. Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.
4. Michael AM. and Ojha TP. 2014. Principles of Agricultural Engineering Vol. II 5th Edition. 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-HistoryFoundation.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. AsianAgri-HistoryFoundation.pp.432-440.
10. Singh, P.K. 2000. Watershed Management: Design and Practices. E-media Publications, Udaipur.

Lecture Schedule

Theory

Topic	No. of Classes
History of water management in ancient and medieval India, Water Management: Definition, scope and importance Rainfed & irrigated farming	1
Water resources: Use and over- utilization of surface and groundwater, floods, drought, dams-benefits and problems	1
Region specific traditional water harvesting and management systems	1
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*	3
Water budgeting, Irrigation water requirement	2
Micro irrigation: Sprinkler, Drip irrigation systems	2
Pitcher irrigation system, maintenance of micro irrigation system, fertigation, advantages and limitations of fertigation	2
Watershed management - concept, objectives, factors affecting and watershed planning.	1
Reservoirs, Ground Water harvesting and conservation (Tanka, Talai, Nadi, Nada, Talab, Khadin).	2
Indian traditional knowledge in rainwater management, soil and water conservation	1

Topic	No. of Classes
Total	**16**

Practicals

Topic	No. of Classes
Measurement of soil moisture by different soil moisture measuring instruments	1
Measurement of irrigation water requirement	1
Determination of bulk density by field method	1
Determination of field capacity by field method	1
Determination of permanent wilting point	1
Case study on water budgeting	1
Study of different types of farm ponds	1
Estimation of farm pond storage capacity	1
Testing of irrigation water quality, EC, pH and TDS	1
Study of different components of sprinkler irrigation system	1
Study of different components of drip irrigation	1
Field visit to micro irrigation system	1
Maintenance of different components of micro irrigation systems	1
Survey of watershed resources	1
Field visit to watershed	1
Field visit to water harvesting structure	1
Total	**16**

Course Title : Research Methodology and Ethics

Course Code : NF-413

Credits Hours : 2 (1+1)

General Objective

i) To give research orientation to students on Natural farming and acquaint about ethics in research

Specific Objectives

i) To provide basic knowledge on research tools and techniques.

ii) 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 & participants 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 & 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. (n.d.). Research Ethics. Retrieved from https://www3.nd.edu/~pkamat/pdf/ethics.pdf.

2. Parveen, Huma & Showkat, Nayeem. (2017). Research Ethics. https:// www.researchgate.net/publication

Learning outcomes

1. Human resource for on-farm research on natural farming
2. Human resource for teaching on natural farming for progressive farmers

Teaching Methods/Activities

- Research tools and techniques
- Pilot data collection and analysis
- Model interpretation

Lecture Schedule

Theory

Topic	No. of Classes
Research Ethics: Basics and importance	1
Experimental techniques: Research design, sampling, data collection, On-station experimentation, On-Farm experimentation, tabulation, Statistical tools and analysis techniques for interpretation of data	1
Geo-tagged characterization: Questionnaire design principles, Questionnaire design for consumers of natural products, Questionnaire design for farmers and producers of natural products,	1
Questionnaire design for processors/traders/exporters, Geo-spatial analysis and mapping of natural farms/producers/traders/consumers	1
Meta data analysis: Concepts, statistical methods, clustering research results, Holism, Positivism, Objectivism,	1
Reductionism, Constructivism, Subjectivism, data source, Variable coding and analysis, interpretation	1
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	1
Parameterization and classification based on macro, regional and micro level	1
Climate resilience of natural farming: Methodology for identification of climate resilient production systems	1

Topic	No. of Classes
GHG's estimation using IPCC, GHG's measurement using instrumentation, Global Warming Potential, Energy & Carbon budgeting	1
Breeding for natural production system: Conventional breeding strategies for natural production, participatory plant breeding	1
Marker aided selection, Stability analysis, Molecular characterization of indigenous organic inputs, Bio-chemical and molecular signature of natural produces	1
Commercial Project Formulation on Natural Farming: Internal rate of return, Pay Back period, B:C ratio, Net Present Value	1
Model project formulation for natural farming, Impact analysis tools and methods	1
Natural Farming System model development: Synthesis of IFS models using primary and secondary data	1
Classification, validation of farming systems	1
Total	**16**

Practicals

Topic	No. of Classes
Synthesis of natural farming system model: Tribal farming systems	1
Synthesis of natural farming system model: Water harvesting based farming systems	1
Meta data analysis in natural farming	2
Identification and niche area and crops for a district or block for natural farming	2
Identification of climate resilient production system using long term meteorological data	2
Commercial project formulation	2
Geo-spatial analysis using GIS platform	2
Carbon and energy budgeting of a natural farm	2
Estimation of GHG emission from IPCC tool	1
Design of Natural Farming System Model	1
Total	**16**

Course Title : Weather Forecasting

Course Code : NF-414

Credits Hours : 3 (2+1)

General Objective

i) To provide comprehensive understanding of weather forecasting principles, challenges, and strategies, and equip them with the necessary skills to contribute to sustainable weather based agricultural practices.

Specific Objectives

i) To provide the knowledge on different types of weather forecasting.

ii) To acquaint the importance of weather forecasting and its applications.

iii) 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's 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.

Practicals

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 & 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.

Learning Outcomes

1. Knowledge enhancement in the field of weather forecasting.
2. Equipped with the knowledge and skills regarding forecasting models.
3. Enhance awareness about weather based agricultural practices.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students' presentation
- Exposure visits
- Hand on experience

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. Publ: 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. *In.* 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. *In.* 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. *In.* 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. *In.* 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. *In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 326-343.

Lecture Schedule

Theory

Topic	No. of Classes
Introduction to agrometeorology – weather, climate, weather parameters and their units, season in Tamil and English and Types of Calendars	1
Ancient wisdom on Weather Forecasting: Rainfall prediction, analysis and forecast of winter monsoon based on ancient literature and simulated models,	1
Rain forecasting in India Almanacs (Panchangs), Measurement of Rainfall, Testing of Traditional Methods of weather forecast	1
Ancient Astronomers, Indian Almanac (Nakshatras, Rashi, Months, Paksha, Seasons, Tithi, Var, Yog, karn, nadi), Krishi Panchang	1
Effect of planets on weather, azimuth, aspects, strength and planet activeness on weather	1
Ancients methods of weather forecast (Analytical Methods, Observational Methods), Principles of Astrometeorology	1
Ancient rainfall predictions techniques 1. Parashara technique, 2. Varahamihira techniques, 3. Predictions based on planets, 4. Bio-indicators and 5. Other ancient rainfall predictions methods	1
Sudden rainfall, Indications of famine, The method of ascertaining the type of cloud of the year	1
Folklore regarding weather Forecasting, ITKs with its description and the practitioner for weather forecasting	1
Agricultural meteorology - Meaning and scope; Importance and scope in crop production, Co-ordinates, Important coordinates of world, India and Tamil Nadu	1
Earth atmosphere-its composition, extent and structure; Atmospheric weather variables	1
Atmospheric pressure, its variation with height	1
Nature and properties of solar radiation, light intensity, quality, direction and duration solar constant, depletion of solar radiation	1
Wave length characteristics and their effect on crop production, shortwave, longwave and the normal radiation, net radiation, albedo	1
Atmospheric temperature, Factors affecting temperature, Temperature on crop production, Heat unit and its use - Heat and cold injuries	1

Topic	No. of Classes
Temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, Energy balance of earth	1
Atmospheric humidity, concept of saturation, vapor pressure	1
Process of condensation, formation of dew, fog, mist, frost, cloud formation and their classification	1
Precipitation, process of precipitation, forms and types of precipitation such as rain, snow, sleet and hail, Artificial rain making and cloud seeding	1
Wind, causes and types of wind, cyclone, anticyclone, land breeze and sea breeze, General circulation, Inter Tropical Convergence Zones (ITCZ), Wind on crop production	1
Indian Monsoon - mechanism and importance in Indian agriculture	1
Weather forecasting – types, methods of weather forecast and their uses, applications of weather forecasts in agriculture and allied sectors, and agencies involved	1
Weather hazards- High winds, drought, floods, tornado, frost, tropical cyclones, thunderstorms, dust storm, lightning and hailstorms and extreme weather conditions such as heatwave and cold wave	1
Agro climatic Zones of India and Tamil Nadu and its characterization	1
Weather and Agriculture, Weather – Crop – Pest & Disease interactions, crop weather calendar, pest weather calendar	1
Modifications of crop microclimate	1
Climatic normal for crops and livestock production.	1
Climate change, climatic variability, global warming, causes of climate change & ENSO	1
Impact of climate change on regional and national Agriculture, Forestry Hydrology, marine and coastal ecosystem	1
Types of Climate Models – GCM and RCM, agencies involved in global and regional climate models	1
Weather based agro advisories	1
Remote sensing and its applications in weather prediction and forewarning	1
Total	**32**

Practicals

Topic	No. of Classes
Visit to agrometeorological observatory, site selection, types of observatories, layout	1
Exposure to instruments, Calculation of local mean time, Time of observation of weather elements and data acquisition techniques	1
Study and use of instruments for measuring air temperature	1
Study and use of instruments for measuring rainfall	1
Study and use of instruments for measuring solar radiation, Estimation of net short-wave radiation, net long wave radiation, total global and net radiation, albedo and bright sunshine duration	1
Study and use of instruments for measuring wind speed and wind direction	1
Study and use of instruments for measuring evaporation rate using USWB Class A open pan Evaporimeter	1
Study and use of instruments for measuring relative humidity and vapour pressure	1
Study and use of instruments for measuring dew	1
Computation of climatic normal using historical weather data	1
Probability analysis of rainfall for crop planning	1
Drawing synoptic charts for understanding weather	1
Study of ancient methods of weather forecast – Panchang and Preparation of Krishi Panchang	1
Practicing Astrometeorology using planet, stars and other celestial bodies	1
Testing local folklore for weather forecasting	1
Preparation of agro advisories based on traditional and conventional methods	1
Total	**16**

Course Title : Basic and Applied Agricultural Statistics

Course Code : Ag. Stat -323

Credits Hours : 3 (2+1)

General Objective

i) To develop knowledge of the various aspects of tools of descriptive and inference Statistics.

Specific Objectives

i) To provide an idea on Statistical concepts of both descriptive and inference Statistics

ii) 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.

Practicals

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.

