VI SEMESTER

S. No.	Course code	Course Title	Credit load
1	AEC 302	Agricultural Finance and Co-Operation	2+1
2	PAT 302	Diseases of Field and Horticultural crops and their management -II	2+1
3	COM 311	Agro Informatics	1+1
4	ENS 301	Environmental Pollution and Management	1+1
5	AEN 301	Pests of Crops and Stored grain and their Management	2+1
6	AGR 303	Practical Crop Production - II *(Rabi* crops*)*	0+2
7	AGR 304	Principles of organic Farming	1+1
8	ABT 301	Plant Bio technology	2+1
9	PBG 302	Crop Improvement	2+1
10	OPT 301	Optional course	1+1
11	NCC 101	NCC* **Total**	**13+11=24**
		***Non-gradial courses compulsory courses**	

AEC 302 Agricultural Finance and Co - operation (2+1)

Theory

Unit 1: Agricultural Finance – Nature and Scope : Agricultural Finance- meaning, scope and significance, credit needs and its role in Indian agriculture. Agricultural credit: meaning, definition, need, classification. Sources of credit - advantages and disadvantages - Rural indebtedness- History and Development of rural credit in India.

Unit 2: Financial Institutions : Sources of agricultural finance: institutional and non-institutional sources and their roles, commercial banks - social control and nationalization of commercial banks. Micro financing including KCC, Micro finance – SHG Models, Lead Bank Scheme, RRBs, Scale of finance and unit cost. Cost of credit. An introduction to higher financing institutions – RBI, NABARD, ADB, IMF, world bank, Insurance and Credit Guarantee Corporation of India. Recent development in agricultural credit: Rural credit policies of Government – Subsidized farm credit - Differential Interest Rate (DIR) Scheme – Loan relief measures

Unit 3: Farm Financial Analysis: Credit analysis: 4 R's, 7 P's and 3C's of credit. Preparation of bankable projects / Farm credit proposals – Feasibility; Appraisal - Time value of money: Compounding and Discounting - Undiscounted and Discounted measures. Preparation and analysis of financial statements

– Balance Sheet, Income Statement and Cash Flow Statement. Basic guidelines for preparation of project reports - Bank norms – SWOT analysis.

Unit 4: Co-operation: Agricultural Cooperation in India – Meaning, brief history of cooperative development in India - Pre and Post - Independence periods and Co-operation in different plan periods, objectives, principles of cooperation, significance of cooperatives in Indian agriculture. Co-operating credit structure: short term and long term. Agricultural Cooperation - credit, marketing, consumer and multi-purpose cooperatives, farmers' service cooperative societies, processing cooperatives, farming cooperatives, cooperative warehousing; role of ICA, NCUI, NCDC, NAFED. Strength and weakness of co-operative credit system, Policies for revitalizing co-operative credit.

Unit 5: Banking and Insurance: Negotiable Instruments: Meaning, Importance and Types - Central bank:
RBI – functions - Credit control – Objectives and Methods: CRR, SLR and Repo rate - Credit rationing - Dear money and cheap money - Financial Inclusion and Exclusion: credit widening and credit deepening monetary policies. Credit gap: Factors influencing credit gap. Non - Banking Financial Institutions (NBFI). NPA – Causes, consequences and mitigation. Crop Insurance: Schemes, Coverage, Advantages and Limitations in Implementation - Estimation of Crop Yields - Assessment of crop losses, Determination of compensation - Weather based crop insurance, features, determinants of compensation. Livestock Insurance Schemes Agricultural Insurance Company of India Ltd (AIC): Objectives and functions.

Practical

Determination of most profitable level of capital use. Optimum allocation of limited amount of capital among different enterprise. Analysis of progress and performance of cooperatives using published data. Analysis of progress and performance of commercial banks and RRBs using published data. Visit to a commercial bank, cooperative bank / cooperative society to acquire first - hand knowledge of their management, schemes and procedures. Visit to District Central Co-operative Bank (DCCB) to study its role, functions and procedures for availing loan – Fixation of Scale of Finance. Estimation of credit requirement of farm business – A case study. Preparation and analysis of Balance Sheet, and Cash Flow Statement – A case study. Exercise on Financial Ratio Analysis. Appraisal of farm credit proposals – A case study. Preparation and analysis of income statement – A case study. Preparation of Bankable projects / Farm Credit Proposals and appraisal - Undiscounted methods and Discounted methods. Techno-

economic parameters for preparation of projects for various agricultural products and its value added products. Seminar on selected topics. Analysis of Different Crop Insurance Products / Visit to crop insurance implementing agency.

Theory Schedule

1. Agricultural Finance - meaning, scope and significance, credit needs and its role in Indian agriculture.
2. Agricultural credit: meaning, definition, need and classification.
3. Sources of credit - advantages and disadvantages.
4. Rural indebtedness - History and Development of rural credit in India.
5. Sources of agricultural finance: institutional and non-institutional sources - their roles.
6. Commercial banks - social control and nationalization of commercial banks.
7. Micro financing including KCC, Micro finance – SHG Models, Lead bank scheme.
8. RRBs, Scale of finance and unit cost. Cost of credit.
9. An introduction to higher financing institutions–RBI, NABARD, ADB, IMF and World Bank.
10. Role of Insurance and Credit Guarantee Corporation of India.
11. Recent developments in agricultural credit.
12. Rural credit policies of Government: Subsidized farm credit- Differential Interest Rate (DIR) Scheme – Loan relief measures
13. Credit analysis: 4 R's, 7 P's and 3C's of credit.
14. Preparation of bankable projects / Farm credit proposals – Feasibility.
15. Appraisal: Time value of money: Compounding and Discounting - Undiscounted and Discounted measures.
16. Preparation and analysis of financial statements – Balance Sheet, Income Statement and Cash Flow Statement.
17. **Mid Semester Examination**

1. Basic guidelines for preparation of project reports- Bank norms – SWOT analysis.
2. Agricultural Cooperation in India – Meaning, brief history of cooperative development in India.
3. Pre and Post - Independence periods and Co-operation in different plan periods, objectives, principles of cooperation, significance of cooperatives in Indian agriculture.
4. Co-operating credit structure: short term and long term. Agricultural Cooperation - credit, marketing, consumer and multi-purpose cooperatives, farmers' service cooperative societies, processing cooperatives, farming cooperatives, cooperative warehousing;
5. Role of ICA, NCUI, NCDC and NAFED.
6. Strength and weakness of co-operative credit system, Policies for revitalizing co-operative credit.
7. Negotiable Instruments: Meaning, Importance and Types.
8. Central bank: RBI – functions, Credit control – Objectives and Methods: CRR, SLR and Repo rate.
9. Credit rationing - Dear money and cheap money.
10. Financial Inclusion and Exclusion: credit widening and credit deepening monetary policies.
11. Credit gap: Factors influencing credit gap.
12. Non - Banking Financial Institutions (NBFI). NPA – Causes, consequences and mitigation.
13. Crop Insurance: Schemes, Coverage, Advantages and Limitations in Implementation.
14. Estimation of Crop Yields - Assessment of crop losses, Determination of compensation.
15. Weather based crop insurance, features, determinants of compensation.
16. Livestock Insurance Schemes
17. Agricultural Insurance Company of India Ltd (AIC): Objectives and functions.

Practical Schedule

1. Determination of most profitable level of capital use.
2. Optimum allocation of limited amount of capital among different enterprise.
3. Analysis of progress and performance of cooperatives using published data.

