Revision of contents of domain courses for M.Sc. Agriculture Analytics

ANAND AGRICULTURAL UNIVERSITY

ANAND – 388 110

Read: Minutes of 62nd Meeting of Academic Council held on 27-06-2024 vide Item No. 62.20

NOTIFICATION

It is hereby notified to all concerned that the 62nd Meeting of Academic Council held on 27-06-2024 has resolved as under vide Item No. 62.20:

"It is hereby resolved that, the revised course content of domain courses for M.Sc. (Agriculture Analytics) as indicated in **Appendix-A** is hereby approved by Academic council."

No. AAU/DR/RES/T-5/ 2401 /2024
Date: 09/07/2024

Director of Research &
Dean P.G. Studies

Copy F.W.Cs. to:

1. PS to Hon'ble Vice Chancellor, Anand Agricultural University, Anand
2. All Members of Academic Council of this University
3. All Officers of this University
4. Registrar, AAU, Anand

Copy to:

1. All Deans/Principals of this University
2. Unit/Sub Unit Officers of this University
3. All Branches of this Section
4. Director, Information Technology, AAU, Anand with request to upload the Notification on circular section of AAU website.

Appendix-A

Module 1: Crop and Soil Analytics

Syllabus	Revised Syllabus
Theory : Production technology of important field crops; Factors affecting crop growth and production. Crop nutrition and nutrient use efficiency; Modern concepts of fertilizer evaluation and nutrient budgeting. Basics of cropping systems; contract, natural & organic farming systems; Site suitability evaluation for different farming systems. Precision agriculture with modern technological tools. Crop yield monitoring & modelling; overview of different crop models. Agricultural bioinformatics: Plant genomic database and their analysis. Soil forming processes and their properties. Soil related dataset and variables; Spatio-temporal variability of soil data. Soil fertility: Maintenance and evaluation techniques; Soil fertility assessment using data mining techniques. Soil & plant testing, fertilizer recommendations based on soil test values Descriptive and prescriptive analysis using soil physicochemical dataset. Proximal soi sensors - Theory and Application; Soil spectral data for predictive analysis of soil properties. Soil productivity assessment under long-term intensive cropping – modeling of direct, residual and cumulative effects of fertilizer use. Modeling of nutrient transformation in soil, sorption/desorption isotherms. Problematic soils & their appraisal, soil contamination, its risk assessment, and remediation techniques.	**Theory :** Production technologies of important crops; Factors affecting crop growth and production, cropping systems, natural and organic farming. Crop physiology; Estimation of crop growth evaluating parameters. Precision agriculture with modern technological tools; IoT based precision agriculture. Crop yield monitoring & modelling; Overview of different crops models. Agricultural bioinformatics; Plant genomic database and their analysis. Soil related dataset and variable; Spatio-temporal variability of soil data. Soil fertility: Maintenance and evaluation techniques; Soil fertility assessment using data mining techniques. Soil & plant testing, fertilizer recommendations based on soil test values, descriptive and prescriptive analysis using soil physicochemical dataset, Crop nutrition and nutrient use efficiency. Proximal sensors: theory and applications; Soil spectral data for predictive analysis of soil properties. Sorption/desorption of chemical constituents in soils. Soil productivity assessment under long-term intensive cropping – modelling of direct, residual and cumulative effects of fertilizer use. Modelling of nutrient transformations in soil, Modern concepts of fertilizer evaluation and nutrient budgeting. Problematic soils & their appraisal, soil contamination, its risk assessment, and remediation techniques.