Learning Outcomes

1. This course will help the students to understand the basic knowledge on data collection and various elementary statistical tools. It will provide critical thinking in the theory of probability and its applications in real life problems. The course will provide an insight to understand the problems that are faced in testing of a hypothesis with reference to the errors in decision making. The knowledge of statistical tools like correlation and regression analysis will help the students to understand the inter-relation between two or more phenomena. Further it imparts knowledge on basic components of sampling methods and has the knowledge of sampling techniques.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested Readings

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

Lecture Schedule

Theory

Topic	No. of Classes
Introduction to Statistics and its application in Agriculture	2
Summarization of Data Types of Data. Scales of measurements of Data. Classification of Data	2

Topic	No. of Classes
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	2
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	2
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	2
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	2
Graphical Location of Median. Mode- Definition, Merits, Demerits and UsesGraphical Location of Mode. Relationship between Mean, Median and Mode	1
Measures of Dispersion. Characteristics for an Ideal Measure of Dispersion Different Types of Measures of Dispersions. Definition of Range, Inter-quartile 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	2
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	2
Probability Theory. 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	2
Normal Distribution, Definition of Random Variable, Discrete and Continuous Random Variable, Normal Distribution- Definition, Prob. Distribution, Mean and Variance, Assumptions of Normal Distribution, Normal Probability Curve	2
Correlation. Definition of Correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation, Types of Correlation Coefficient, Properties of Correlation Coefficient	2

Topic	No. of Classes
Regression, Definition of Linear Regression, Regression Equations, Regression Coefficients, Properties of Regression Coefficients	2
Test 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	3
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)	2
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	2
Total	**32**

Practicals

Topic	No. of Classes
Diagrammatic and Graphical representation of data, Simple, Multiple, Sub-divided and Percentage Bar Diagrams. Pie-diagram, Graphical Presentation of Data – Histogram, Frequency Polygon and Ogives	2
Measures of Central Tendency, Calculation of A.M., Median and Mode (Ungrouped and Grouped data)	2
Measures of Dispersion, Calculation of S.D. and C.V. (Ungrouped and Grouped data)	2
Correlation, Scatter Diagram, Karl Pearson's Coefficient of Correlation, Regression Analysis, Regression Equations, Regression Coefficients	3
Application of t-test (one sample, two samples independent and dependent)	3
Analysis of Variance one way classification, Completely Randomized Design (CRD)	2
Sampling. Selection of random sample using simple random sampling	2
Total	**16**

Semester VIII

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

For B.Sc. Natural Farming (Hons.)

- 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.

B.Sc. Natural Farming (Research)

The students opting for B.Sc. Natural Farming (Research) degree will undergo 40 credits research work in 4th year out of which 20 credits will be elective courses related to his/ her research project.

Skill Enhancement Courses

A student admitted into 1st year of B.Sc. (Hons.) Natural Farming degree programme will take 2 skill enhancement courses each of 2 credits in each semester of first year. Likewise the student continuing his/her study into 2nd year of B.Sc. (Hons.) Natural Farming will undergo 2 skill enhancement course each of 2 credits in each of the 2 semesters of 2nd year.

The student can select these courses from a basket of skill enhancement courses as indicated below or courses offered by a College. The courses may be offered as module of complementing courses to help the student to achieve skill in a specific area of his interest.

A college will select such skill enhancement courses in which it has strength as well as there is prospect of local employment and entrepreneurship development.

Indicative List of Skill Enhancement Courses

S. No.	Course Title	Credits
1.	Natural Farming for Crops, Vegetables and Orchard	2(0+2)
2.	Production Technology of Bio-inputs	2(0+2)
3.	Business Management in Natural Farming	2(0+2)
4.	Seed Production and Certification under Natural Farming	2(0+2)
5.	Agro-Eco Tourism in Natural Farming	2(0+2)
6.	Animal Feed Management under Natural Farming	2(0+2)
7.	Analytical Techniques and Instrumentation for Soil Health Card	2(0+2)
8.	Landscape Designing and Gardening	2(0+2)
9.	Self Sustainable Kitchen Gardening	2(0+2)
10.	Commercial Bee-Keeping under Natural Farming	2(0+2)
11.	Commercial Sericulture	2(0+2)
12.	Beneficial insect farming	2(0+2)
13.	Bio-fertlizer and biopesticide (microbials) production	2(0+2)
14.	Production Technology of Biocontrol agents	2(0+2)
15.	Mushroom Production Technology	2(0+2)

S. No.	Course Title	Credits
16.	Post-harvest Processing technology	2(0+2)
17.	Plantation Crop Production and Processing	2(0+2)
18.	Poultry Production Technology	2(0+2)
19.	Piggery Production Technology	2(0+2)
20.	Commercial Horticulture	2(0+2)
21.	Floriculture and Landscaping	2(0+2)
22.	Natural Food Processing	2(0+2)
23.	Agriculture Waste Management	2(0+2)
24.	Video Production	2(0+2)
25.	E-marketing for natural farm produce	2(0+2)
26.	Production & Marketing of aerated and non-aerated liquid manures	2(0+2)

Elective Courses

S. No.	Course Number	Title
1.	Ag Econ (E) 413	Agri-Business Management
2.	Agron (E) 413	Management of natural resources
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	Bio pesticides and Bio fertilizers
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

Elective Course 1

Course Title : Agri-Business Management

Course Code : Ag Econ (E) 413

Credits Hours : 3 (2+1)

General Objective

i) To acquaint the student with meaning and concepts of agri-business management

Specific Objectives

i) 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 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 & SWOT analysis, Management functions: Roles & 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 & positioning, Marketing mix and marketing strategies, Consumer behavior analysis, Product Life Cycle (PLC), Sales & Distribution Management, Pricing policy, various pricing methods, Project Management definition, project cycle, identification, formulation, appraisal, implementation, monitoring and evaluation, Project Appraisal and evaluation techniques.

Practicals

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,

Learning Outcomes

1. An enhanced knowledge on agri business entrepreneurship

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience

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.

Lecture Schedule

Theory

Topic	No. of Classes
Transformation of agriculture into agribusiness, various stakeholders and components of agribusiness systems	2
Importance of agribusiness in the Indian economy and New Agricultural Policy	2

Topic	No. of Classes
Distinctive features of Agribusiness Management: Importance and needs of agro-based industries	2
Classification of industries and types of agro-based industries. Institutional arrangement, procedures to set up agro based industries	2
Constraints in establishing agro-based industries, Agri-value chain: Understanding primary and support activities and their linkages	2
Business environment: PEST & SWOT analysis	2
Management functions: Roles & activities, Organization culture.	2
Planning, meaning, definition, types of plans. Purpose or mission, goals or objectives, Strategies, polices procedures, rules, programs and budget	4
Components of a business plan, Steps in planning and implementation	2
Organization staffing, directing and motivation. Ordering, leading, supervision, communications, control	2
Capital Management and Financial Management of Agribusiness. Financial Statements and their importance	2
Marketing Management: Segmentation, targeting & positioning. Marketing mix and marketing strategies	2
Consumer behavior analysis, Product Life Cycle (PLC). Sales & Distribution Management, Pricing policy, various pricing methods	2
Project Management definition, project cycle, identification, formulation, appraisal, implementation, monitoring and evaluation. Project Appraisal and evaluation techniques	4
Total	**32**

Practicals

Topic	No. of Classes
Study of agri –input markets: Seed, fertilizers pesticides	1
Study of output markets: grains, fruits, vegetables, flowers	2
Study of product market, retails trade commodity trading, and value added products	2
Study of financing institutions- Cooperative, Commercial Bank, RRBs, Agribusiness Finance Limited, NABARD	2
Preparations of projects and Feasibility reports for agribusiness entrepreneur	2

Topic	No. of Classes
Appraisal /evaluation techniques of identifying viable project- Non discounting techniques	2
Case study of agro- based industries.	2
Trend and growth rate of price of agricultural commodities	1
Net present worth technique for selection of viable project. Internal rate of return	2
Total	**16**

Elective Course 2

Course Title : Management of Natural Resources

Course Code : Agron (E) 413

Credits Hours : 3 (2+1)

General Objectives

i) To study how best the natural resources can be utilized for sustainable development.

Specific Objectives

i) To enlighten students about available natural resources and their relationship with crop production.

ii) 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 & 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.

Practicals

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.

Learning Outcomes

1. The students will be able to learn about use of natural resources for sustainable development.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested Readings

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

Lecture Schedule

Theory

Topic	No. of Classes
Introduction to Natural Resource Bases: Concept of resource, classification of natural resources	2
Factors influencing resource availability, distribution and uses	2
Interrelationships among different types of natural resources. Concern on Productivity issues	2
Ecological, social and economic dimension of resource management	2
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 & management	6
Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems, Water ecology and management	4
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	6
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	2
Principles of erosion control - Introduction to contouring, strip cropping. Contour bund - Graded bund and bench terracing	4
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	2
Total	**32**

Practicals

Topic	No. of Classes
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	3
Estimation of soil loss and calculation of erosion index, Leveling concepts and practical utility in agriculture	3
Preparation of contour maps, Concept of vegetative water ways and design of grassed water ways	3
Wind erosion and estimation process, Different irrigation pumps and their constructional differences, Farm pond construction and its design aspects.	4
Visit to nearby farm pond, Visit to an erosion site, Exposure to strip cropping/contour bunding	3
Total	**16**

Elective Course 3

Course Title : Agricultural Journalism

Course Code : EE (E) 413

Credits Hours : 3 (2+1)

General Objective

i) To impart knowledge and skill in agricultural journalism.

Specific Objectives

i) 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 Proofreading: definition, signs and symbols of proofreading, level of proofreading, duties of a proof-reader Layout– meaning, principles of layout and design.

Practicals

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.

Learning Outcomes

1. Learners should utilize their knowledge to collect and disseminate farm information by practicing agricultural journalism

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Brain storming
- Group activities

- Discussion
- Advance organizer

Suggested Readings

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

Lecture Schedule

Theory

Topic	No. of Classes
Journalism– Meaning, nature, importance and types of journalism	1
Agricultural Journalism – Meaning, definition, principle, objectives, types, and scope. Similarities and difference between agricultural journalism and other types of journalism	3
Role of agricultural journalist, Training of agricultural journalist	2
Qualities of journalist, Role of journalist/journalism in agricultural development and development of newspaper and magazines readers	1
Newspaper and magazines as communication media: Characteristics, kinds and functions of newspaper and magazines, Characteristics of newspaper and magazines readers	2
Form, content, style and language of newspaper and magazines, Standard part of newspaper and magazines	2
The agricultural story: Types of Agriculture stories, subject matter of the agricultural story, structure of the agricultural story	1

Topic	No. of Classes
Gathering farm information- Sources of farm information: abstracting from research and scientific materials, interviews, coverage of events Other sources: electronic media, field study	2
Success stories-definition, nature, components, guidelines of writing a success story	2
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	3
Readability measure-readability eases core, automated readability index, gunning fog index How to improve readability of articles and stories	3
Use of photograph in agricultural journalism – Basic principles of photography – composition, exposure, lens, light. Use of artwork (Graphs, charts, maps, etc.) Writing the captions	3
Editorial mechanism: Copy reading, headline and title writing Proofreading: definition, signs and symbols of proofreading, level of proofreading, duties of a proof-reader	3
Layout–meaning, principles of layout and design	3
Review of lessons and course	1
Total	**32**

Practical

Topic	No. of Classes
Practice in writing an agricultural news story	2
Practice in writing an agricultural feature story	2
Covering agricultural events for the information collection	1
Practice in interviewing for the information collection	1
Abstracting stories from research and scientific materials and wire services	1
Selecting pictures and artwork for the agricultural story	1
Practice in editing, copy reading	2
Practice in headline and title writing	2
Practicing proof reading	1
Practice in lay outing of newspaper	1
Testing copy with a readability formula	1
Visit a publishing office	1
Total	**16**

Elective Course 4

Course Title : Landscaping

Course Code : Hort (EA) 323

Credits Hours : 3 (2+1)

General Objective

i) To educate the students on scope and importance of landscaping and its career options.

ii) To educate the students on different principles and elements of landscaping, different components of landscaping

Specific Objectives

i) To educate the students on designing different styles and types of gardens.

ii) To enable the students to identify different ornamental plants and their utilization in landscaping design.

iii) 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.