4. Analysis of progress and performance of commercial banks and RRBs using published data.
5. Visit to a commercial bank, cooperative bank / cooperative society to acquire first - hand knowledge of their management, schemes and procedures.
6. Visit to District Central Co-operative Bank (DCCB) to study its role, functions and procedures for availing loan – Fixation of Scale of Finance.
7. Guest lecture on Role and functions of Commercial Bank and Lead Bank / NABARD and its Role and Functions.
8. Estimation of credit requirement of farm business – A case study.
9. Preparation and analysis of Balance Sheet and Cash Flow Statement – A case study.
10. Exercise on Financial Ratio Analysis. Appraisal of farm credit proposals – A case study.
11. Preparation and analysis of income statement – A case study.
12. Preparation of Bankable projects / Farm Credit Proposals and appraisal.
13. Undiscounted methods and Discounted methods.
14. Techno-economic parameters for preparation of projects for various agricultural products and its value added products.
15. Analysis of Different Crop Insurance Products / Visit to crop insurance implementing agency.
16. Seminar on selected topics.
17. **Practical Examination.**

References

1. Muniraj, R. 1987. Farm Finance for Development. Oxford & IBH. New Delhi.
2. Subba Reddy, S and P. Raghu Ram. 2011. Agricultural Finance and Management. Oxford & IBH. New Delhi.
3. Lee, W.F., M.D. Boehlje, A.G. Nelson and W.G. Murray. 1998. Agricultural Finance. Kalyani Publishers. New Delhi.
4. Mammoria, C.B. and R.D. Saxena. 1973. Cooperation in India. Kitab Mahal. Allahabad. Patnaik, V.E. and A.K. Roy. 1988. Cooperation and Cooperative Management. Kalyani Publishers. Ludhiana.

PAT 302 Diseases of Field and Horticultural crops and their management-II (2+1)

Theory

Etiology, symptoms, mode of spread, survival, epidemiology and integrated management of important diseases

Unit-I Diseases of cereals: Wheat

Unit- II Diseases of Pulses, Oilseeds and Cash crops

Pulses: chick pea and lentil; **Oilseeds:** sunflower and mustard; **Cash crops:** sugarcane and cotton

Unit- III Diseases of Fruits and vegetables crops

Fruits: mango, citrus, grapevine, sapota, jackfruit, pineapple, ber, apple, peach plum and strawberry;
Vegetables: cucurbits, peas, potato, beet root, radish, cassava, colacasia and yam

Unit- IV Diseases of Spices, Plantation and Flower crops

Spices: chillies, turmeric, ginger, onion, garlic, coriander, cardamom; **Plantation crops:** black pepper and vanilla; **Flower crops:** rose, Jasmine, marigold,crossandra, chrysanthemum, tube rose , carnation, lillium and orchids

Unit- V Diseases of medicinal crops and mushroom cultivation

Medicinal crops: gloriosa, coleus, stevia and aloe; **Mushroom cultivation:** Importance of mushroom and cultivation of button mushroom, oyster mushroom, milky mushroom and paddy straw mushroom-pest and diseases of mushroom

PRACTICAL

Study of symptoms and host parasite relationship of the important diseases of wheat, chick pea, lentil, sunflower , mustard , cotton, sugarcane, mango , citrus, grapevine, sapota , jackfruit , pineapple, ber, apple , peach, plum , strawberry, cucurbits , potato , peas , beet root , radish , cassava, colacasia, yam , chillies, turmeric, ginger, onion, garlic, coriander, cardamom, black pepper, vanilla, rose, Jasmine, marigold, crossandra, chrysanthemum, tube rose , carnation, lillium , orchids, gloriosa, coleus, stevia and aloe and cultivation of button mushroom, oyster mushroom, milky mushroom and paddy straw mushroom.

THEORY

Etiology, symptoms, mode of spread, survival, epidemiology and integrated management of

1. Diseases of wheat
2. Diseases of chickpea and lentil
3. Diseases of sunflower and mustard
4. Diseases of cotton
5. Diseases of sugarcane
6. Diseases of mango
7. Diseases of citrus
8. Diseases of grapevine
9. Diseases of sapota, jack fruit , pineapple and ber
10. Diseases of apple
9. Diseases of peach, plum and strawberry
10. Diseases of cucurbits
11. Diseases of Potato-I (Fungal diseases)
12. Diseases of Potato-II (bacterial and viral diseases)
13. Diseases of peas, beet root and radish
14. **Mid semester examination**

15. Diseases of cassava, colacasia and yam
16. Diseases of chillies
17. Diseases of turmeric and ginger
18. Diseases of onion and garlic
19. Diseases of cardamom and coriander
20. Diseases of black pepper, betel vine and vanilla
21. Diseases of rose and jasmine
22. Diseases of marigold, crossandra and chrysanthemum
23. Diseases of tube rose and carnation
24. Diseases of lillium and orchids
25. Diseases of gloriosa and coleus
26. Diseases of stevia and aloe
27. Diseases of stored grains and their management
28. Post harvest diseases of fruit and vegetables
29. Mushroom-edible and poisonous mushroom- importance of mushroom
30. Cultivation of button mushroom and oyster mushroom
31. Cultivation of milky mushroom and paddy straw mushroom
32. Pest and diseases of mushroom

PRACTICAL

Study of symptoms and host-parasite relationship of:

33. Diseases of wheat
34. Diseases of chick pea, lentil, sunflower and mustard
35. Diseases of cotton and sugarcane
36. Diseases of mango and sapota
37. Diseases of citrus and grapevine
38. Diseases of jackfruit , pineapple, ber, apple , peach, plum , strawberry
39. Diseases of cucurbits
40. Diseases of potato , peas , beet root and radish
41. Diseases of cassava, colacasia and yam
42. Field visit/ exposure visit to hilly fruits , vegetables and plantation crops / mushroom unit
43. Diseases of chillies, turmeric and ginger
44. Diseases of coriander, cardamom, black pepper and vanilla,
45. Diseases of rose, Jasmine, marigold and crossandra
46. Diseases of tube rose , carnation, lillium and orchids,
47. Diseases of gloriosa, coleus, stevia and aloe
48. Cultivation of oyster , milky and paddy straw mushroom cultivation
49. **Final practical examination**

Reference:

27. Arjunan.G. Karthikeyan, G, Dinakaran ,D. Raguchander,T. 1999 Diseases of Horticultural Crops, AE Publications, Coimbatore.

28. Rangasawmi ,G and Mahadevan, A. 1998. Diseases of crop Plants in India, Prentice Hall of India Pvt. Ltd., New Delhi

29. Prakasam, V., Valluvaparidasan, V., Raguchander, T. and K.Prabakar. 1997. Field crop diseases, AE Publication, Coimbatore.

30. Agrios, G.N. 2008. Plant Pathology, Academic Press, New York
31. Rangaswami, G. 2005. Diseases of Crop plants in India. Prentice Hall of India Pvt. Ltd., New Delhi
32. Thakur, B.R. 2006. Diseases of field crops and their management

COM 311 Agro- Informatics (1+1)

Theory

Unit I: Information and Communication Technology (ICT)

ICT and its importance – Computer Fundamentals - Basic anatomy of the computer system: Input devices, CPU, Output devices, Memory: Primary and secondary - Software – Types: System software, Application software and Utility software – Software terminologies: Firmware, Liveware, Freeware, Shareware, Commercial software, Proprietary software, Semi-free software - Internet - World Wide Web – URL – Domain names - Protocols: HTTP, HTTPS - Internet Applications: Email, File sharing web apps,
Social Networks, Online shopping, Video Conferencing – HTML: Introduction, Editor, HTML Documents –
Tags: <head>, <body>, <title>, <heading>, <paragraph>, </br>, <table>, <li>, <ul>, <href>, <img>, <hr> and <marquee>.

Unit II: Spreadsheet and Database

Electronic spreadsheet – Microsoft Excel - Worksheet manipulation: insert, delete, move, copy and hide worksheet – Cell manipulation: copy, edit and format cell data – Charts - Create Bar and Pie charts - PIVOT table - DBMS: Database terms: Data, Database, DBMS, RDBMS, Row, Column, Table – Database
Architecture – Data types: char, varchar(), int, float() – Use of databases in agriculture.

Unit III: C Programming

Introduction to Computer Programming – Programming languages - Translators: Compilers and Interpreters - Algorithm – Flowchart - Introduction to C – Structure of C program - Data types, Variables, Constants, Operators: Arithmetic, Relational, Logical, Assignment - Input/Output: scanf(), printf() - Control statements: if, if else – Loop: while, do while, for.

