Courses for Ph. D. in Agronomy

Course No.	Course Title	Credits/ Marks
AGRON 600	**RESEARCH METHODOLOGY AND TECHNIQUES**	**4 / 100**
AGRON 601	**CROP PRODUCTION AND SYSTEM MODELING**	**4 / 100**
AGRON 602	**ADVANCES IN CROP GROWTH AND PRODUCTIVITY**	**4 / 100**
AGRON 603	**ADVANCES IN SOIL FERTILITY MANAGEMENT**	**4 / 100**
AGRON 604	**ADVANCES IN IRRIGATION MANAGEMENT**	**4 / 100**
AGRON 605	**ADVANCES IN WEED MANAGEMENT**	**4 / 100**
AGRON 606	**INTEGRATED FARMING SYSTEMS FOR SUSTAINABLE AGRICULTURE**	**4 / 100**
AGRON 607	**SOIL CONSERVATION AND WATERSHED MANAGEMENT**	**4 / 100**
AGRON 608	**STRESS CROP PRODUCTION**	**4 / 100**

AGR 600: RESEARCH METHODOLOGY AND TECHNIQUES 4 Credits/100 Marks

UNIT I
Definition, objectives and types of research; Research processes, Criteria of Good Research, Nature and scope of agronomic research. Defining research problems; Research Project Planning and Management.

UNIT II
Biometric observations; Analysis of crop growth – recording dry matter, measuring leaf area; Concept of growth analysis parameters – CGR, RGR, LAI, NAR etc; Economics and energetics of cop production.

UNIT III
Agro-meteorological observations – data recording, analysis, presentation and interpretation. Correlation studies of weather data and crop growth.

UNIT IV
Laboratory techniques involved in soil and plant analysis. Basic knowledge of working in laboratory. Basic principles of laboratory techniques commonly used in agronomic research. Collection of soil and plant samples and processing for laboratory analysis.

UNIT V
Basic principles of experimental design; Lay out of field plot experimental design; Data processing and analysis – multiple correlation and regression, analysis of variance and covariance. Test of significance – t test, z test, F test.

UNIT VI
Interpretation of result – concept of least significant difference (LSD), DMRT, contrast analysis, missing plot techniques; analysis of cropping system data – intercropping and sequential cropping. Graphical and tabular presentation of data.

UNIT VII
Importance and need of scientific temper, values and ethics in research: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT VIII
Computer application in agronomic research; Statistical analysis of data by using softwares.

AGR 601: CROP PRODUCTION AND SYSTEM MODELING 4 Credits/100 Marks

UNIT I
Systems classification; flow charts, modeling techniques and methods of integration - state, rates and driving variables, feedbacks and relational diagrams.

UNIT II
Elementary models for crop growth based on basic methods of classical growth analysis.

UNIT III
Crop modeling methods for crop-weather interaction, climate change and variability components.

UNIT IV
Potential production: leaf and canopy CO2 assimilation, respiration, dry matter accumulation, crop phenology and dry matter distribution and development in different crops.

UNIT V
Production by moisture availability ,potential evapotranspiration, water balance of the soil, and production with nutrient and moisture limitations.

UNIT VI
Practical on Simulation of elementary models for crop growth, Simulation of potential, production, Simulation with limitations of water and nutrient management options, Sensitivity analysis using different climatic years and crop management practices

AGR 602: ADVANCES IN CROP GROWTH AND PRODUCTIVITY

4 Credits/100 Marks

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

UNIT II
Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and Limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship; principles involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.

UNIT III
Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial measures; heat unit concept of crop maturity: concept and types of heat units.

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

UNIT V
Source-sink relationships. Translocation of photosynthates and factors influencing transport of sucrose. Physiological and molecular control of sink activity – partitioning efficiency and harvest index. Crop growth models-empirical models testing and yield prediction.

UNIT VI

Practical on field measurement of root-shoot relationship in crops at different growth stages; Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc., at different stages of crop growth; Measurement of light interception, light extinction coefficient, energy utilization efficiency based energy intercepted, and realized; Computation of harvest index of various crops; Assessment of crop yield on the basis of yield attributing characters; Construction of crop growth curves based on growth analysis data; Computation of competition functions, viz. LER, IER aggressivity competition index etc in intercropping; Senescence and abscission indices; Analysis of productivity trend in un-irrigated areas; Analysis of productivity trend in irrigated areas

AGR 603: ADVANCES IN SOIL FERTILITY MANAGEMENT

4 Credits/100 Marks

UNIT I

Modern concepts of nutrient availability; nutrient response functions and availability indices. Importance of root morphology in nutrient availability.

UNIT II

Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils.

UNIT III

Chemical equilibria (including solid-solution equilibria) involving nutrient ions in soils, particularly in submerged soils.

UNIT IV

Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.

UNIT V

Modern concepts in fertilizer application; soil fertility evaluation techniques; role of soil tests in fertilizer recommendations; site-specific nutrient management for precision agriculture, Use of SPAD chlorophyll meter and LCC as tools of fertilizer N management.

UNIT VI

Monitoring physical, chemical and biological changes in soils; permanent manurial trials and long-term fertilizer experiments; soil productivity under long-term intensive cropping; direct, residual and cumulative effect of fertilizer use.

UNIT VII

Fertilizer use in problem soils; Fertilizers and environmental pollution; Soil health and quality; phytoremediation.