Practicals

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.

Learning Outcomes

1. Students will be able to learn about the implication of landscape principles in designing various landscapes like both public and private institutions.
2. Students will be equipped with software knowledge like AUTOCAD to design various landscape projects.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested Readings

1. Principles of landscape gardening by S.Y. Chandrasekhar and B. Hemla Naik.
2. Textbook of floriculture and landscaping by Anil K. Singh and Anjana Sisodia.

Lecture Schedule

Theory

Topic	No. of Classes
Importance and scope of landscaping	1
Principles of landscaping	1
Garden styles and types	1
Terrace gardening and vertical gardening	1
Garden components and adornments	1
Lawn making, establishment and maintenance	2
Rockery water garden,	3
Walk-paths, bridges, other constructed features	1

Topic	No. of Classes
Gardens for special purposes	2
Trees: selection, propagation, planting schemes, canopy management, Shrubs and herbaceous perennials: selection, propagation, planting schemes, architecture.	3
Climber and creepers importance, selection, propagation, planting	2
Annuals: selection, propagation, planting scheme	1
Other garden plants: palms, ferns, grasses and cacti succulents.	1
Pot plants: selection, arrangement, management.	1
Bio-aesthetic planning: definition, need, planning; landscaping of urban and rural areas	2
Peri-urban landscaping	2
Landscaping of schools, public places like bus station, railway station, townships, river banks, hospitals, play grounds, airports, industries, institutions,	3
Bonsai principles and management	2
CAD application	2
Total	**32**

Practical

Topic	No. of Classes
Identification of trees, shrubs and annuals	3
Propagation of trees, shrubs and annuals,	2
Pot plants; care and maintenance of plants, potting and repotting	1
Identification of tools and implements used in landscape design	1
Training and pruning of plants for special effects	1
Lawn establishment and maintenance	2
Layout of formal gardens	1
Layout of informal gardens	1
Designing of conservatory and lathe house.	1
Use of computer software	1
Visit to important gardens /parks /institutes	1
Total	**16**

Elective Course 5

Course Title : Commercial Plant Breeding

Course Code : GPB (E) 413

Credits Hours : 3 (2+1)

General Objective

i) This course has been designed to impart basic understandings on commercial plant breeding with special emphasis on major crops of commercial interest and seed as well as IPR issues related to commercial plant breeding.

Specific Objectives

i) To discuss about hybrid development and various crop improvement aspects of field crops viz., rice, wheat, maize, pearl millet, sorghum, pigeonpea, chickpea, green gram, black gram, lentil, soybean, groundnut, rapeseed-mustard, cotton etc.

ii) To provide understanding on tissue culture and biotechnological approaches as alternative strategies for development of line and cultivars.

iii) To impart knowledge on seed production, release and notification of varieties and PPV&FR Act, 2001.

Theory

Types of crops and modes of plant reproduction, Line development and maintenance breeding in self and cross pollinated crops (A/B/R and two line system) for development of hybrids and seed production, Genetic test of commercial hybrids, Advances in hybrid seed production of maize, rice, sorghum, pearl millet, castor, sunflower, cotton pigeon pea, Brassica etc. Quality seed production of vegetable crops under open and protected environment, Alternative strategies for the development of the line cultivators: haploid inducer, tissue culture techniques and biotechnological tools, IPR issues in commercial plant breeding: DUS testing and registration of verities under PPV & FRA Act, Variety testing, release and notification systems in India, Principles and techniques of seed production, types of seeds, quality testing in self and cross pollinated crops.

Practicals

Floral biology in self and cross pollinated species, selfing and crossing techniques, Techniques of seed production in self and cross pollinated crops using A/B/R and

two line system, Learning techniques in hybrid seed production using male-sterility in field crops, Understanding the difficulties in hybrid seed production, Tools and techniques for optimizing hybrid seed production, Concept of rouging in seed production plot, Concept of line its multiplication and purification in hybrid seed production, Role of pollinators in hybrid seed production, Hybrid seed production techniques in sorghum, pearl millet, maize, rice, rapeseed-mustard, sunflower, castor, pigeon pea, cotton and vegetable crops, Sampling and analytical procedures for purity testing and detection of spurious seed, Seed drying and storage structure in quality seed management, Screening techniques during seed processing viz. grading and packaging, Visit to public private seed production and processing plants.

Learning Outcomes

Students will understand the importance of commercial plant breeding starting from hybrid seed production of major field crops, release and notification of varieties and IPR protection of the same.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested Readings

1. "Commercial Plant Breeding at a glance" by Phundan Singh, Pratibha Bisen, Reshu Tiwari. Daya Publishing House
2. "Plant Breeding: Principles and Methods" by B. D. Singh. Kalyani Publishers
3. "Principles of Plant Breeding (1st & 2nd Edition)" by RW Allard.
4. "Breeding Field Crops" by JM Poehlman.

Lecture Schedule

Theory

Topic	No. of Classes
Introduction on commercial plant breeding	1
Types of crops and modes of plant reproduction	2

Topic	No. of Classes
Line development and maintenance breeding in cross pollinated crops (A/B/R and two line system) for development of hybrids and seed production	2
Line development and maintenance breeding in self pollinated crops (A/B/R and two line system) for development of hybrids and seed production	2
Genetic purity test of commercial hybrids	1
Advances in hybrids seed production of rice and pigeon pea	3
Advances in hybrids seed production of maize and pearl millet	2
Advances in hybrids seed production of castor, brassica and sunflower	3
Advances in hybrids seed production of sorghum and cotton	2
Quality seed production of vegetable crops under open and protected environment	2
Alternative strategies for development of the line and cultivars : Haploid inducer, Tissue culture and techniques and biotechnological tools	4
IPR issues in commercial plant breeding: DUS testing and registration of varieties under PPV & FR Act.	3
Variety testing, release and notification system in India	2
Principles and Techniques of seed production, Types of seeds, quality testing in self and cross pollinated crops	3
Total	**32**

Practicals

Topic	No. of Classes
Floral biology in self and cross pollinated species, selfing and crossing techniques	1
Techniques of seed production in self and cross pollinated crops using (A/B/R and two line system)	1
Concept of rouging in seed production plot	1
Learning techniques in hybrid seed production using male sterility in field crops	1
Role of pollinators in hybrid seed production	1
Understanding the difficulties in hybrid seed production	1
Tools and techniques for optimizing hybrid seed production	1
Concept of line its multiplication and purification in hybrid seed production	1

Topic	No. of Classes
Hybrid seed production techniques in pearl millet and maize	1
Hybrid seed production techniques in rice and pigeon pea	1
Hybrid seed production techniques in sorghum and Cotton and vegetable crops	1
Hybrid seed production techniques vegetable crops	1
Sampling and analytical procedure for purity testing and detection of spurious seed	1
Seed drying and storage structure in quality seed management	1
Screening techniques during seed processing viz., Grading and packaging	1
Visit to public private seed production and processing plants	1
Total	**16**

Elective Course 6

Course Title : Food Safety and Standards

Course Code : Hort (EB) 323

Credits Hours : 3 (2+1)

General Objective

i) To educate the students on how to apply food science knowledge to improve the taste, nutrition and safety of value added food products.

Specific Objectives

i) To develop the skills to convert raw materials into safe, attractive food products.

ii) To manage the production of food products.

iii) To use scientific knowledge to develop new products.

Theory

Food safety –Definition, Importance, Scope and Factors affecting Food Safety, Hazards and Risks, Type of Hazards - Biological, Chemical Physical hazards, Management of hazards – Need, Control of Parameters, Temperature Control, Food Storage, Production Design, Hygiene and Sanitation in Food Service Establishments- Introduction. Sources of contamination and their control, Waste Disposal, Pest and Rodent Control, Personnel Hygiene, Food safety Measures,

Food Safety Management Tool- Basic concepts, PRPs, GHPs, GMPs, SSOPs etc. HACCP.ISO series, TQM- concept and need for quality, components of TQM, Kaizen, Risk Analysis, Accreditation and Auditing, Water Analysis, Surface Sanitation and Personal Hygiene, Food laws and Standards Indian Food Regulatory Regime, FSSAI,. Global Scenario CAC, Other laws and standards related to food, Recent Concerns-New and Emerging Pathogens, Packaging, Product labelling and Nutritional labelling, Genetically modified food/transgenic, Organic foods, Newer approaches to food safety, Recent Outbreaks, Indian and International Standards for food products.

Practicals

Water quality analysis physio–chemical and microbiological, Preparation of different types of media, Microbiological examination of different food samples, Assessment of surface sanitation by swab/rinse method, Assessment of personal hygiene. Biochemical tests for identification of bacteria, Scheme for the detection of food borne pathogens, Preparation of plants for Implementation of FSMS-HACCP, ISO: 22000.