Unit IV: Agroinformatics

Agroinformatics – Needs and objectives - e-Agriculture : Concept, Meaning, Terminologies and Importance - e-Agriculture – National and International scenario - ICT for Data collection, formation of development programmes, monitoring and evaluation of programmes - Decision support systems: Taxonomy, Components, Framework, Classification and applications in Agriculture -Expert systems - Concepts and Importance – Components – User Interface – Knowledge Base – Inference Mechanism – Inference Rule - Designing an Expert Systems - Advantages and disadvantages of Expert Systems - Information systems for supporting farm decisions.

Unit V: Models and Computer Controlled Devices

Introduction to computer based agricultural models: Model, Simulation, Systems analysis models, Subsystems, Types: Mechanistic process models, Operational models, Statistical models and dynamic simulation models - List of agricultural models - Computer controlled devices – Sensor – Drones – Robots
– Internet of Things (IoT) and Cloud Computing for Agriculture.

Practical

Innards of computer – Booting and shutdown – Practice of DOS commands: dir, cd, mkdir, rmdir, del, cls, attrib, ren, copy, move, ipconfig, ping - Software practices – Installation / Uninstallation – Windows apps: Sticky Notes, Steps Recorder, Snipping Tool – Pin and unpin the programs – System tray customization – Shortcut keys - Microsoft Excel - Entering a formula in a cell, Built-in functions: SUM, AVERAGE, MIN, MAX, COUNT, COUNTIF, IF – Import and export data - Charts - Create Bar and Pie charts
– PIVOT table - MS-ACCESS: Creating agriculture database – Entering, editing, deleting data – Creating Forms – Query wizard: select, update, delete – Reports - Internet Applications: Email, File sharing web

apps: Dropbox, Google drive - Social Networks, Online shopping, Video Conferencing – Creating a web page: HTML editor – Tags: <head>, <body>, <title>, <heading>, <paragraph>, </br>, <table>, <li>, <ul>, <href>, <img>, <hr> and <marquee> - Develop algorithms and represent the same in the flowchart for the following problems -To calculate Leaf Area Index (LAI) -To calculate the Crop Growth Rate (CGR) - To find the greatest average seed sales of two districts during samba season - Familiarizing with the Integrated Development Environment of C Editor for coding, saving, compiling, debugging and executing

– C Programs: Display TNAU motto "Till, Toil, Triumph" – Calculate Leaf Area Index (LAI) – Calculate the Crop Growth Rate (CGR) - Find the greatest average seed sales of two districts during samba season - e-Agriculture – Leveraging social media in agriculture (Social networks) - ICT in agriculture – Paperless data collection using google survey tools - Online photo and video editing tools - Simulating crop yield: InfoCrop - Base file creation for rice and maize (Weather, Varietal characters, Agronomy practices, Soil data) – Interpretation - InfoCrop – Climate change impact studies on rice and maize - Smartphone mobile apps in Agriculture for farm advices, crop protection, market price, postharvest management - Decision support systems - Expert systems - Information systems for supporting farm decisions - Crop calendar – Crop planning tool for farmers.

Lecture Schedule

1. Introduction to Computers - Basic anatomy of the computer system: Input devices, CPU, Output devices, Memory: Primary and secondary.
2. Software – Types: System software, Application software and Utility software – Software terminologies: Firmware, Liveware, Freeware, Shareware, Commercial software, Proprietary software, Semi-free software.
3. Internet - World Wide Web – URL – Domain names - Protocols: HTTP, HTTPS - Internet Applications: Email, File sharing web apps, Social Networks, Online shopping, Video Conferencing – HTML: Introduction, Editor, HTML Documents – Tags: <head>, <body>, <title>, <heading>, <paragraph>, </br>, <table>, <li>, <ul>, <href>, <img>, <hr> and <marquee>.
6. Electronic spreadsheet – Microsoft Excel - Worksheet manipulation: insert, delete, move, copy and hide worksheet – Cell manipulation: copy, edit and format cell data – Charts - Create Bar and Pie charts - PIVOT table.
7. DBMS: Database terms: Data, Database, DBMS, RDBMS, Row, Column, Table – Database Architecture – Data types: char, varchar(), int, float() – Use of databases in agriculture.
8. Introduction to Computer Programming – Programming languages - Translators: Compilers and Interpreters - Algorithm – Flowchart.
9. Introduction to C – Structure of C program - Data types, Variables, Constants, Operators: Arithmetic, Relational, Logical, Assignment - Input/Output: scanf(), printf().
10. Control statements: if, if else – Loop: while, do while, for.
11. **Mid-Semester Examination**

1. Agroinformatics – Needs and objectives - e-Agriculture : Concept, Meaning, Terminologies and Importance
2. e-Agriculture – National and International scenario
3. ICT for Data collection, formation of development programmes, monitoring and evaluation of programmes.
4. Decision support systems: Taxonomy, Components, Framework, Classification and applications in Agriculture.
5. Expert systems - Concepts and Importance – Components – User Interface – Knowledge Base – Inference Mechanism – Inference Rule - Designing an Expert Systems - Advantages and disadvantages of Expert Systems - Information systems for supporting farm decisions.
6. Introduction to computer based agricultural models: Model, Simulation, Systems analysis models, Subsystems, Types: Mechanistic process models, Operational models, Statistical models and dynamic simulation models - List of agricultural models.
7. Computer controlled devices – Sensor – Drones – Robots.

8. Internet of Things (IoT) and Cloud Computing for Agriculture.

Practical Schedule

1. Innards of computer – Boot and shutdown – Windows apps: Sticky Notes, Steps Recorder, Snipping Tool – Pin and unpin the programs – System tray customization – Shortcut keys.
2. Software practices – Installation / Uninstallation – Practice of DOS commands: dir, cd, mkdir, rmdir, del, cls, attrib, ren, copy, move, ipconfig, ping.
3. Microsoft Excel - Entering a formula in a cell, Built-in functions: SUM, AVERAGE, MIN, MAX, COUNT, COUNTIF, IF – Import and export data - Charts - Create Bar and Pie charts – PIVOT table.
4. MS-ACCESS: Creating agriculture database – Entering, editing, deleting data – Creating Forms – Query wizard: select, update, delete – Reports.
5. Internet Applications: Email, File sharing web apps: Dropbox, Google drive - Social Networks, Online

   shopping, Video Conferencing – Creating a web page: HTML editor – Tags: <head>, <body>, <title>, <heading>, <paragraph>, </br>, <table>, <li>, <ul>, <href>, <img>, <hr> and <marquee>.
6. Develop algorithms and represent the same in the flowchart for the following problems -To calculate Leaf Area Index (LAI) -To calculate the Crop Growth Rate (CGR) - To find the greatest average seed sales of two districts during samba season.
7. Familiarizing with the Integrated Development Environment of C Editor for coding, saving, compiling, debugging and executing – C Programs: Display TNAU motto "Till, Toil, Triumph" – Calculate Leaf Area Index (LAI) – Calculate the Crop Growth Rate (CGR) - Find the greatest average seed sales of two districts during samba season.
8. Looping statements: Calculate the average yield of last 10 years Rice yield of our District - Write a C program to find total, maximum, minimum and average rain fall of last five years in our District.
9. e-Agriculture – Leveraging social media in agriculture (Social networks).
10. ICT in agriculture – Paperless data collection using google survey tools - Online photo and video editing tools.
11. Simulating crop yield: InfoCrop - Base file creation for rice and maize (Weather, Varietal characters, Agronomy practices, Soil data) – Interpretation.
12. InfoCrop – Climate change impact studies on rice and maize.
13. Smartphone mobile apps in Agriculture for farm advices, crop protection, market price, postharvest management.