Practical : ▪ Measurement of crop shoot-root relationship at different growth stages ▪ Crop yield contributing characters, yield calculations, and yield estimation ▪ Estimation of crop growth evaluating parameters ▪ Assessment of crop yield based on yield attributing characters ▪ Simulation of elementary models for crop growth ▪ Computation of cost of cultivation, and relevant economical indices ▪ Overview of bioinformatics database and their analysis ▪ Fertilizer's recommendations based of VRT and STCR techniques ▪ Soil survey technique and mapping using remote sensing tools ▪ Techniques of land use planning, Land capability classification ▪ Hands on soil sensing using visible and near infrared spectroscopy, Fourier transforms infrared spectroscopy, X-ray fluorescence, X-ray diffraction, etc. ▪ Quality indices of irrigation water	**Practical :** ▪ Measurement of crop shoot-root relationship at different growth stage ▪ Crop yield contributing characters, yield calculations, and yield estimation ▪ Assessment of crop yield based on yield attributing characters ▪ Simulation of elementary models for crop growth ▪ Overview of bioinformatics database and their analysis ▪ Fertilizers' recommendations based on VRT and STCR techniques ▪ Soil survey technique and mapping using remote sensing tools, Technique of land use planning, land capability classification ▪ Hands on soil sensing using visible and near infrared spectroscopy, Fourier transforms infrared spectroscopy, X-ray fluorescence, X-ray diffraction, ICP etc. ▪ Hands-on instrumentation for crop parameter estimation ▪ Soil fertility assessment using remote-sensing data ▪ Quality indices of irrigation water

Module 2: Weather and Water Analytics

Syllabus	Revised Syllabus
Theory : Earth sun relationship, radiation, general circulation models, local and tertiary circulation, forces, and types of winds. Water vapour in the atmosphere, psychrometry, stability and instability conditions in the atmosphere. Platforms for data collection – ground based, aerial and space based. Satellite orbits – geosynchronous and sun synchronous. Condensation; clouds and their classification; the hydrological cycle; precipitation processes, artificial rainmaking, thunderstorms and dust storm; air masses and fronts; tropical and extra-tropical cyclones. Indian monsoon, Modern techniques of weather forecasting; Global Forecast System, Regional and mesoscale forecast system (WRF, ARPS, GFS, GEFS, CFS). Climate change, El Nino, La Nino, and ENSO. Crop weather charts, calendars and diagrams; General concepts of radiation in relation to agriculture, photosynthetically active radiation, saturation light intensity and efficiency of light utilization. Heat units, Weather and climate effects on crop growth and development, Weather, climate, and livestock. Weather based decision support system and agromet advisory. Basics & background actualities on agricultural water – quantified assessments, comparisons, and inputs for DSS. On farm and off farm water resource systems including rainwater harvesting & irrigation Systems; Quantified indicators for assessing/monitoring. operational efficacies of ponds, water conservation structures/practices, wells, aquifers, and canals. Scheduling of irrigation, Irrigation methods & command area development along with functional data domain & analysis towards irrigation efficiencies including Micro Irrigation Systems with smarter elements & data acquitting. Fundamentals of Hydrology & Hydrologic Elements, including abstractions, hydrographs & their analysis, methods/measurements of hydrological attributes. Hydrometry, and statistical analysis of water data as used in agriculture.	**Theory :** Earth-sun relationship, radiation and seasons. Winds dynamics, forces, and circulation models. Water vapour in the atmosphere and psychrometry. Thermodynamics of atmosphere and gas laws. Modern techniques of weather forecasting. Air masses and Fronts, Tropical and extra-tropical cyclones. Crop weather calendars and radiation in relation to agriculture. Energy fluxes. Stability of the atmosphere and air pollution. Evapotranspiration. Hydrological Cycle, Condensation. Water balance and length of growing period. Applications of weather forecasting. Climate change- causes, changes, general impacts, impacts on agriculture, adaptation, mitigation, projection scenarios. El Nino, La Nino, and ENSO – causes, indices, impacts on Indian monsoon and seasons. Weather based decision support system, agromet advisory services. Weather and climate effects on crop growth and development. Hydrologic cycle. Data based architecture of hydrologic elements. Watersheds: Conceptual framework, Characterizations, and Data domains. Hydrologic simulations: models, modelling and data applications. Best principles and practices for integrated development and management of Indian Watersheds. Delineation and prioritization of ground water recharge using GIS with data-based case studies. Stochastic and time series analysis of water. Irrigation methods, irrigation scheduling and command area development.