Learning Outcomes

1. Students will be able to understand the implications of food science technology to develop different value added products and its marketing and safety standards.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested Readings

1. Text book of Food Science and Technology by Avantina Sharma.

Lecture Schedule

Theory

Topic	No. of Classes
Food safety –Definition, importance and scope	1
Factors affecting Food Safety	1

Topic	No. of Classes
Hazards and Risks, Type of Hazards - Biological, Chemical Physical hazards. Management of hazards – Need	2
Control of Parameters. Temperature Control	2
Food Storage	1
Production Design	1
Hygiene and Sanitation in Food Service Establishments- Introduction	3
Sources of contamination and their control, Waste Disposal	2
Pest and Rodent Control	2
Personnel Hygiene, Food safety Measures	3
Food Safety Management Tool- Basic concepts. PRPs, GHPs, GMPs, SSOPs etc. HACCP.ISO series.	2
TQM- concept and need for quality, components of TQM, Kaizen, Risk Analysis	2
Accreditation and Auditing and Water Analysis	1
Surface Sanitation and Personal Hygiene	1
Food laws and Standards Indian Food Regulatory Regime, FSSA.	1
Global Scenario CAC. Other laws and standards related to food.	1
Recent concerns-New and Emerging Pathogens	1
Packaging, Product labelling and Nutritional labelling	1
Genetically modified food/transgenic	1
Organic foods	1
Newer approaches to food safety, Recent outbreaks	1
Indian and International Standards for food products	1
Total	**32**

Practical

Topic	No. of Classes
Water quality analysis physico – chemical and microbiological.	2
Preparation of different types of media.	2
Microbiological examination of different food samples	2
Assessment of surface sanitation by swab/rinse method	2
Assessment of personal hygiene	2
Biochemical tests for identification of bacteria	2
Scheme for the detection of food borne pathogens	2

Topic	No. of Classes
Preparation of plants for Implementation of FSMS-HACCP, ISO:22000	2
Total	**16**

Elective Course 7

Course Title : Bioformulation and Nanoformulation

Course Code : PP (EA) 322

Credits Hours : 3 (2+1)

General Objectives

i) To get acquainted with the applications of bioformulation and Nano-formulation.

ii) To get acquainted with the advanced techniques of nanotechnology in plant protection and agricultural applications.

Specific Objectives

i) To enable students to acquire expertise and skill to develop bioformulation and Nano-formulation.

ii) To know the importance of biopesticides and biofertilizers.

iii) To make the students know about various techniques involved in biofertilizers and biopesticides production.

iv) To get knowledge on essential oils, botanicals, predators, parasitoids, Pheromones, and parapheromone and their application in insect pest management.

v) To get concepts on agrochemical formulations with nanoparticles and acquaint them with nanotechnology.

Theory

Introduction and history of biological control of pests and diseases, Microbial biopesticides: the global and Indian market scenario; biopesticides for organic agriculture, Different phytopathogenic biocontrol agents: Mode of action, Different entomopathogenic biocontrol agents: Mode of action, Microbial inoculants as biofertilizer candidates, Production, quality assessment and methods of application of biopesticides and biofertilizers, Regulatory system of

biopesticides in India, Formulations of plant essential oils, botanicals, Pheromone, and parapheromone and their application in insect pest management, Use of predators and parasitoids for insect pest management, Nanotechnology: its applications in pest and disease diagnosis and management, Nano biopesticides: Concept and importance, different techniques of producing nano biopesticides, Nano Fertilizers: Concept and importance, Types of nano fertilizers, Different techniques of producing nano fertilizers, Green synthesis of nano fertilizers, green slow-release fertilizer composition based on urea-modified hydroxyapatite nanoparticles

Practicals

Introduction & acquaintance with biopesticide laboratory, Preparation of culture media, Isolation and purification of bioagent from soil and infected insects, Microscopic study of different microbial bioagents, *In vitro* assay of microbial bioagents against plant pathogens.

In vitro compatibility study among different microbial bioagents, Mass multiplication of biopesticides, Population enumeration of biocontrol agents in different biopesticides, Preparation of plant extracts and their efficacy test against insect pests, Use of pheromone parapheromone for monitoring and management of insect pests, Bioassay of Entomopathogenic biocontrol agents on insect pests, Preparation of microbial inoculants of biofertilizer microbes, Compatibility of biofertilizer microbes, Preparation of solid & liquid consortia of biofertilizer microbes.

Learning Outcomes

By the end of this course, students will be able to

1. To have an in-depth knowledge of different types of bioformulation and Nano-formulation and their role in plant and soil health
2. Know the methods of isolation, purification, and identification of various beneficial microorganisms
3. Method of production of various biopesticides and biofertilizers

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities

- Hand on experience

Suggested Readings

1. Allhoff, Fritz and Lin, Patrick (Eds) 2009. *Nanotechnology and Society*, ISBN: 978-1-4020- 6208-7 Springer Publications, UK.
2. Baker, E.F. and James, R.C. 1982. *Biological Control of Plant Pathogens.* American Phytopathological Society.
3. Boland, G.J. and David, L.1998. *Plant microbe interactions and Biological Control*. Kuykendall Marel Dekker, INC.
4. Borkar, S.G. 2015.Beneficial Microbes as Biofertilizers and its Production Technology.
5. Ciancia, A. and Mukerji, K.J. 2007. *General Concepts of Integrated Pest and Disease Management.* Edited Published by Springer.
6. Cincholkar, S.B. and Mukherji, K.G. 2007. *Biological Control of Plant Diseases.* Hawarth Food and Agricultural products.
7. Gnanamanickam, S.S. 2002. *Biological control of crop Disease.* Kuykendall Marel Dekker, INC.
8. Ramanujam, B. and Rabindra, R.J. 2006. *Current Status of Biological Control of Plant Disease using Antagonistic Organisms in India.* Precision Fototype Services Bangalore.
9. Singh, S.P. and Hussanini, S.S. 1998. *Biological Suppression of Plant Disease, Phytoparasitic Nematodes and Weeds*. Precision Fototype Services Bangalore.

Lecture Schedule

Theory

Topic	No. of Classes
Introduction and history of biological control of pests and diseases	2
Microbial biopesticides: the global and Indian market scenario; biopesticides for organic agriculture	2
Different phytopathogenic biocontrol agents: Mode of action	2
Different entomopathogenic biocontrol agents: Mode of action	2
Microbial inoculants as biofertilizer candidates	2
Production, quality assessment and methods of application of biopesticides and biofertilizers	3
Regulatory system of biopesticides in India	2

Topic	No. of Classes
Formulations of plant essential oils, botanicals, Pheromone, and parapheromone and their application in insect pest management	2
Use of predators and parasitoids for insect pest management	2
Nanotechnology: its applications in pest and disease diagnosis and management	2
Nano biopesticides: Concept and importance, different techniques of producing nano biopesticides	4
Nano Fertilizers: Concept and importance, Types of nano fertilizers, Different techniques of producing nano fertilizers	4
Green synthesis of nano fertilizers, green slow-release fertilizer composition based on urea-modified hydroxyapatite nanoparticles	3
Total	**32**

Practical

Topic	No. of Classes
Introduction & acquaintance with biopesticide laboratory	1
Preparation of culture media Isolation and purification of bioagent from soil and infected insects	2
Microscopic study of different microbial bioagents	1
In vitro assay of microbial bioagents against plant pathogens	1
In vitro compatibility study among different microbial bioagents	1
Mass multiplication of biopesticides	2
Population enumeration of biocontrol agents in different biopesticides	1
Preparation of plant extracts and their efficacy test against insect pests	2
Use of pheromone, parapheromone for monitoring and management of insect pests	1
Bioassay of Entomopathogenic biocontrol agents on insect pests	1
Preparation of microbial inoculants of biofertilizer microbes	1
Compatibility of biofertilizer microbes	1
Preparation of solid & liquid consortia of biofertilizer microbes	1
Total	**16**

Elective Course 8

Course Title : Biopesticides and Biofertilizers

Course Code : PP (EB)413

Credits Hours : 3 (2+1)

General Objective

i) To get acquainted with the applications of biopesticides and biofertilizers.

Specific Objectives

i) To provide knowledge on principles, methods, and mechanisms of bio-control agents and their use against plant diseases.

ii) To provide knowledge on principles, methods, and mechanism of biofertilizers and their use in agriculture.

Theory

History and concept of bio pesticides, Importance, scope and potential of bio pesticides, Definitions, concepts and classification of bio pesticides viz. Pathogen, botanical pesticides, and bio rationales. Botanicals and their uses. Mass production technology of bio-pesticides, Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes, Methods of application of bio pesticides. Methods of quality control and Techniques of bio pesticides. Impediments and limitation in production and use of bio pesticides.

Biofertilizers - Introduction, status and scope. Structure and characteristics features of bacterial biofertilizers – Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia; Cynobacterial bio fertilizers- Anabaena, Nostoc, Hapalosiphon and fungal biofertilizers – AM mycorrhiza and ectomycorhiza. Nitrogen fixation –Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilisation and phosphate mobilization, K solubilisation. Production Technology: Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertiizers, FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers, sets etc. Biofertilizers-Storage, shelf life, quality control and marketing. Factors influencing the efficiency of biofertilizers.

Practicals

Isolation and purification of important biopestisides: T*richoderma, Pseudomonas, Bacillus, Metarhyzium* etc. and its production, Identification of important botanicals, Visit to biopesticide laboratory in nearby area, Field visit to explore naturally infected cadavers, Identification of entomopathogenic entities in field condition, Quality control of biopesticides, Isolation and purification of *Azospirillum, Azotobactor, Rhizobium,* P-solubilizers and cyanobacteria, Mass multiplication and inoculums production of biofertilizers, Isolation of AM fungi-Wet sieving method and sucrose gradient method, Mass production of AM inoculants**.**

Learning Outcomes

By the end of this course, students will be able to

1. To have an in-depth knowledge of different types of biopesticides and biofertilizers and their role in plant and soil health
2. Know the methods of isolation, purification, and identification of various beneficial microorganisms
3. Method of production of biopesticides and biofertilizers

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested Readings

1. Baker, E.F. and James, R.C. 1982. Biological Control of Plant Pathogens. American Phytopathological Society
2. Biofertilizers for Sustainable Agriculture- Sampat Nehra, Aavishkar Publishers, Jaipur, India
3. Boland, G.J. and David, L.1998. Plant microbe interactions and Biological Control. Kuykendall Marel Dekker, INC.
4. Borkar, S.G. 2015.Beneficial Microbes as Biofertilizers and its Production Technology

5. Ciancia, A. and Mukerji, K.J. 2007. General Concepts of Integrated Pest and Disease Management. Edited Published by Springer.
6. Cincholkar, S.B. and Mukherji, K.G. 2007. Biological Control of Plant Diseases. Hawarth Food and Agricultural products.
7. Earthworm Vermiculture and Vermicomposting, R.K. Bhatnagar, R.K. Palta, Kalyani Publishers
8. Fungal Biopesticides and VAM applications- P.C. Trivedi, Pointer publishers, Jaipur, India
9. Gnanamanickam, S.S. 2002. Biological control of crop Disease. Kuykendall Marel Dekker, INC.
10. Handbook of Microbial Biofertilizers- Dr. Awani Kr. Singh, Agrotech Press, Jaipur, India
11. Organic Farming- A.K. Singh, New India Publishing Agency, New Delhi
12. Organic Farming: Standards, Accreditation, Certification and Inspection- Dushyent Gehlot, Agrobios (India)
13. Ramanujam, B. and Rabindra, R.J. 2006. Current Status of Biological Control of Plant Disease using Antagonistic Organisms in India. Precision Fototype Services Bangalore.
14. Singh, S.P. and Hussanini, S.S. 1998. Biological Suppression of Plant Disease, Phytoparasitic Nematodes and Weeds. Precision Fototype Services Bangalore.