1. Decision support systems
2. Expert systems - Information systems for supporting farm decisions.
3. Crop calendar – Crop planning tool for farmers.
4. **Final Practical Examination**

Reference:

23. Introduction to Information Technology, 2012, Second Edition, ITL Education Solutions Limited, PEARSON Education.
24. Firuza Aibara, HTML 5 for Beginners, 2012, Shroff Publications.
25. John Walkenbach, Excel 2010 Bible, Wiley publishing, Inc
26. Balagurusamy, E., Programming in ANSI C, 2017, Seventh Edition, McGraw Hill Education.
27. Saravanan, R., Kathiresan, C and Indra Devi, T., 2011. Information & communication technology for agriculture and rural development. New India Publ. Agency.
28. Aggarwal, P.K., Naveen Kalra and Subhash Chander, Infocrop: A generic simulation model for annual crops in tropical environments, Indian Agricultural Research Institute, New Delhi.
29. Malcolm J. Blackie, Information Systems for Agriculture, 2012, Springer Netherlands.
30. Smart Sensing Technology for Agriculture and Environmental Monitoring, 2012, Editors: Mukhopadhyay and Subhas Chandra (Ed.), Springer
31. John Billingsley, Arto Visala and Mark Dunn, 2008, Robotics in Agriculture and Forestry – 46th Chapter from book Springer Handbook of Robotics.

28. Introduction to Expert Systems, 3rd Edition by Peter Jackson
29. Introduction to Artificial Intelligence and Expert Systems, 2007 by Dan W. Patterson.
30. Balagurusamy, E., Computing Fundamentals & C Programming, Second Edition, 2017, McGraw Hill Education.
31. A.S. Sandhu, 2004. Text book on Agricultural Communication Process and Methods. Oxford & TBH.
32. C.J. Date: Data Base Design, Addison Wesley.

E-Reference

1. https://www.scribd.com/document/249057939/InfoCrop-Help
2. InfoCrop: A dynamic simulation model for the assessment of crop yields, losses due to pests, and environmental impact of agro-ecosystems in tropical environments. P.K. Aggarwal et al., Agricultural Systems 89 (2006) 47–67.
3. http://www.sciencedirect.com/science/article/pii/S0168169916303623
4. Web-based crop model: Web InfoCrop – Wheat to simulate the growth and yield of wheat
5. http://excelpro.ir/wp-content/uploads/2015/10/Excel-2010-Bible.pdf
6. https://www.researchgate.net/publication/226105300_Decision_Support_Systems_Concepts_Progress_and_Issues_-_A_Review
7. *https://www.hindawi.com/journals/js/2015/195308/ Applications of Smartphone-Based Sensors in Agriculture: A Systematic Review of Research*
8. http://ncert.nic.in/ncerts/l/kect214.pdf
9. http://teacherlink.ed.usu.edu/tlresources/training2/Google/GoogleForms.pdf
12. http://www.fao.org/publications/card/en/c/24f624ea-7891-45e8-9b24-66cbf13f004d/
13. http://indiagovernance.gov.in/files/ict_in_agriculture.pdf
14. www.manage.gov.in/studymaterial/AKM-E.pdf
15. https://www.researchgate.net/publication/233910963_Application_of_Cloud_Computing_in_Agricultural_Sectors_for_Economic_Development

ENS 301 – Environmental Pollution and Management (1+1)

Theory

Unit-I-Pollution in Environment-Introduction-Pollution- Pollutants – Contaminants – Source and types of pollution in Soil-Water-Air-Impact on environment-Pollution Status in India

Unit– II Waste water Management: Waste water – Different types of waste water-pollutants and contaminants-Impact of waste water on ecosystem –Eutrophication – Biomagnification – Water borne diseases –Wastewater treatment methods – Physical, chemical and Biological – General water treatments-Wastewater recycling – Constructed wetlands-Reed bed system -Legislation and standards

Unit-III-Management of polluted soils: Soil pollutants – Sources – Urban and Industrial – Heavy metal – Pesticides – PAH's and PCB's-E-Waste-Fate of pollutants in Soil - Management of soil pollution – Bio and phyto remediation of polluted soil

Unit-IV - Air Pollution and its Management: Air pollutants from industrial and domestic sources **–** Fate of air pollutants-Air pollution indicators - Monitoring and Control measures – Role of plants in controlling air pollutants-Legislation and Air quality standards - – Noise Pollution – Sources, Effect and Control Measures-Indoor air pollution and control measures

Unit-V- Solid waste management: Solid waste –Sources – Sludge from Industry and farm waste-Characteristics – Environmental problems – Management of sludge and farm wastes – Disposal methods – Sanitary land fills – Incineration – Pyrolysis - Recycling –Energy recovery –Composting – Vermicomposting – Maturity indices assessment-Standards and Legislation

Unit-VI-Environmental standards, Regulation and EIA - Environmental standards-CPCB Norms for discharging industrial effluents to public sewers- CDM and Carbon foot print-Environmental Impact Assessment: Stages of EIA -Monitoring and Auditing – Environmental clearance procedure in India

Lecture Schedule:

1. Introduction-Pollution- Pollutants – Contaminants – Source and types of pollution in Soil-Water-Air-Impact on environment-Pollution Status in India
2. Waste water – Different types of waste water-pollutants and contaminants-Impact of waste water on ecosystem –Eutrophication – Biomagnification – Water borne diseases –
3. Wastewater treatment methods – Physical, chemical and Biological – General water treatments-
4. Wastewater recycling – Constructed wetlands-Reed bed system -Legislation and standards
5. Soil pollutants – Sources – Urban and Industrial – Heavy metal – Pesticides – PAH's and PCB's-E-Waste
6. Fate of pollutants in Soil - Management of soil pollution – Bio and phyto remediation of polluted soil
7. Air pollutants from industrial and domestic sources **–** Fate of air pollutants-Air pollution indicators – Air pollution episodes-Monitoring and Control measures–
8. Role of plants in controlling air pollutants- Legislation and Air quality standards,
9. **Mid Semester Examination**
10. Noise Pollution, Sources, Effect and Control Measures, Indoor air pollutants and control mesures
11. **S**olid waste –Sources – Sludge from Industry and farm waste-Characteristics – Environmental problems
12. Management of solid waste, Disposal methods, Sanitary land fills, Incineration, Pyrolysis
13. Recycling –Energy recovery –Composting – Vermicomposting – Maturity indices assessment-Standards and Legislation
14. Environmental standards-CPCB Norms for discharging industrial effluents to public sewers
15. Environment Impact Assessment,Introduction, Stages of EIA, -Monitoring and Auditing
16. CDM and Carbon foot print

17. Environmental clearance procedure in India

Practical Schedule

1. Sample collection and preservation from contaminated sistes
2. Waste water treatment by physical (column study with vermiculite and activated charcoal) and chemical (Alum treatment)
3. Waste water treatment through constructed wetland system and charecterisation
4. Estimation of Chlorides, Phosphates in waste water
5. Analysis of Nitrogen in industrial effluent and sludge
6. Collection of PAH's contaminated soils and analysis by GC-MS
7. Biosorption of heavymetal (Cr) by using Water hyacinth and analysis through AAS
8. Pesticide Residue analysis in contaminated water
9. Analysis of SPM in air, Methane and CO_2 in Municipal dumping site
10. Assessing the efficiency of plants to control Indoor air pollutants
11. Analysis of Organic carbon in Sludge and Organic manure
12. Composting and Vermicomposting of farm wastes
13. Energy recovery from wastes
14. Maturity indices of compost- C:N ratio and Phytotoxicity test
15. Maturity indices of compost: starch iodine test and sulphide test
16. Visit to water treatment plant
17. **Final practical examination**

Reference:

1. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (*Concepts, Connections, and Solutions).* Brooks/cole, Cengage learning publication, Belmont, USA
2. P.D. Sharma, 2009, Ecology and Environment, Rastogi Publications, Meerat, India **E-Books:** Chiras D.D., 2016. Environmental Science, Tenth Edition. Jones & Bartlett Learning, Burlington, MA. ISBN: 978-1-284-05705-8, 708 Pages

AEN 301 Pests of Crops and Stored Produces and their Management (2+1)

Theory

Unit I: Distribution, bionomics, symptoms of damage and management strategies for insects and non-insect pests of rice, wheat, maize, sorghum, cumbu, ragi, tenai,redgram, green gram, black gram, bengal gram, cowpea, groundnut, castor, gingelly, sunflower, safflower, jatropa, soybean and mustard.