Water Data prospects in present information age along with broad array of all-purpose hydrologic & hydraulic computations. Watershed development including physiographic features, integrated management & development of water, soil, vegetation & other natural resources; functional/operational attributes on soil conservation, erosion control and water productivity analytics. Hydrologic simulations & modeling encompassing rainfall-runoff relationships, water balance & water productivity attributes, groundwater recharging.	
Practical : ▪ Instruments for measurement of meteorological elements; agromet observatory. Measurement of weather parameters ▪ Climatic normal, extremes, mapping, and identification features ▪ Statistical technique for computation of normal, moving average, climatic parameters/indices etc. ▪ Computation on heat and radiation utilization by plants ▪ Estimation of energy fluxes and evapotranspiration. ▪ Climate change impact and adaptation analysis for ▪ Tools, techniques, and conjunctive use of water from wells, canals, and ponds ▪ Computation of irrigation scheduling indicators ▪ Hydrological modelling and water budgeting ▪ Rainfall climatology statistics and drought indices	**Practical :** ▪ Instruments and measurements of meteorological parameters ▪ Estimation of Evapotranspiration ▪ Computation of climatic information from weather records, timeseries analysis of weather variables ▪ Computation of heat indices and prediction of crop phenology ▪ Measurement of PAR and computation of radiation utilization by plants ▪ Estimation of energy fluxes ▪ Weather based modelling in agriculture ▪ Hands on climate projection/forecast products ▪ Hands on exercise on global climatic predictors for rainfall ▪ Determining atmospheric stability and pollution dispersion ▪ Preparation of weather forecast based agromet advisory ▪ Practical: Hydrologic data analysis ▪ Practical: Calibration and validation of a watershed model

Module 3: Agricultural Market Analytics

Syllabus	Revised Syllabus
Theory and Practical: Basic of Agricultural Marketing-concepts and definitions of Agricultural Marketing-its new role. Market and market structure, problems in Agricultural marketing. Characteristics of agricultural product and production factors affecting demand for and supply of farm products. Market intermediaries and their role- need for regulation in present context. Market efficiency, costs, margins, and price spread. Market Infrastructure- Marketing Co-Operatives- APMC Regulated Markets- Direct Marketing, Contract Farming, Contract Marketing and Retailing-Supply Chain Management. State Trading, Warehousing and other Government Agencies- Performance and Strategies-Market Infrastructure Needs, Performance and Government Role-Value Chain Finance, Market Information. Market Integration Analysis- Market Research, Designing Questionnaires, Sampling-Identification of Markets, Analysis and Conclusion, Data Collection: Primary, Secondary, Data Analysis- Arrival and Price Behaviours, Price Transmission Analysis, Price Volatility, Intra and Inter Year Price Movements, Market Integration Analysis, Stationarity Checking, Lag Selection Criteria, Johanson Co-Integration Test, Granger Causality Test, Vactor Error Correction Model (VECM). Price Forecasting-Time Series Analysis, Spatial and Temporal Price Relationship, Price Forecasting-Time Series Models, Selection of Commodities, Market and Data, The Modelling Approach-Univariate Linear Time Series Models: Exponential Smoothing, ARIMA, ARIMAX, Seasonal Decomposition etc. – Univariate Non-Linear Time Series Models: ARCH, GARCH, EGARCH, TGARCH etc., Validation of the Forecasts with Different Statistical Measures, Forecasts Precision, Dissemination of Price Forecasts.	**Theory and Practical:** Basic of Agricultural Marketing-concepts and definitions of Agricultural Marketing-its new role. Market and market structure, problems in Agricultural marketing. Characteristics of agricultural product and production factors affecting demand for and supply of farm products. Market intermediaries and their role- need for regulation in present context. Market efficiency, costs, margins, and price spread. Market Infrastructure- Marketing Co-Operatives- APMC Regulated Markets- Direct Marketing, Contract Farming, Contract Marketing and Retailing-Supply Chain Management. State Trading, Warehousing and other Government Agencies- Performance and Strategies-Market Infrastructure Needs, Performance and Government Role-Value Chain Finance, Market Information. Market Integration Analysis- Market Research, Designing Questionnaires, Market Integration Analysis, Stationarity Checking, Lag Selection Criteria, Johanson Co-Integration Test, Granger Causality Test, Vactor Error Correction Model (VECM). Price Forecasting-Time Series Analysis, Spatial and Temporal Price Relationship, Price Forecasting-Time Series Models, Selection of Commodities, Market and Data, The Modelling Approach-Univariate Linear Time Series Models: Exponential Smoothing, ARIMA, ARIMAX, Seasonal Decomposition etc. – Univariate Non-Linear Time Series Models: ARCH, GARCH, EGARCH, TGARCH etc., Validation of the Forecasts with Different Statistical Measures, Forecasts Precision, Dissemination of Price Forecasts. Demand and supply Analysis – Demand and supply relationship, Estimation of demand and supply – Demand model: Quadratic almost ideal demand system (QUAIDS). Supply –Production function approach,