Lecture Schedule

Theory

Topic	No. of Classes
History and concept of biopesticides	1
Importance, scope, and potential of biopesticides	1
Definitions, concepts, and classification of bio-pesticides *viz.* Pathogen, botanical pesticides, and bio rationales	3
Botanicals and their uses	2
Mass production technology of bio-pesticides	3
Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes	2
Methods of application of biopesticides	1

Topic	No. of Classes
Methods of quality control and Techniques of biopesticides, Impediments, and limitations in production and use of biopesticides	2
Biofertilizers - Introduction, status, and scope	1
Structure and characteristics features of bacterial biofertilizers – Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia	3
Cynobacterial bio fertilizers- Anabaena, Nostoc, Hapalosiphon and fungal biofertilizers – AM mycorrhiza and ectomycorhiza	2
Nitrogen fixation –Free living and symbiotic nitrogen fixation	2
Mechanism of phosphate solubilisation and phosphate mobilization, K solubilization	2
Production Technology: Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertiizers	2
FCO specifications and quality control of biofertilizers	1
Application technology for seeds, seedlings, tubers, sets etc. Bio Fertilizers- Storage, shelf life, quality control and marketing. Factors influencing the efficiency of biofertilizers	4
Total	**32**

Practical

Topic	No. of Classes
Isolation and purification of important biopesticides: *Trichoderma, Pseudomonas, Bacillus, Metarhizium* and its production	4
Identification of important botanicals	1
Visit to biopesticide laboratory in nearby area	1
Field visit to explore naturally infected cadavers	1
Identification of entomopathogenic entities in field condition	1
Quality control of biopesticides	1
Isolation and purification of *Azospirillum, Azotobacter, Rhizobium,* P-solubilizers and cyanobacteria	4
Mass multiplication and inoculums production of biofertilizers	1
Isolation of AM fungi- Wet sieving method and sucrose gradient method	1
Mass production of AM inoculants	1
Total	**16**

Elective Course 9

Course Title : System Simulation and Agro-advisory

Course Code : Ag Met (EA) 413

Credits Hours : 3 (2+1)

General Objectives

i) To impart the theoretical and practical knowledge of various models for estimation of crop weather responses.

Specific Objectives

i) To impart the knowledge of statistical and simulation modeling in crop yield estimation.

ii) To get acquainted with different weather forecasting techniques and their usability analysis.

iii) To study about the preparation and dissemination of agro-advisory bulletin.

Theory

System Approach for representing soil-plant-atmospheric continuum, system boundaries, Crop models, concepts & techniques, types of crop models, data requirements, relational diagrams, Evaluation of crop responses to weather elements; Elementary crop growth models; calibration, validation, verification and sensitivity analysis, Potential and achievable crop production- concept and modeling, techniques for their estimation, Crop production in moisture and nutrients limited conditions; components of soil water and nutrients balance, Weather forecasting, types methods, tools & techniques, forecast verification; Value added weather forecast, ITK for weather forecast and its validity; Crop-Weather Calendars; Preparation of agro-advisory bulletin based on weather forecast, Use of crop simulation model for preparation of Agro-advisory and its effective dissemination.

Practicals

Preparation of crop weather calendars, Preparation of agro-advisories based on weather forecast using various approaches and synoptic charts, Working with statistical and simulation models for crop growth, Potential & achievable production; yield forecasting, insect & disease forecasting models, Simulation with limitations of water and nutrient management options, Sensitivity analysis of varying weather and crop management practices, Use of statistical approaches in

data analysis and preparation of historical, past and present meteorological data for medium range weather forecast, Feedback from farmers about the agro-advisory.

Learning Outcomes

Students will be able to understand the basic concept of crop modeling techniques and preparation of agro-advisories for farmers.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested Readings

1. Introduction to Agrometeorology by H. S. Mavi.
2. Agricultural Meteorology by G.S.L.H.V. Prasado Rao.
3. Advances in Plant Atmospheric Interactions (Eds. Rao, V.U.M., Rao, A.V.M.S., Rao, G.G.S.N., Ramana Rao, B.V., Vijaya Kumar, P. and Venkateswarlu, B), Central Research Institute for Dryland Agriculture (CRIDA), Santoshnagar, Hyderabad.
4. Text Book of Agricultural Meteorology. ICAR by MC Varshneya & PB Pillai.
5. Principles of Agricultural Meteorology by OP Bishnoi.

Lecture Schedule

Theory

Topic	No. of Classes
System approach for representing soil-plant-atmospheric continuum, system boundaries	3
Crop models, concepts & techniques, types of crop models	2
Data requirements for crop models and relational diagrams	1
Evaluation of crop responses to weather elements	2
Elementary crop growth models	2
Model calibration, validation, verification and sensitivity analysis	2

Topic	No. of Classes
Potential and achievable crop production – concept and modeling techniques for their estimation	2
Crop production in moisture and nutrient limited conditions; components of soil, water and nutrient balance	3
Importance and concept of weather forecasting	2
Types, methods of weather forecasting - short, medium and long range weather forecast	2
Modern techniques in weather forecasting	2
Value addition in weather forecast	1
ITK for weather forecast and its validity	2
Crop- Weather Calendars, usefulness and limitations	2
Preparation of Agro-advisory bulletin based on weather forecast	2
Use of crop simulation model for preparation of Agro-advisory and its effective dissemination	2
Total	**32**

Practicals

Topic	No. of Classes
Preparation of crop weather calendars for major field crops	3
Preparation of agro-advisories based on medium range weather forecasts	1
Analysis of synoptic chart/ weather reports	1
Verification of Medium range weather forecast	1
Working with statistical models, development of crop yield forecasting models and insect & pest disease forecasting model	2
Preparation of inputs files for simulation models	1
Working with simulation models (CERES-Rice) for crop growth	1
Simulation of potential and achievable production	1
Simulation with limitations of water and nutrient management options in rice using CERES-Rice	1
Sensitivity analysis for varying weather and crop management practices in rice	1
Use of statistical approaches in climate data analysis	1
Studies on past and present meteorological data for medium range weather forecast	1
Collection and analysis of feedback from farmers about the agro-advisory	1
Total	**16**

Elective Course 10

Course Title : Hi-tech Horticulture

Course Code : Hort (EC) 413

Credits Hours : 3 (2+1)

General Objectives

i) To educate the students on hi-tech horticulture and its different components.

Specific Objectives

i) To educate the students on the latest technology of hi-tech horticulture.

ii) To educate students on the concepts and prospects of hi-tech horticulture.

Theory

Introduction & importance; Nursery management and mechanization; micro propagation of horticultural crops; Modern field preparation and planting methods, Protected cultivation: advantages, controlled conditions, method and techniques, Micro irrigation systems and its components; EC, pH based fertilizer scheduling, canopy management, high density orcharding, Components of precision farming : Remote sensing, Geographical Information System (GIS), Differential Geo-positioning System (DGPS), Variable Rate Applicator (VRA), application of precision farming in horticultural crops (fruits, vegetables and ornamental crops); mechanized harvesting of produce.

Practicals

Types of polyhouses and shade net houses, Intercultural operations, tools and equipments identification and application, Micro propagation, Nursery- portrays, micro-irrigation, EC, pH based fertilizer scheduling, canopy management, visit to hi-tech orchard/nursery.

Learning Outcomes

1. Students will be able to learn about the latest concepts of hi-tech horticulture.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested Readings

1. Hi-tech Horticulture by T.A. More.
2. Greenhouse operation and management by Paul V. Nelson.

Lecture Schedule

Theory

Topic	No. of Classes
Introduction, scope and importance of hi-tech horticulture	2
Objectives, present status and future prospects of Hi-tech Horticulture	2
Components of Precision farming	2
Hi-tech Nursery management of horticultural crops (vegetables, flowers and MAPs)	8
Protected cultivation of Horticultural crops (fruits, vegetables and flowers)	6
Hi-tech propagation	2
High Density Planting	2
Hi-tech canopy management of horticultural crops	2
Hydroponics	2
Post-Harvest Management of hi-tech horticultural crops	2
Nutrient management	2
Total	**32**

Practical

Topic	No. of Classes
Hi-tech nursery management	1

Topic	No. of Classes
Canopy management	1
Hi-tech plant propagation structures	1
Hydroponics	1
Post-harvest management	1
Hi-tech cultivation of commercial horticultural crops	4
Plasticulture	1
Fertigation	1
Micro-irrigation	1
Vertical farming	1
Integrated Nutrient Management	1
Integrated Pest Management	1
Total	**16**

Elective Course 11

Course Title : Protected Cultivation

Course Code : Hort (ED) 413

Credits Hours : 3 (2+1)

General Objective

i) To educate students on the scientific and commercial cultivation of important value added products in protected cultivation.

Specific Objectives

i) To educate the students on different protected structures.

ii) To educate the students on agro-techniques and management of different horticultural crops under protected environmental conditions.

Theory

Protected cultivation- importance and scope, status of protected cultivation in India and World types of protected structure based on site and climate, Cladding material involved in greenhouse/poly house, Greenhouse design, environment control, artificial lights, Automation, Soil preparation and management, Substrate management, Types of benches and containers, Irrigation and fertigation

management, Propagation and production of quality planting material of horticultural crops, Greenhouse cultivation of important horticultural crops-rose, carnation, chrysanthemum, gerbera, orchid, anthurium, lilium, tulip, tomato, bell pepper, cucumber, strawberry, pot plants etc. Cultivation of economically important medicinal and aromatic plants, Off- season production of flowers and vegetables, Insect pest and disease management.

Practicals

Raising of seedlings and saplings under protected conditions, use of portrays in quality planting material production, Bed preparation and planting of crop for production, Inter cultural operations, Soil EC and pH measurement. Regulation of irrigation and fertilizers through drip, fogging and misting.

Learning Outcomes

1. Students will be able to learn about the installation of protected structures and production of off-season crops under those structures.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested Readings

1. Greenhouse operation and management by Paul V. Nelson.
2. Protected cultivation of Horticultural crops by Madan Kr. Jha, Sujan Singh Paikra, Manju Rani Sahu.