Unit II. Distribution, bionomics, symptoms of damage and management strategies of insects and non-insect pests of cotton and sugarcane, green manures (Sunnhemp, Sesbania, Daicha. Glyricidia), forage crops (Lucere and Subabul)

Unit III: Distribution, bionomics, symptoms of damage and management strategies of insect and non insect pests of Brinjal, Bhendi, Tomato, Chillies, Onion, Garlic, Moringa, Amaranthus, Crucifers, Cucurbits, Mango, Citrus, Banana, Guava, Grapevine and Sapota

Unit IV: Distribution, bionomics, symptoms of damage and management strategies of insect and non insect pests of Pomegranate, Papaya, Aonla, Apple, Pine apple, Custard apple and Jack, Potato, Sweet potato, Tapioca, Yam, Colocasia, Coconut, Arecanut, Tea, Coffee, Cashew, Cocoa, Betelvine, Ginger, Turmeric, Coriander, Cardamom, Pepper, Curry leaf and Tamarind

Unit V: Distribution, bionomics, symptoms of damage and management strategies of insect and non insect pests of Rose, Jasmine, Crossandra, Chrysanthemum, Tuberose, Cut flowers, Glory lily, Coleus, Stonebreaker, Aswagantha, Senna, Periwinkle and Lawn. Distribution, bionomics, symptoms of damage and management strategies of pests of and stored products. Rodents and birds of agricultural importance and their management. Locusts and their management.

Practical

Identification of symptoms of damage and life stages of important pests of different field crops *vi.*, cereals, millets, pulses, oilseeds, cotton, sugarcane and green manure crops and horticultural crops *viz.*, vegetables, fruits, spices, tubers, plantation crops, flower crops, medicinal plants, lawn and stored products.

Lecture schedule:

Distribution, bionomics, symptoms of damage and management strategies for insects and non-insect pests of

12. Rice – Sucking pests
13. Rice – Borers and defoliators
14. Maize, sorghum and cumbu
15. Wheat, ragi and tenai
16. Redgram, bengalgram, blackgram, greengram and cowpea
17. Groundnut, gingelly and sunflower
18. Castor, soybean, safflower, jatropha and mustard
19. Cotton – Sucking pests
20. Cotton – Bollworms, borers and defoliators

1. Sugarcane
2. Green manures and forage crops - sunnhemp, sesbania, daincha, lucerne, subabul and gliricidia
3. Brinjal, bhendi and tomato
4. Chillies, onion, garlic, moringa and amaranthus
5. Crucifers
6. Cucurbits
7. Mango
8. **Mid semester examination**
   Citrus and banana

Guava, grapevine and sapota
Pomegranate, papaya and aonla Apple,
pine apple, custard apple and jack

Potato, sweet potato, tapioca, yam and colocasia
Coconut and arecanut
Tea and coffee

Cashew, cocoa and betelvine Ginger,
turmeric and coriander, Cardamom, pepper,
curry leaf and tamarind

Rose, jasmine, crossandra, chrysanthemum, tuberose and cut flowers Gloriy
lily, coleus, stone breaker, aswagantha, senna, periwinkle and lawn

Role of physical, biological, mechanical and chemcial factors in deterioration of
grain Stored product pests

Methods of grain storage and various methods of stored product pest management
Mites, slugs and snails, rodents and bird pests
Locusts and their management

Practical schedule: Identification of symptoms of damage and life stages of pests of

6. Pests of rice
7. Pests of maize, sorghum , cumbu, ragi and tenai
8. Pests of pulses
9. Pests of groundnut, gingelly sunflower and castor
10. Pests of cotton
11. Pests of sugarcane
12. Pests of green manures and forage crops -sunnhemp, sesbania, daincha, lucerne, subabul and gliricidia
13. Pests of brinjal, bhendi and tomato
14. Pests of chillies,onion, garlic, moringa and amaranthus
15. Pests of crucifers and cucurbits
16. Pests of mango, citrus, sapota, banana, grapevine and guava
17. Pests of pomegranate, aonla, papaya, jack, pine apple, custard apple, ber and apple
18. Pests of potato, sweet potato and tapioca
19. Pests of coconut , cashew, cocoa , betelvine , coffee and tea
20. Pests of turmeric, ginger, coriander, cardamom, pepper and curry leaf
21. Pests of rose, jasmine, crossandra, chrysanthemum and tuberose
22. Pests of stored products

References:

1. Manisegaran, S. and R.P.Soundararajan. 2010. *Pest Management in Field Crops- Principles and Practices.* Agrobios, Jodhpur, India. 316p. {ISBN (10): 81-7754-321-0}
2. David, B.V. and V.V. Ramamurthy. 2011. *Elements of Economic Entomology*, Namrutha Publications, Chennai. 386 p. {ISBN: 978-81-921477-0-3}
3. Muthukrishnan,N., N.Ganapathy, R.Nalini and R.Rajendran.2005. *Pest Management in Horticultural Crops.* New Madura Publishers, Madurai. 325p. {ISBN: 81-902832-0-0}
4. Awasthi, V.B. 2007. *Agricultural Insect Pests and their Control,* Scientific publishers (India), Jodhpur, 267p. {ISBN 81-7233-491-5}
5. Dhaliwal, G.S. and Ramesh Arora. 2004. *Integrated pest management Concepts and Approaches,* Kalyani Publishers, Ludhiana, 427p. {ISBN: 81-7663-904-4}
6. Regupathy, A. and R.Ayyasamy. 2013. *A Guide on Crop Pests*. Namrutha Publications, Chennai, 368 p. {ISBN: 978-81-921477-1-0}
7. Srivastava, K.P. and G.S. Dhaliwal. 2011. *A text book of Applied Entomology*. Vol. II, Kalyani Publishers, Ludhiana. 368p. {ISBN: 978-81-272-6752-0}

8. Nair,M.R.G.K.1986. *Insects and mites of crops in India.* Publications and Information Division, ICAR, NewDelhi. 408p.
9. ParvathaReddy.2010. *Insect, Mite and Vertebrate Pests and their Management in Horticultural Crops.* Scientific Publishers, Jodhpur. 384p. {ISBN: 978-81-7233-628-8}
10. Butani, D.K. and M.G.Jotwani.2013. *Insects in Vegetables.* Daya Publishing House, NewDelhi. 356p.
11. Regupathy,A. and R.Ayyasamy.2013. *A Guide on Crop Pests.* Namrutha Publications, Chennai.368p. {ISBN: 978-81-921477-1-0}
12. Nair, M.R.G.K. 1995. *Insects and Mites of Crops in India.* Indian council of Agricultural Research, New Delhi, 408p.
13. Ayyar, T.V.R. 1963. *Hand Book of Economics Entomology for South India.* Govt. Press Madras.
10. Sivasubramanian, P., K.Samiayyan, N.Ganapathy, K. Bhuvaneswari and S.Jayaprabhavathi.2012. *A treatise on Integrated Pest Management.* Associated Publishing Company, New Delhi. 287 p.
14. Srivastava, K.P. and D.K.Butani. 2009. *Pest Management in Vegetables* (Vol. I & II). Studium Press (India) Pvt. Ltd., New Delhi . 777p. {ISBN: 978-81-907577-3-7}
15. Sathe,T.V. 2012. *Pests of Ornamental Plants.* Daya Publishing House, New Delhi.199p. {ISBN: 978-81-7035-757-5}

E- References:

7. http://www.ncipm.org.in
8. http://agritech.tnau.ac.in/
9. http://www.nbaii.res.in/
10. http://www.nrcg.res.in/
11. ipm.illinois.edu

AGR 303 Practical crop Production – II (Rabi crop) (0+2)

16. Each student will be allotted a minimum land area of 100/200 m^2 and he / she will do all field operations in the allotted land from field preparation to harvest and processing.

17. Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce.

18. Any irrigated dry crop (maize / sorghum / pearl millet / finger millet / cotton / groundnut / sunflower / sesame)

Practical Schedule for Irrigated dry crop (Eg. Maize):

19. Ecosystem - Climate and weather - Seasons and varieties of Tamil Nadu

20. Selection of field - Main field preparation - seed treatment - Application of manures and fertilizers - Sowing - Weed management and practicing pre- emergence application of herbicides - Thinning and gap filling - Estimation of plant population - Top dressing - Weed management - Water management - Pest management - Observation on nutrient and weeds - Recording growth, yield attributes and yield

21. Harvesting, threshing and cleaning the produce - Cost of cultivation and economics

1 & 2 .Study of ecosystems, climate, weather, seasons and varieties of Tamil Nadu
3 & 4. Selection of field for maize cultivation
5 & 6. Acquiring skill in seed treatment practices
7 & 8. Study and Practice of main field preparation for maize
9 & 10. Practicing of application of manures and fertilizers for maize
11 & 12. Practicing sowing of maize
13 &14. Acquiring skill in pre-emergence application of herbicides
15 &16. Estimation of plant population and acquiring skill in gap filling and thinning
17 & 18. Observation on nutritional deficiency symptoms and corrective measures
19 & 20. Study of weeds and weed management in maize
20 & 21. Recording growth parameters and assessing dry matter production
22 & 23 Study of water management practices for maize
24 & 25. Observation of insect pests and diseases and their management
26 & 27. Estimation of yield and yield parameters in maize
28 & 29. Harvesting, threshing and cleaning of the produce
30 & 31. Harvesting, threshing and cleaning of the produce
32 & 33. Working out cost of cultivation and economics

25. **Practical**

References:

Ahlawat, I.P.S., Om Prakash and G.S.Saini.2010. Scientific Crop Production in India. Rama Publishing House, Meerut.

Crop Production Guide. 2012. Directorate of Agriculture, Chennai and Tamil Nadu Agricultural University, Coimbatore.

Rajendra Prasad. 2012. Text Book on Field Crop Production, Indian Council of Agrl. Research, New Delhi. Reddy,S.R. 2012. Agronomy of field crops. Kalyani publishers, New Delhi.

Chidda Singh.1997. Modern techniques of raising field crops. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. Crop Production Guide. 2012. Directorate of Agriculture, Chennai and Tamil Nadu Agricultural University, Coimbatore.

E-References:

www.cimmyt.org

AGR 304 Principles of Organic Farming (1+1)

Theory:

Unit - I: Components and Principles of Organic Cotton

Organic farming: Definition - Scope - principles and concepts - history of organic farming - global scenario - biodiversity: importance and measure to preserve biodiversity - pre requisites for Organic farming:- Soil organic carbon: status and improvement strategies.

Unit - II: Organic sources of Nutrients

Organic sources of nutrients - manures and other inputs - on farm and off farm sources - organic waste recycling - methods - Soil and crop management - inter cropping, crop rotation, green manures, cover crops, mulching - bio fertilizers.

Unit - III: Non - Chemical weed and Pest disease management

Non-chemical weed management methods: preventive, physical, cultural, mechanical and biological measures - Bio-intensive pest and disease management.

Unit - IV: Indigenous Technical Knowledge (ITK)

Indigenous Technical Knowledge (ITK) in organic agriculture - scientific rationale - soil, nutrient, weed, water, management - prospects and problems in organic farming.

Unit - V: Certification of label

Organic certification - NPOP guidelines - Certification agencies in India - crop production standards - Quality considerations - labeling and accreditation process - marketing and export opportunities.

Lecture Schedule:

1. Organic farming; definition - prospects - principles and concepts - History and genesis of organic farming in World and India: Present status in World, India and Tamil Nadu.
2. Introduction to bio - diversity; importance and measures to preserve bio - diversity.
3. Pre-requisites and basic steps for organic farming; conversation to organic farming - planning and processes in practices - IFS approach - Integration of animal components.
4. Organic carbon; status and improvement strategies - conservative tillage systems.
5. Sources of organic manures - plant, animal and microbial origin - on - farm resources; FYM, green manures, crop residues, poultry manure, sheep and goat manures, biogas slurry and vermicompost.
1. Off-farm resources; coir pith, press mud, oilcakes, flyash, bio compost, minerals, bone meal, bio fertilizers, traditional preparations.
2. Organic waste recycling methods and techniques - composting, vermicomposting, *in situ* composting - system approach.
3. Soil and crop management in organic farming; Inter cropping and companion planting, crop rotation green manures and cover crops, mulching.
4. **Mid semester examination**
10. Weeds - Ecology - habitat management of weeds - Non - chemical weed management methods; preventive, physical, cultural, use of tools and implements and biological measures - good crop husbandry practices.
11. Integrated pest and diseases management - bio control agents, bio rational pesticides; minerals, botanicals, soaps, trap crops, bird perches, and traditional preparations - sanitation.
12. Indigenous technical knowledge (ITK) in organic agriculture - rationale and principles - general, indigenous practices for soil, nutrient, weed, water pest and disease management in farming - ITK's in farmers practice.
13. Benefits and problems in organic farming.
14. Organic farming; Promotional activities; role of government and NGO's - action plan - policy considerations.
15. Economic evaluation of organic production systems - cost - benefit analysis and comparison with conventional systems.

16. Organic certification - procedures - certification agencies in India - labeling, marketing and export opportunities.
17. Crop production standards - NPOP guidelines - principles, recommendations and standards - Quality considerations - assessment methods - premium and export opportunities.

Practical Schedule:

1. Resource inventory of organic farm- Soil sampling and analysis for organic carbon and pesticide residues / contaminants.
2. Raising of green manures (Sunnhemp / Daincha / Fodder cowpea).
3. Incorporation of green manure - seed treatment and raising of field crop (Rice / Maize / Cowpea / Cotton / Gingelly).
4. Hands on practice on preparatory cultivation; soil and water conservation methods.
5. Hands on experience on recycling techniques; bio-composting and vermicomposting.
6. Quantification of nutrients from organic sources and application of manures and bio- fertilizers.
7. Exposure visit to an organic farm to learn ITK based preparations.
8. Organic crop production and weed management.
9. Skill development in composting farm residues.
10. Organic crop production and pest management.
11. Exposure visit to bio-control agent (*Pseudomonas, Trichoderma* etc.,) production units.
12. Organic crop production and diseases management.
13. Skill development in vermicompost preparation.
14. Hands on training on grading, packaging and post-harvest management.
15. Exposure visit to organic market out lets.
16. Exposure visit to organic certification agencies / Directorate of Organic Certification, Tamil Nadu.
17. **Practical Examination**

References:

Dahama, A.K.2009. Organic farming for sustainable agriculture, Agrobros publishers.
SP. Palaniappan and K Annadurai. 2008. Organic Farming: Theory and Practice. 2008. Scientific Publishers.
Panda, S.C. 2012. Principles and Practices of Organic Farming. Agribios (India), Jodhpur.
Gehlot, D. 2010. Organic Farming- Components and Management. Agribios (India), Jodhpur.
Dushyant Gehlot . 2010. Organic farming: Components and management.Agrobios (India), Jodhpur.
Ranjan Kumar Biswas.2014. Organic farming in India. N.D.Publishers.New Delhi.