UNIT VIII

Practical on Design of soil fertility experiments; Collection and processing of soil and plant samples for nutrient analysis; Handling of common laboratory equipments used for soil and plant sample analysis; Analysis of soil samples for soil pH, organic carbon, available nitrogen, available phosphorus, available sulphur, lime requirement, electrical conductivity; Analysis of

plant samples for nitrogen, phosphorus, potassium and sulphur; Soil fertility experimental data analysis and interpretations; Correlation and regression studies of plant nutrient and crop growth and yield; Determination of soil biomass carbon; Determination of micronutrients in soils and plants by AAS; Visit to long term fertilizer experiment stations.

AGR 604: ADVANCES IN IRRIGATION MANAGEMENT

4 Credits/100 Marks

UNIT I

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

UNIT II

Soil-plant-water relationships, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological process and crop productivity.

UNIT III

Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops.

UNIT IV

Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in design and operation of irrigation projects; irrigation management in principal crops and cropping system; quality of irrigation water and management of saline water for crop production.

UNIT V

Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of anti-transpirations; fertilizer use in relation to irrigation; optimizing the use of given irrigation supplies.

UNIT VI

Land suitability for irrigation, land irrigability classification; integrated water management in command areas, farmer's participation in command areas, irrigation legislation.

UNIT VII

Practical on Determination of water infiltration characteristics and water holding capacity of soil profiles; Moisture extraction pattern of crops; Consumptive use, water requirement of a given cropping pattern for optimum / variable productivity; Crop planning at the farm and project level; Agronomic evaluation of irrigation projects, case studies.

AGR 605: ADVANCES IN WEED MANAGEMENT **4 Credits/100 Marks**

UNIT I

Crop weed competition in different cropping situations; changes in weed flora, various causes and effects; integrated weed management in major cropping systems.

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

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

UNIT IV
Advances in herbicide application techniques; antidotes and crop protection; compatibility of herbicides of different groups; compatibility of herbicides with other pesticides, herbicide development, registration procedures.

UNIT V
Recent advances in herbicide resistance in weed and its management; development of transgenic herbicide resistant crops; invasive weeds, aquatic and parasitic weeds and their management; advances in weed utilization.

UNIT VI
Relationship of herbicides with tillage, fertilizer and irrigation; bioherbicides and herbal herbicides, allelochemicals, herbicide bioassays.

UNIT VII
Practical on Phytosociological analysis of weed flora in major cropping system; Studies on propagule production potential of major weeds; Determination of critical period of crop weed competition; Studies on mode of action of herbicides; Economic utilization of weeds; Herbicide bioassays.

AGR 606: INTEGRATED FARMING SYSTEMS FOR SUSTAINABLE AGRICULTURE
4 Credits/100 Marks

UNIT I
Farming systems: definition, concept and scope; Components of farming systems in plains and hills; classification of farming systems according to type of rotation, intensity of rotation, degree of commercialization and mechanization, water supply, enterprises. Integrated farming systems.

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

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

UNIT IV
Simulation models for cropping systems; agronomic management in different cropping systems; preparation of different farming system models; evaluation of different farming systems.

UNIT V
New concepts and approaches of farming systems and cropping systems and organic farming; case studies on different farming systems.

AGR 607: SOIL CONSERVATION AND WATERSHED MANAGEMENT

4 Credits/100 Marks

UNIT I
Soil erosion: definition, nature and extent of erosion; types of erosion, factors affecting erosion.

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

UNIT III
Watershed management: definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas. Farming systems in watershed areas.
UNIT IV
Land use capability classification, alternate land use systems; agro-forestry; ley farming; jhum management - basic concepts, Drainage and agronomic management; Measures to prevent soil erosion.

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

AGR 608: STRESS CROP PRODUCTION **4 Credits/100 Marks**

UNIT I
Stress and strain terminology; nature and stress injury and resistance; causes of stress, Response of plants to abiotic stresses: Abiotic stresses affecting plant productivity.

UNIT II
Low temperature stress: freezing injury and resistance in plants, measurement of freezing tolerance, chilling injury and resistance in plants, Tolerance mechanism-crucial role of membrane lipids, practical ways to overcome the effect of low temperature tress through, soil and crop manipulations.

UNIT III
High temperature or heat stress: meaning of heat stress, heat injury and resistance in plants, Tolerance mechanisms- role of membrane lipids and HSPs, practical ways to overcome the effect of heat stress through soil and crop manipulations.

UNIT IV

Water deficit stress: meaning of plant water deficient stress and its effect on growth and development, water deficit injury and resistance, practical ways to overcome effect of water deficit stress through soil and crop, manipulations.

UNIT V

Excess water or flooding stress: meaning of excess water stress, its kinds and effects on crop plants, excess water stress injury and resistance, practical ways to overcome excess water stress through soil and crop manipulations.

UNIT VI

Salt stress: meaning of salt stress and its effect on crop growth, salt stress injury and resistance in plants, practical ways to overcome the effect of salt stress through soil and crop manipulations.

UNIT VII

Environmental pollution: air, soil and water pollution, and their effect on crop growth and quality of produce; ways and means to prevent environmental pollution. Heavy metal stress: Aluminum and cadmium toxicity in acid soils. Role of Phytochelatins (heavy metal binding proteins).

UNIT VIII

Practical on Determination of electrical conductivity of plant cell sap and soil water; Determination of osmotic potential and tissue water potential; Measurement of transpiration rate; Measurement of stomatal frequency; Determination of proline content of plant parts; Determination of Relative Leaf water content of plants; Quantification of anti oxidative enzymes like *Super oxide desmutase* (SOD); Determination of membrane injury index(MII); Determination of chlorophyll stability index (CSI); Studying the role of growth regulators in amelioration of abiotic stress effects in plants; Determination of soil water potential and content by psychrometry and other systems; Studies on effect of osmotic and ionic stress on seed germination and seedling growth