Lecture Schedule

Theory

Topic	No. of Classes
Importance and scope of protected cultivation of horticultural crops in India against the backdrop world	1
Different types and designs of protected structures based on site and climate.	1
Cladding materials for protected structures	1
Different environmental devices of protected structures (Temperature, light, CO_2, humidity, ventilation)	1
Types of benches, containers used in protected structures	1
Selection criteria, production system and growing media in protected structures	1
Off season protected cultivation of selected vegetable crops (Tomato, capsicum, cucumber)	3
Production of horticultural propagating material	1
Off season protected cultivation of selected flower crops	1
Protected cultivation of rose, carnation, tulip, orchids and chrysanthemum	4
Protected cultivation of gerbera, anthurium and lilium	3
Protected cultivation of strawberry	1
Protected cultivation of medicinal and aromatic plants	3
Diseases of protected vegetable crops and their management	2
Insect pests of protected vegetable crops and their management	2
Diseases of protected flower crops and their management	2
Insect pests of protected flower crops and their management	2
Drip irrigation and fertigation of protected crops	2
Total	**32**

Practical

Topic	No. of Classes
Site selection and orientation of protected structure	1
Constructional composition and design of different types of protected structures	2
Natural and forced ventilation in protected system	1
Growing media, portrays, preparation and propagation techniques of selected vegetable crops	2

Topic	No. of Classes
Growing media, preparation and propagation techniques of selected flower crops	1
Pinching, pruning and trellising in selected protected vegetable crops	4
Drip system, identification of components and fertigation practices	1
Measurement of EC and PH of drip water and fertigation	1
Heating and cooling of forced ventilation	1
Disease and insect pest control measures	1
Total	**16**

Elective Course 12

Course Title : Climate Resilient Agriculture

Course Code : Ag Met (EB) 413

Credits Hours : 3 (2+1)

General Objective

i) To make the students aware of the climate change issues with respect to its extent and impact and impart knowledge about various means to minimize climate change impact on agriculture and allied sectors.

Specific Objectives

i) To impart the concept of climate resilient agriculture under the present context of climate change.

ii) To study the integrated role of different sectors in building resilience to climate change in agriculture.

Theory

Climate change and impacts of climate change on agriculture and food security; crop productivity under different climate change scenarios including extreme events such as drought, flood, pest and disease outbreak etc. Basics of adaption and mitigation in the agricultural sectors; analyzing and assessing climate vulnerability to identify vulnerable sectors and possible adaptation options in agriculture; assessing biophysical and socio-economic impacts on agricultural sector; risk assessment strategies, preparedness for weather and climate risks in agriculture; application of geospatial tools and techniques for sustainable

agriculture.

Climate resilient agriculture (CRA) – concept, scope and importance with special reference to India, climate resilient technologies for enhancing crop productivity and sustainability – role of weather & climatic information, agro-advisories, ICTs and simulation models; climate resilient agronomic practices – crop/cultivar selection, crop diversification/ crop mixtures; water management practices – rain water harvesting, micro-irrigation, deficit irrigation and drainage management, organic/natural farming, integrated farming systems (IFS); site specific nutrient management (SSNM), conservation agriculture technologies to build soil organic carbon, harnessing microbial biodiversity, biomass recycling; use of renewable sources of energy; climate resilient pest-disease management strategies.

Breeding strategies for development of climate change resilient crops and varieties, development of biotic and abiotic stress tolerant/resistant cultivars under changed climatic scenarios including extreme weather events.

Practicals

Acquaintance with meteorological instruments including AWS, Statistical techniques to study trend of climatic parameters, Analysis of extreme weather events using non-parametric tests, Building climate change scenarios under different futuristic emission of GHGs, Designing strategies to mitigate the effect of climate change using climate resilient crops/cultivars, climate resilient technologies and manipulation of cropping patterns, Acquaintance with ICTs for effective dissemination of local weather information and agro-advisories, Analysing carbon sequestration potential of different agro-ecosystems; Designing 'climate smart village' model considering the availability of resources. Awareness programme on climate change and climate resilient agriculture among farming community.

Learning Outcomes

1. Students will acquire the basic concept of climate change and climate resilient agriculture including climate resilient technologies to minimize the adverse impact of climate change on agricultural productivity.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation

- Group activities
- Hand on experience

Suggested Readings

1. Climate Resilient Animal Agriculture by GSLHV Prasada Rao (New India Publishing Agency).
2. Climate Resilient Agriculture Adaptation and Mitigation Strategies by Bhan Manish, New India Publishing Agency.
3. FAO (2013) Climate-Smart Agriculture Sourcebook.

Lecture Schedule

Theory

Topic	No. of Classes
Climate change and global warming- concept of climate variability and climate change, green house effect, global warming and global warming potential	2
Observed changes in major climatic parameters and associated environmental changes; impacts of climate change on agriculture and food security	2
Crop productivity under different climate change scenarios including extreme events such as drought, flood, pest and disease outbreak etc. Basics of adaption and mitigation in the agricultural sectors	2
Analyzing and assessing climate vulnerability to identify vulnerable sectors and possible adaptation options in agriculture	2
Assessing biophysical and socio-economic impacts on agricultural sector; risk assessment strategies, preparedness for weather and climate risks in agriculture	2
Application of geospatial tools and techniques for sustainable agriculture	1
Climate resilient agriculture (CRA) – meaning, concept, scope and importance with special reference to India, Climate smart village, success stories of CRA	2
Climate resilient technologies for enhancing crop productivity and sustainability – role of weather & climatic information, agro-advisories, ICTs and simulation models	2

Topic	No. of Classes
Climate resilient agronomic practices – crop/cultivar selection, crop diversification/ crop mixtures; water management practices – rain water harvesting, micro-irrigation, deficit irrigation and drainage management	3
Organic/natural farming, integrated farming systems (IFS)	2
Site specific nutrient management (SSNM), conservation agriculture technologies to build soil organic carbon, harnessing microbial biodiversity	3
Biomass recycling; use of renewable sources of energy	2
Climate resilient pest-disease management strategies	3
Breeding strategies for development of climate change resilient crops and varieties, development of biotic and abiotic stress tolerant/resistant cultivars under changed climatic scenarios including extreme weather events.	4
Total	**32**

Practical

Topic	No. of Classes
Acquaintance with meteorological instruments including AWS	1
Statistical techniques to study trend of climatic parameters	2
Analysis of extreme weather events using non-parametric tests	1
Building climate change scenarios under different futuristic emission of GHGs	2
Designing strategies to mitigate the effect of climate change using climate resilient crops/cultivars, climate resilient technologies and manipulation of cropping patterns	2
Acquaintance with ICTs for effective dissemination of local weather information and agro-advisories	2
Analysing carbon sequestration potential of different agro-ecosystems	2
Designing ‘climate smart village’ model considering the availability of resources	2
Awareness programme on climate change and climate resilient agriculture among farming community	2
Total	**16**

Elective Course 13

Course Title : Biotechnology of Crop Improvement 3 (2+1)

Course Code : ABT (E) 413

Credits Hours : 3 (2+1)

General Objective

i) To familiarize the students with the cell biology at molecular level, genetic engineering, bioinformatics and microbial technology and practical on basic molecular biology techniques.

Specific Objectives

i) To acquaint with biotechnological tools of crop improvement.

ii) To know about direct and indirect methods of gene transfer.

iii) To introduce about gene editing in plants.

iv) To provide knowledge about marker assisted breeding and genomic selection.

Theory

Impact of Biotechnology on crop improvement and the perspective of society: Various biotechnological techniques available for crop improvement – Plant Tissue Culture, Genetic Engineering, Genome editing, Marker Assisted breeding and Genomic Selection, Biosafety regulations and their application in Agricultural Biotechnology, Soma clonal variation and its use in crop improvement: embryo culture, anther/pollen culture, somatic embryogenesis, artificial seeds, techniques of protoplast culture, regeneration and somatic cell hybridization, achievements and limitations, utility in the improvement of crop plants, Direct and Indirect methods of gene transfer in plants - Agrobacterium-mediated gene transfer in dicots and monocots, Direct DNA delivery methods (microinjection, particle gun method, electroporation), gene targeting, Gene silencing techniques, introduction to siRNA, siRNA technology, Micro RNA, construction of siRNA vectors, principle and application of gene silencing, creation of transgenic plants, debate over GM crops, introduction to methods of genetic manipulation in different model systems.

Introduction to genome editing – Various tools of genome editing, CRISPR-Cas9 with specific emphasis on Indian regulations, Cloning genomic targets into CRISPR/Cas9 plasmids, electroporation of Cas9 plasmids into cells, purification of DNA from Cas9 treated cells and evaluation of Cas9 gene editing, *in vitro*

synthesis of single guide RNA (sgRNA), using Cas9/sgRNA complexes to test for activity on DNA substrates, evaluate Cas9 activity by T7E1 assays and DNA sequence analysis, Applications of CRISPR/cas9 technology in crop plants, Marker Assisted Breeding & Genomic Selection: Introduction to various DNA-based markers and their use in marker-assisted breeding, Foreground Selection, Recombinant Selection and background Selection, Marker-assisted backcross breeding, marker-assisted selection – success stories, Introduction to Genomic Selection.

Practicals

Agrobacterium-mediated transformation in tobacco – preparation of construct, transfer to binary vector, transform *Agrobacterium*, prepare explant, Inoculation and Co-cultivation, antibiotic based selection of putative transformants, validation using PCR; Genome editing- preparation of CRISPR/Cas construct, direct transfer to plant, analysis of the targets, Planning of a MABB programme – selection of parents, crossing strategies, marker analysis.

Learning Outcomes

1. Undergraduate students will be able to demonstrate and apply their knowledge molecular biology to solve the problems of crop biotechnology.
2. Undergraduate students will be competent to perform biotechnology related activities using basic laboratory instruments and by following techniques of plant cell culture and molecular biology for crop improvement.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested Readings

1. Brown, T. A. (2006). Genomes (3rd ed.). New York : Garland Science Pub.
2. Gene Cloning and DNA Analysis, 2010 Retrieved from http:// biolab.szu.edu.cn/ other web/lzc/genetic%20engineering/courseware/b1.pdf.
3. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
4. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). Principles of Gene

Manipulation and Genomics, 7th Edition: Oxford: Blackwell Scientific Publications.

5. Sander JD and Joung JK. (2014). CRISPR-Cas systems for Editing, Regulating and Targeting Genomes. Nat Biotechnol. 32:347-355.