E:References:

1. www.ifoam.org
2. www.apeda.org
3. www.cowindia.org
4. www.ncof.org
5. www.earthfooda.co.uk,
6. www.newfarm.org/training

ABT 301 Plant Biotechnology (2+1)

Theory

Unit I Basics of Plant Tissue Culture

Plant tissue culture: Concepts, history and scope - Media and Culture Conditions - Sterilization techniques- Regeneration methods - morphogenesis, organogenesis and embryogenesis - culture types - callus culture and cell suspension culture; shoot tip and meristem tip culture; anther and pollen culture; ovule and embryo culture

Unit II Applied Plant Tissue Culture

Micropropagation - banana and ornamental plants; National certification and Quality management of TC plants- Applications of organ culture - Meristem tip culture (virus free plants) and anther culture (doubled haploids)- Protoplast isolation and fusion- somaclonal variation- synthetic seeds - secondary metabolite production- invitro germplasm conservation

Unit III Basic Molecular Biology

Genome organization- prokaryotes vs eukaryotes- Central dogma of life - Structure of nucleic acids - DNA replication, aminoacids and their classification- genetic codes- transcription, translation and protein synthesis- Structure of a gene, regulation of gene expression, Operon concept- basic techniques in molecular biology-Blotting techniques- Polymerase chain reaction- DNA sequencing methods.

Unit IV Recombinant DNA Technology and Genetic Transformation

DNA manipulation enzymes: Polymerases, restriction endonucleases and ligases - Different types of vectors: plasmids, phagemids, cosmids, BAC - Construction of recombinant DNA molecules- Bacterial transformation - Direct and indirect gene transfer methods in plants: microinjection, electroporation, particle bombardment, *Agrobacterium* mediated method - Tissue specific promoters, selectable and scorable markers, reporter genes- Molecular analysis of transgenic plants – Transgenic plants: herbicide, pest and disease resistant, abiotic stress resistant, nutritional enhancement and traits for improved quality- Detection of GMOs – regulations and biosafety.

Unit V Molecular Marker Technology and Molecular Breeding

DNA markers - hybridization based markers (RFLP) - PCR based markers: RAPD, SSR, AFLP, and SNPs - DNA fingerprinting of crop varieties – Development of mapping populations- linkage and QTL analysis-principles, methods and applications of Marker Assisted Selection in crop improvement- Applications of Plant Genomics and genome databases

Practicals

Biotech Laboratory organization, safety regulations – basics of reagents and solution preparation- Plant tissue culture media preparation- shoot tip culture (rose) - Meristem culture (tapioca)- Micro propagation of banana - Callus culture – Culturing of E. coli and determination of growth curve-Isolation of bacterial plasmid DNA- Restriction Digestion and Ligation- Competent cell preparation and Bacterial transformation – confirmation of transformation through colony screening - DNA extraction from plants- Quantification of DNA and quality check through Agarose gel electrophoresis - Molecular marker analysis- DNA fingerprinting using RAPD/SSR markers - NTSys- analysis of diversity in crop plants- Visit to tissue culture units /biotech labs in seed industry/Bt cotton field/tissue culture banana fields

Lecture Schedule

14. Plant tissue culture: Concepts, history and scope
15. Media and Culture Conditions and Sterilization techniques
16. Regeneration methods - morphogenesis, organogenesis and embryogenesis
17. Culture types - callus culture and cell suspension culture; shoot tip and meristem tip culture
18. Anther and pollen culture; ovule and embryo culture
19. Micropropagation - banana and ornamental plants
20. National certification and Quality management of TC plants
21. Meristem tip culture (virus free plants) and anther culture (doubled haploids)
22. Protoplast isolation and fusion- somaclonal variation-synthetic seeds
23. Secondary metabolite production, *invitro* germplasm conservation
24. Genome organization- prokaryotes vs eukaryotes
25. Central dogma of life - Structure of nucleic acids
26. DNA replication- Mechanism
27. Transcription and Post transcriptional processing - RNA splicing
28. Translation - Amino acids and their classification, genetic codes and protein synthesis
29. Concept and structure of a gene- classical and modern concept
30. **Mid semester Examination**
31. Regulation of gene expression, Operon concept
32. Blotting techniques and Polymerase chain reaction
33. DNA sequencing methods
34. DNA manipulation enzymes: Polymerases, restriction endonucleases and ligases
35. Different types of vectors: plasmids, phagemids, cosmids, BAC
36. Construction of recombinant DNA molecules- Bacterial transformation
37. Direct and indirect gene transfer methods in plants: microinjection, electroporation, particle bombardment, *Agrobacterium* mediated method
38. Tissue specific promoters, selectable and scorable markers, reporter genes,Molecular analysis of transgenic plants
39. Transgenic plants: herbicide, pest and disease resistant, abiotic stress resistant,
40. Transgenic plants: nutritional enhancement and traits for improved quality
41. Detection of GMOs – regulations and biosafety.
42. DNA markers - hybridization based markers (RFLP) - PCR based markers: RAPD, SSR, AFLP, and SNPs
43. DNA fingerprinting of crop varieties
44. Development of mapping populations
45. Linkage and QTL analysis
46. Principles, methods and applications of Marker Assisted Selection in crop improvement
47. Applications of Plant Genomics and genome databases

Practical schedule

15 Biotech Laboratory: Organization and Safety Regulations
16 Basics of Reagents and Solution Preparation
17 Plant Tissue Culture Media Preparation
18 Shoot Tip Culture of Rose
19 Meristem Tip Culture of Tapioca
20 Micropropagation of Banana

1. Callus Culture
2. Isolation of Bacterial Plasmid DNA
3. Restriction Digestion and Ligation
4. Competent Cell Preparation and Bacterial Transformation
5. Confirmation of Transformation through Colony Screening
6. Genomic DNA Extraction from Plants
7. Quantification of DNA and Quality Check through Agarose Gel Electrophoresis

8. DNA Fingerprinting using PCR
9. NTSys- Analysis of Diversity in Crop Plants
10. Visit to Tissue Culture Units /Biotech Lab in Seed Industry/Bt Cotton Field – Lateral Flow Strip Assay
11. **Final Practical Examination**

Reference

Chawla. H S. 2009. **Introduction to Plant Biotechnology (3/e).** CRC Press , London. 730 P ISBN 9781578086368

Boopathi, N. M. 2013. Genetic Mapping and Marker Assisted Selection - Basics, Practice and Benefits. Springer Publications

Brown, T. A. 2010. **Gene Cloning and DNA Analysis: An Introduction,** 6th Edition, Wiley-Blackwell- Companion site (Chapters 1 to 12 and 15)

Chahal, G. S. and Gosal, S. S. 2003. *Principles and Procedures of Plant Approaches Breeding Biotechnological and Conventional*. Narosa Publishing House, New Delhi

Dubey, R. C. 2014. A textbook of Biotechnology. 5th revised Edn. S. Chand Publications. New Delhi

George, E. F, Hall M. A. and Geert-Jan De Klerk. 2009. **Plant Propagation by Tissue Culture,** 3rd Edition, Springer, The Netherlands. 501p.

Gupta, P. K. , 2015. *Elements of Biotechnology* 2nd Edn. Rastogi and Co. , Meerut.

Neal Stewart, Jr. C. 2008. Plant Biotechnology and Genetics: Principles, Techniques and Applications John Wiley & Sons, Inc ISBN: 978-0-470-04381-3

Nelson, D. S. and M. M. Cox. 2012. **Lehninger's Principles of Biochemistry. Sixth edition. Chapters- 1,3,8,9,25,26,28** (weblinks, tutorials and lecture companion art) W. H. Freeman and

Razdan M K, 2014. *Introduction to plant Tissue Culture* 2nd Edn. Science Publishers, inc. USA.

Singh, B. D. 2012. *Plant Biotechnology*. Kalyani publishers, Ludhiana

Tomar, R. S. , Parakhia, M. V. , Patel, S. V. and Golakia, B. A. , 2010. *Molecular markers and Plant Biotechnology*, New Publishers, New Delhi.

Xu**,** Y 2010. **Molecular Plant Breeding.** International Maize and Wheat Improvement Centre (CIMMYT). 752 Pages

E- Reference

1. http://www. isaaa. org/india/- Briefs
2. http://www. nal. usda. gov.
3. http://www. agbiotechnet. com.
4. http://www. agbioworld. org
5. http://www. cropgen. org.
6. http://www. agbiosafety. unl. edu/.