Lecture Schedule

Theory

Topic	No. of Classes
Genome organization and analysis – Nuclear and organellar genomes, genome size, C-Value paradox; transposable elements, Genome Complex	2
Molecular Markers: Types of molecular markers [RFLP, AFLP, SCARs, CAPS, SSRs, STMS and SNPs], MAS/ MAB, QTL analysis	3
Genome sequencing, various methods of sequencing (Sanger Dideoxy, Chemical method, Maxam Gilbert, Next Gen Sequencing)	2
Bioinformatics basics, scope and importance of bioinformatics, biological databases [PIR, SWISSPROT, gene bank, DDBJ, DNA sequence analysis, sequence submission and retrieval system. Tools for Sequence alignment- BLAST	2
Plasmids; Bacteriophages, Cosmid, phagemid, Artificial chromosome vectors (YACs; BACs), expression vectors. bacterial transformation, electroporation, etc.	3
Gene cloning and Genetic engineering- restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase, etc.; cohesive and blunt end ligation, linkers; adaptors; homopolymer tailing	4
cDNA synthesis; cDNA and genomic libraries, labelling of DNA for probes, hybridization techniques: northern, southern and western	4
Applications of transgenic crop technology - Herbicide resistance; Pest resistance, disease resistance; abiotic stress tolerance, male sterility- Barnase-Barstar; Delayed fruit ripening, nutritional quality, Molecular pharming and Bio-safety concerns of transgenic plants	4
Gene silencing techniques; introduction to siRNA and miRNA; CRISPR/Cas9 technology and its applications	2
Microbial enzymes in food processing; Industrial production of enzymes fermentation- alcoholic and non-alcoholic probiotics, vitamins, and antibiotics	2
Fuels and industrial chemicals- Alkanes, industrial ethanol Cell immobilization for product enhancement	2
Biosensors and nanotechnology and its application	2
Total	**32**

Practical

Topic	No. of Classes
Plasmid DNA extraction, Restriction digestion, Gel electrophoresis	3
Gene cloning and vector construction	2
Bacterial transformation and screening of recombinant plasmids	2
Sequence (DNA, RNA and Protein) alignment and analysis	1
Plant DNA extraction and PCR based marker analyses.	2
Gene transfer using different methods, reporter gene expression, selection of transformed tissues/plants	3
Molecular analysis of transgenic [PCR, Western Blotting, ELISA]	3
Total	**16**

Elective Course 14

Course Title : Geoinformatics and Remote Sensing, Precision farming

Course Code : Soil (E) 412

Credits Hours : 3 (2+1)

General Objective

i) Enabling students acquire knowledge on basics of remote sensing technique for precision farming applications.

Specific Objective

i) To provide a comprehensive knowledge of remote sensing, precision farming and its benefits in improving crop production and soil health management.

Theory

Introduction and history of remote sensing; sources, Principles of remote sensing, propagation of radiations in atmosphere; Interaction with matter, Application of remote sensing techniques land use soil surveys, crop stress and yield forecasting, Advantages and disadvantages of remote sensing, Remote sensing institutes in India, Basic Concepts about geoinformatics.

What is artificial intelligence; History of artificial intelligence, Fundamentals of big data & machine learning (ML), Use of artificial intelligence in autonomous systems: agricultural robots and drone monitoring systems, driverless tractors,

automated sprinklers and self-harvesting machines etc.; Use of AI in crop analysis: monitoring soil quality, promoting organic crops, monitoring weeds, precision agriculture, using drones for crop analysis; Role of AI for sustainability and climate change, yield and demand forecasting, food tech/wider value chain including impact of blockchain, AI use for in the emerging markets; Technology deployment like sensors , AI and agricultural technologies and How to scale AI for agricultural technologies applications, Responsible AI in agriculture, Data sharing; Expert System: Introduction to expert system, Characteristics and features of expert system, Applications of Expert System, Importance of Expert system, Rule based system architecture; Software Agents.

Practicals

Familiarization with different remote sensing equipments and data products, Interpretation of aerial photographs and satellite data for mapping of land resources, Global positioning system (GPS), Basics of Geographic Information System (GIS), Georeferencing of topo sheets.

Live examples and case study of AI use in Agriculture, Search and Control strategies: Blind search, Breadth - first search, Depth First search, Hill climbing method, Best First search, Branch and Bound search, Programming in Prolog Syntax and meaning of Prolog Programs, Using Data Structures, Controlling Back- tracking, Input and Output, Built-in Predicates, Using Prolog Grammar Rules, Higher level assignments/exercises for implementation using Prolog.

Learning Outcomes

1. The course will be useful in understanding the use of geoinformatics in agriculture, basics of remote sensing and its use in precision agriculture for improvement of crop production and management of soil health**.**

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested Readings

1. *Data Analytics in Bioinformatics: A Machine Learning Perspective*. Editor(s):. Rabinarayan Satpathy, Tanupriya Choudhury, Suneeta Satpathy, Sachi Nandan.
2. *Machine Learning Approaches to Bioinformatics* By Zheng Rong Yang.
3. Text Book of *Remote Sensing and Geographical Information Systems By M. Anji Reddy.*
4. *Precision Agriculture Technologies for Food Security and Sustainability By* A El-Kader, M Sherine, M El-Basioni, M Basma.

Lecture Schedule

Theory

Topic	No. of Classes
Introduction and history of remote sensing; sources, Principles of remote sensing, propagation of radiations in atmosphere	3
Interaction with matter, Application of remote sensing techniques land use soil surveys, crop stress and yield forecasting, Advantages and disadvantages of remote sensing	4
Remote sensing institutes in India, Basic Concepts about geoinformatics	2
What is artificial intelligence; History of artificial intelligence, Fundamentals of big data & machine learning (ML)	2
Use of artificial intelligence in autonomous systems: agricultural robots and drone monitoring systems, driverless tractors, automated sprinklers and self-harvesting machines etc.	4
Use of AI in crop analysis: monitoring soil quality, promoting organic crops, monitoring weeds, precision agriculture, using drones for crop analysis	3
Role of AI for sustainability and climate change, yield and demand forecasting, food tech/wider value chain including impact of blockchain, AI use for in the emerging markets	4
Technology deployment like sensors, AI and agricultural technologies and how to scale AI for agricultural technologies applications	4
Responsible AI in agriculture, Data sharing	2
Expert System: Introduction to expert system, Characteristics and features of expert system	2
Importance of Expert system, Rule based system architecture; Software Agents	2
Total	**32**

Practical

Topic	No. of Classes
Familiarization with different remote sensing equipments and data products	1
Interpretation of aerial photographs and satellite data for mapping of land resources	1
Global positioning system (GPS)	1
Basics of Geographic Information System (GIS)	1
Georeferencing of topo sheets	1
Live examples and case study of AI use in Agriculture, Search and Control strategies	2
Blind search, Breadth - first search, Depth First search	1
Hill climbing method, Best First search, Branch and Bound search	2
Programming in Prolog Syntax and meaning of Prolog Programs	1
Using Data Structures	1
Controlling Back- tracking. Input and Output	1
Built-in Predicates, Using Prolog Grammar Rules	2
Higher level assignments/exercises for implementation using Prolog	1
Total	**16**

Elective Course 15

Course Title : Micro-propagation Technologies

Course Code : Hort (EE) 413

Credits Hours : 3 (2+1)

General Objective

i) The objective of the course is to provide basic knowledge on tissue culture techniques.

Specific Objective

i) To educate the students in detail about the sterilization techniques for explants, preparation of stocks and working solution, culturing of explants, regeneration of whole plants from different explants and hardening procedures.

Theory

Introduction, History, Advantages and limitations. Types of cultures (seed, embryo, organ, callus, cell), Stages of micro propagation, Axillary bud proliferation (Shoot tip and meristem culture, bud culture), Organogenesis (callusy and direct organ formation), Somatic embryogenesis, cell suspension cultures, production of secondary metabolites, Soma clonal variation, Cryopreservation.

Practicals

Identification and use of equipment's in tissue culture Laboratory, Nutrition media composition, sterilization techniques for media, containers and small instruments, sterilization techniques for explants, Preparation of stocks and working solution, Preparation of working medium, Culturing of explants: Seeds, shoot tip and single node, Callus induction, Induction of somatic embryos regeneration of whole plants from different explants, Hardening procedures.

Learning Outcomes:

1. To enable the students to apply various horticultural skills and knowledge in their career.
2. To identify and prescribe sustainable options in horticulture which benefit the environment while maintaining the productivity and economic viability.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading)
- Students presentation
- Group activities
- Hand on experience

Suggested Readings

1. Basics of Horticulture by Jitendra Singh.
2. Introduction to Horticulture by N. Kumar.
3. Handbook of Horticulture by K.L. Chadda.

Lecture Schedule

Theory

Topic	No. of Classes

Topic	No. of Classes
Introduction, History, Advantages and limitations	2
Types of cultures (seed, embryo, organ, callus, cell)	8
Stages of micro propagation, Axillary bud proliferation (Shoot tip and meristem culture, bud culture)	8
Organogenesis (callus and direct organ formation)	4
Somatic embryogenesis	2
Cell suspension cultures	3
Production of secondary metabolites	3
Soma clonal variation, Cryopreservation	2
Total	**32**

Practical

Topic	No. of Classes
Identification and use of equipment's in tissue culture Laboratory	2
Nutrition media composition, sterilization techniques for media, containers and small instruments,	2
Sterilization techniques for explants, Preparation of stocks and working solution,	3
Preparation of working medium	3
Culturing of explants: Seeds, shoot tip and single node,	2
Callus induction, Induction of somatic embryos regeneration of whole plants from different explants	2
Hardening procedures	2
Total	**16**

Elective Course 16

Course Title : Commercial Seed Production

Course Code : SST-413

Credits Hours : 3 (2+1)

General Objective

i) To impart a comprehensive knowledge on seed production of crops and their relevance to crop performance with adequate practical training.

Specific Objective

i) To introduce the basic principles of planting material production at commercial scale and seed quality evaluation.

Theory

General Principles of Seed Production**:** Raising the seed crop, Introduction, Procurement of a class of Improved seeds, Reporting to Monitoring or certification Agency, Principles and practices of selection of area and agronomic requirement of seed production of field crops, Importance of isolation distance and Rouging, Principles of hybrid seed production in field crops, Principles and practices of selection of area and agronomic requirement of seed production of horticultural crops, Concept of apomixis, male sterility and self-incompatibility and its application in hybrid seed production of horticultural crops.

General Principles of Seed Processing: Introduction, Objectives of Seed Processing, Seed Drying, Principles of Drying, Water vapour equilibrium, Methods of drying seeds, Cleaning and grading, Air and screen machines, Dimensional separators, Density separators, Surface texture separators, Colour separators, Spiral separators, Electric separators, Vibrator separators, Separation based on Affinity to liquids, Seed treatment, Temperature treatment, Chemical treatment, Bagging and Labelling

General Principles of Seed Testing: Seed testing-Introduction, Procedure of Seed testing, components of seed quality testing genetic, physical, physiological and seed health testing, Seed sampling, Types of seed sampling, Requirements of sampling, Concept of seed viability and vigour; dormancy, types and principles of seed dormancy, Physiological quality of seed, Principles of seed Germination, types of germination, biochemical and genetic basis.

Seed Certification: History, concept and objectives of seed certification; seed certification agency/organization and staff requirement Indian Minimum Seed

Certification Standards (I.M.S.C.S.) - general and specific crop standards including GM varieties, field and seed standards.

Seed Industry and Seed Marketing : Introduction, Evolution of the seed industry, Development of the vegetable and Flower seed industry, Seed marketing – concept, definition and purpose, importance and promotion of quality seed, formal and informal seed supply systems, Seed marketing intelligence and product mix, sales promotion, distribution channels, marketing costs and margins; packaging and labeling, Seed Associations, Factors influencing seed marketing, Seed marketing programs, Seed industry organizations, Marketing of public versus private players, Demand and supply of seed; role of seed replacement rate (SRR), seed multiplication ratio (SMR), economics of seed production; determining seed needs, Seed pricing and price policy, seed processing and /packaging, demand forecasting and factors affecting demand for seeds, effect of price and farm income on seed demand.

Biotechnology in Seed Technology: History of plant tissue culture, Laboratory organization, Composition of nutrient medium, Micro-propagation, Axillary bud proliferation approach, Meristem and shoot tip culture, Bud culture, Advantages of Micro-propagation, Problems associated with micro-propagation, Synthetic seed production, Types of synthetic seeds, methods of development of synthetic seeds, Components of nutrient media for synthetic seed development**,** Storage of synthetic seeds, Advantages and limitations of synthetic seed production.

Practicals

Planning of Seed Production, requirements for different classes of seeds in field crops - unit area and rate.

Operation and handling of mechanical drying equipments; effect of drying temperature and duration on seed germination and storability seed processing equipments; seed treating equipments.

Seed production in cross pollinated crops with special reference to land, isolation, Planting ratio of male and female lines, synchronization of parental lines and methods to achieve synchrony; supplementary pollination, pollen storage, hand emasculation and pollination in tomato, Hybrid seed production in Maize, detasseling in maize, identification of rogues and pollen shedders, Pollen collection, storage, viability and stigma receptivity; gametocide application and visits to seed production plots etc., Visit to seed processing plant and commercial controlled and uncontrolled Seed Stores, Seed industries and local entrepreneurships visit to nearby areas, Different methods of examination of seeds to assess seed-borne microorganisms and to quantify infection percentage,

detection of seed borne fungi, bacteria and viruses, identification of storage fungi, control of seed borne diseases, seed treatment methods.**,** Maintenance of aseptic conditions and sterilization techniques, Preparation of nutrient stocks for synthetic media**,** Selection of explants for callus induction, Preparation of MS medium for micro-propagation and Callus induction**,** Selection of explants for callus induction**,** Preparation of MS medium for micro-propagation and Callus induction**,** Inoculation of explants for micro-propagation, Inoculation of explants for callus induction and subsequently regeneration of plantlets from matured seeds of field and horticultural crops**,** Synthetic seed preparation.

Learning Outcomes

1. The students will get exposed to complete coverage of the subject with requisite knowledge on seed science and technology.

Teaching Methods/Activities

- Lectures
- Assignment (Writing/ Reading): To be decided by the instructors
- Students presentation: Included in the practical
- Group activities: Practical
- Hand on experience: Practical format

Suggested Readings

1. Agarwal RL. 1997. Seed Technology. 2nd Ed. Oxford & IBH.
2. Chawla H.S. (2008) Introduction to Plant Biotechnology second edition, Oxford &IBH publishing Co. Ltd. 113-B Shahpur Jat, New Delhi-110049.
3. Justice OL & Bass LN. 1978. Principles and Practices of Seed Storage. Castle House Publ. Ltd.
4. McDonald MB Jr & Copeland LO. 1997. Seed Production: Principles and Practices. Chapman & Hall.
5. Singhal NC. 2003. Hybrid Seed Production in Field Crops. Kalyani.
6. Thompson JR. 1979. An Introduction to Seed Technology. Leonard Hill.
7. Tunwar NS & Singh SN. 1988. Indian Minimum Seed Certification Standards. CSCB, Ministry of Agriculture, New Delhi.

Lecture Schedule

Theory

Topic	No. of Classes
Raising the seed crop, Introduction, Procurement of a class of Improved seeds	1
Reporting to Monitoring or certification Agency	1
Principles and practices of selection of area and agronomic requirement of seed production of field crops	1
Importance of isolation distance and rouging	1
Principles of hybrid seed production in field crops	1
Principles and practices of selection of area and agronomic requirement of seed production of horticultural crops	1
Concept of apomixes, male sterility and self-incompatibility and its application in hybrid seed production of horticultural crops.	1
Introduction, Objectives of Seed Processing	1
Seed Drying, Principles of Drying, Water vapour equilibrium	1
Methods of drying seeds	1
Cleaning and grading, Air and screen machines, Dimensional separators, Density separators, Surface texture separators, Color separators, Spiral separators, Electric separators, Vibrator separators, Separation based on Affinity to liquids	1
Seed treatment, Temperature treatment, Chemical treatment, Bagging and Labelling	1
Seed testing-Introduction, Procedure of Seed testing, components of seed quality testing genetic, physical, physiological and seed health testing	1
Seed sampling, Types of seed sampling, Requirements of sampling	1
Concept of seed viability and vigour; dormancy, types and principles of seed dormancy	1
Physiological quality of seed, Principles of seed Germination, types of germination, biochemical and genetic basis	1
History, concept and objectives of seed certification; seed certification agency/organization and staff requirement Indian Minimum Seed Certification Standards (I.M.S.C.S.) - general and specific crop standards including GM varieties, field and seed standards	2
Introduction, Evolution of the seed industry, Development of the vegetable and Flower seed industry	1
Seed marketing – concept, definition and purpose, importance and promotion of quality seed, formal and informal seed supply systems	2

Topic	No. of Classes
Seed marketing intelligence and product mix, sales promotion, distribution channels, marketing costs and margins; packaging and labeling	1
Seed Associations, Factors influencing seed marketing, Seed marketing programs	1
Seed industry organizations, Marketing of public versus private players	1
Demand and supply of seed; role of seed replacement rate (SRR), seed multiplication ratio (SMR), economics of seed production; determining seed needs	1
Seed pricing and price policy, seed processing and /packaging, demand forecasting and factors affecting demand for seeds, effect of price and farm income on seed demand	1
History of plant tissue culture, Laboratory organization, Composition of nutrient medium, Micro-propagation, Axillary bud proliferation approach, Meristem and shoot tip culture, Bud culture, Advantages of Micropropagation, Problems associated with micropropagation	3
Synthetic seed production, Types of synthetic seeds, methods of development of synthetic seeds	1
Components of nutrient media for synthetic seed development**,** Storage of synthetic seeds, Advantages and limitations of synthetic seed production	2
Total	**32**

Practicals

Topic	No. of Classes
Planning of Seed Production, requirements for different classes of seeds in field crops - unit area and rate	1
Operation and handling of mechanical drying equipment; effect of drying temperature and duration on seed germination and storability seed processing equipment; seed treating equipment	1
Seed production in cross pollinated crops with special reference to land, isolation	1
Planting ratio of male and female lines, synchronization of parental lines and methods to achieve synchrony; supplementary pollination, pollen storage, hand emasculation and pollination in tomato	2
Hybrid seed production in Maize, DE tasseling in maize, identification of rogues and pollen shedders	1

Topic	No. of Classes
Pollen collection, storage, viability and stigma receptivity; gametocide application and visits to seed production plots etc.	1
Visit to seed processing plant and commercial controlled and uncontrolled Seed Stores, Seed industries and local entrepreneurships visit to nearby areas	1
Different methods of examination of seeds to assess seed-borne microorganisms and to quantify infection percentage, detection of seedborne fungi, bacteria and viruses, identification of storage fungi, control of seed borne diseases, seed treatment methods	1
Maintenance of aseptic conditions and sterilization techniques, Preparation of nutrient stocks for synthetic media	1
Selection of explants for callus induction, Preparation of MS medium for micro propagation and Callus induction	1
Inoculation of explants for micro-propagation, Inoculation of explants for callus induction and subsequently regeneration of plantlets from matured seeds of field and horticultural crops	2
Synthetic seed preparation	1
Students presentation	1
Group activities	1
Total	**16**

Online Courses

The students will have to take a minimum of 20 credits of online courses (any one or more courses totaling at least 16 weeks or 30 hours' duration) as a partial requirement for the B.Sc (Hons) Natural Farming. The online courses can be from any field such as Basic Sciences, Humanities, Commerce, Business Management, Languages including foreign language, Communication skills, Music, etc. and can be taken from SWAYAM, Diksha, NPTEL, mooKIT, edX, Coursera, or any other portal. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses. The courses will be non-gradial as separate certificates would be issued by the Institute/ University 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. The courses can be taken during whole span of degree parogramme asper choice of students. The courses will be non-gradial (as separate certificates would be issued by the institutes offering the course). The MOOC courses taken by the student will be separately registered/ approved at the University level. The final transcript will indicate the title of courses taken by the student and the total weeks.

List of Suggestive On-line Courses

Course Title	Duration	Credits
Digital Media	16 weeks	1
Basics of Photography	12 weeks	1
Design, Technology and Innovation	8 weeks	1
Visual Communication Design for Digital Media	4 weeks	1
Certificate course in Environmental Sustainability	8 weeks	1
Consumer Protection Legislation	8 weeks	1
Communication and Extension for Sustainable Development	15 weeks	1
Intellectual Property	12 weeks	1
Biopsychology	15 weeks	1

Course Title	Duration	Credits
NGO'S and Sustainable Development	15 weeks	1
Counseling Psychology	12 weeks	1
Gender Sensitization: Society Culture and Change	16 weeks	1
Basics of Health Promotion and Education Intervention	8 weeks	1
Psychology of Stress, Health and Well-being	12 weeks	1
Diet Management in Health & Disease	12 weeks	1
Dairy and Food process and products technology	12 weeks	1
Thermal Processing of Foods	12 weeks	1
Nano-technology, Science and Applications	8 weeks	1
Food Science & Processing	12 weeks	1
Diet Management in Health & Disease	8 weeks	1
Human Nutrition and Biochemistry	12 weeks	1
Personality Development and Communication Skills	8 weeks	1
Public Speaking	8 weeks	1
Personality Development	8 weeks	1
Emotional Intelligence	8 weeks	1
Yoga Practices1	12 weeks	1
Yoga Practices2	12 weeks	1
Ethics: Theories and Applications	12 weeks	1
Information Sources and Library Services	6 weeks	1
Qualitative Research Methods and Research Writing	12 weeks	1
Food Science & Processing	12 weeks	1
Food Safety & Quality Control	8 weeks	1
*Communication Skills and Computer Operations	24 weeks	2
*Human Resource Management	24 weeks	2
*Business Plan and Finance Management	24 weeks	2
$ Physical Education, First Aid and Yoga (to be added)	Compulsory Non-credit Course (CNC)	
$ Start-up (to be developed)		

SAUs will be free to include more Elective courses with approval from their competent bodies.

$ Compulsory Non-Credit (CNC) course for student.

* The list of Non-Credit courses will be uploaded on College/University website. The student will have choice to select courses of his/her choice up to 20 credits.