PBG 302 Crop Improvement (2+1)

THEORY

Unit I: Cereals

Place of origin – putative parents – related wild species – breeding objectives–breeding methods– conventional and innovative methods-heterosis breeding and important varieties in following cereals: Rice, Wheat,Maize,Sorghum, Pearl millet,Finger millet

Unit II: Pulses and Oilseeds

Place of origin – putative parents – related wild species – breeding objectives–breeding methods– conventional and innovative methods-heterosis breeding and important varieties in following crops Pulses: Redgram , Bengal gram, Greengram, Blackgram, Cowpea, Soybean. Oilseeds: Groundnut, Sunflower,Gingelly, Castor, Rape and Mustard.

Unit III:Cash crops, FodderandHorticultural crops

Place of origin – putative parents – related wild species – breeding objectives–breeding methods– conventional and innovative methods-heterosis breeding and important varieties in following crops

Fibres: Cotton; Sugars: Sugarcane; Starch: Potato; Fumitories: Tobacco, Fodder: Guinea grass, Napier, Cumbu – Napier, Lucerne,*Stylosanthes*; Horticultural crops: Bhendi, Tomato, Brinjal, Papaya, Banana

Unit IV: Breeding for Biotic and Abiotic stresses and Quality

Breeding for insect resistance – mechanisms, basis, genetics of insect resistance - suitable breeding methods- merits and demerits of resistance breeding; Breeding for disease resistance – horizontal and vertical resistance- Gene for gene hypothesis – mechanisms, genetics of disease resistance; Suitable breeding methods for disease resistance- exploitation of vertical resistance in plant breeding- multilines, gene pyramiding, gene deployment.

Breeding for Abiotic stress – drought – mechanisms, basis, genetics of drought resistance - suitable breeding methods -limitations of drought resistance breeding; Breeding for Abiotic stress – salinity and alkalinity;

Breeding for quality traits- Important quality traits in different crops- nutritional quality of cereals and pulses-Genetics of nutritional traits-breeding methods- Breeding for low toxic substances- limitations of breeding for enhanced nutritional quality

Unit V: Hybrid seed production techniques and ideotype breeding

Hybrid seed production techniques in rice, maize and redgram

Ideotype breeding- main features-difference between traditional and ideotype breeding- - crop ideotypes in rice, wheat, cotton- steps in ideotype breeding- merits and demerits of ideotype breeding

PRACTICAL

Observation on floral biology – anthesis and pollination – selfing – crossing techniques – observation on cultivated germplasm, wild species – Experimental design – handling segregating generations- Yield trials in following crops- Rice, Maize and Sorghum,Pearl milletand Finger millet, Redgram, Bengal gram, Green gram, Black gram, Cowpea and Soybean, Groundnut and Sunflower, Sesame and Castor, Cotton, Sugarcane, Guinea grass, Cumbu – Napier hybrids, Lucerneand*Stylosanthes*,Bhendi, Brinjal, Tomato, Papaya and Banana, Study of quality characters in rice, Study of donor parents for different characters, General seed production techniques in field crops, Visit to AICRP and seed production plots of different field crops

Lecture schedule

Place of origin – putative parents – related wild species – breeding objectives–breeding methods– conventional and innovative methods-heterosis breeding and important varieties in following crops:

1. Cereals: Rice.
2. Cereals: Rice.
3. Cereals: Rice.
4. Cereals: Wheat
5. Cereals : Maize
6. Cereals: Sorghum
7. Cereals: Pearl millet, Finger millet,
8. Pulses: Redgram
9. Pulses: Greengram, Blackgram,
10. Pulses: Soybean, Bengal gram
11. Pulses: Cowpea
12. Oilseeds: Groundnut
13. Oilseeds: Gingelly, Rapeseed and Mustard
14. Oilseeds: Castor and Sunflower
15. Fibres: Cotton
16. Sugars: Sugarcane
17. **Mid Semester Examination.**
18. Starch: Potato
19. Fumitories: Tobacco
20. Forage grassesand legumes: Guinea grass, Napier, Cumbunapierhybrid,Lucerne,*Stylosanthes*
21. Breeding for sexually propagated horticultural crops-Bhendi, Tomato
22. Breeding for sexually propagated horticultural crops- Brinjal, Papaya
23. Breeding for clonally propagated horticultural crops- Banana
24. Breeding for insect resistance – mechanisms, basis, genetics of insect resistance- suitable breeding methods- merits and demerits of resistance breeding
25. Breeding for disease resistance –horizontal and vertical resistance- Gene for gene hypothesis – mechanisms, genetics of disease resistance
26. Suitable breeding methods for disease resistance- exploitation of vertical resistance in plant breeding- multilines, gene pyramiding, gene deployment.
27. Breeding for Abiotic stress – drought – mechanisms, basis, genetics of drought resistance - suitable breeding methods-limitations of drought resistance breeding
28. Breeding for Abiotic stress – salinity and alkalinity
29. Breeding for quality traits- Important quality traits in different crops- nutritional quality of cereals and pulses-
30. Genetics of nutritional traits-breeding methods- Breeding for low toxic substances-limitations of breeding for enhanced nutritional quality
31. Hybrid seed production techniques in rice
32. Hybrid seed production techniques in maize
33. Hybrid seed production techniques in redgram
34. Ideotype breeding- main features-difference between traditional and ideotype breeding- - crop ideotypes in rice, wheat, cotton- steps in ideotype breeding- merits and demerits of ideotype breeding

Practical schedule

Observation on floral biology – anthesis and pollination – selfing – crossing techniques – observation on cultivated germplasm, wild species – Experimental design – handling segregating generations- Yield trials in following crops.

1. Rice

2. Maizeand Sorghum
3. Pearl milletandFinger millet
4. Redgram, Bengal gramand Soybean
5. Green gram,Black gram and Cowpea
6. Groundnut and Sunflower.
7. Sesame and Castor
8. Cotton
9. Sugarcane
10. Guinea grass, Cumbu – Napier hybridsLucerne and *Stylosanthes*
11. Bhendi, Brinjal, Tomato
12. Papayaand Banana
13. Study of quality characters in rice
14. Study of donor parents for different characters
15. General seed production techniques in field crops
16. Visit to AICRP and seed production plots of different field crops
17. **Final Practical Examination**

References

Singh, B.D. 2007. Plant breeding - Principles and methods.

Phundan Singh. 2015. Essentials of Plant Breeding. Kalyani Publishers, New Delhi

Harihar Ram and HariGovind Singh, 1994. Crop breeding and Genetics. Kalyani Publishers, New Delhi.

D.N.Bharadwaj.2012. Breeding Field Crops. Agrobios (India),Jodhpur - 342002

HariHar Ram,2011. Vegetable Breeding– Principles and Practice, Kalyani Publishers, New Delhi.

N.Kumar.2006. Breeding of horticultural crops- Principles and Practices. New India Publishing Agency. New Delhi

D.A.Sleper and J.M.Poehlman. 2007. Breeding Field Crops. Blackwell Publishing Professional (USA)

H.H.Ram. 2011. Crop Breeding and Biotechnology. Kalyani Publishers (India)

Chopra, V.L. 1990. Plant Breeding. Theory and Practice. Oxford and IBH Publishing Co., New Delhi.

Daniel Sundararaj, D., G.Thulasidas, and M. Stephan Dorairaj. 1997. Introduction to Cytogenetics and Crop improvement. Popular Book Depot, Chennai - 15.

Sharma, J.R. 1994. Principles and practice of Plant Breeding. Tata McGraw - Hill Publishing Co. Ltd., New Delhi.

Singh, R.B., R.M. Singh and B.D. Singh, 1984. Advances in Cytogenetics and crop improvement. Kalyani Publishers, New Delhi.

E- References

1. www.cimmyt.org
2. www.nbpgr.nic.in
3. www.irri.org