Demand and supply Analysis – Demand and supply relationship, Estimation of demand and supply – Demand models: Food Characteristics demand system, Linear expenditure demand system, Transcendental logarithmic system, Almost Ideal Demand System (AIDS), Quadratic almost ideal demand system (QUAIDS), Demand – Expenditure growth effects on prediction, Household demand for food grains, Demand for non-food grains, Indirect demand for food grains – seed, feed, industrial use, wastage, total indirect demand, Domestic demand for food grains, Supply – crop output model – production function approach, yield function approach, crop acreage model – crop wise irrigated and unirrigated acreage model, input-output data, Estimation procedure, short-run output supply and factor demand elasticities, long-run output supply, and factor demand elasticities, total factor productivity (TFP), supply projection.	Estimation procedure, short-run output supply, long-run output supply. Total Factor Productivity (TFP).

Module 4: Risk Analysis and Modelling

Syllabus	Revised Syllabus
Theory : Risk and Vulnerability assessment for adaptation planning, Yield loss and weather based insurance and their applications. Water balance- Surface water, groundwater and their interaction, On-farm & off-farm water resources system. Rainfall-runoff relationships, hydrometric & statistical analysis of hydrologic data, Hydrologic simulation modeling. Introduction of risk involved in Agriculture. Types of risk in Agriculture. Explanation of market risk with examples and past occurred risk through graphs. What is production risk? What is Agriculture production risk? Its definition and examples. Explanation of Financial risk with concrete examples. Involvement of institutional risk, human or personal risk by giving examples. Risk involve with nature & therefore resources. Modeling and other strategies to measure the risk. Modelling of the spatial-temporal variations of the hydroclimatic extremes. Modeling whole-farm income and risk management decisions, Econometric analyses with regard to adoption of risk management tools. Use of Remote Sensing and GIS in risk analysis, modeling and management. Distributions: Types of distributions. The Introduction of Statistical Distributions. Poisson; Gumbel & Fisher –Typette Type-II distributions in details and their applications. (Agriculture, weather, and another fields). Applications of above distributions in Agriculture & Weather and its importance. What is extreme value theory/events ? How it happens ? How in agriculture & weather it occurres. Methods to predict – natural disasters. Methods to predict climatic extreme events. Historical & recent examples of occurrence of extreme events. Prediction of extreme events and methods. Extreme events and their	**Theory :** Introduction to hazard, risk and vulnerability. Assessment of vulnerability of agriculture to climate change. Introduction of risk involved in agriculture. Types of risk in Agriculture. Agriculture water scarcity and soil loss: Risk, vulnerability and consequences. AHP-Multi-criteria decision making (MCDM) method and its applications. Rainfall-runoff relationships, hydrometric & statistical analysis of hydrologic data, Hydrologic simulation modeling. Agricultural flood vulnerability assessment and risk quantification L-Moment based distribution fitting. Extreme events under climate change. Agricultural drought risk assessment using different modeling techniques. Applications of distribution and probability theory in agriculture & weather and its importance. Application of artificial neural networks in flood forecasting. Application of artificial neural networks in drought forecasting. Use of remote sensing and GIS in risk analysis, modeling and management. Methods to predict – natural disasters. Stochastic analysis of hydroclimatic variables. Historical & recent examples of occurrence of extreme events. Assessment of climate change impact on hydro-climatic variables. Effects of runoff generation methods and simulation time steps on flood assessment. Modeling of the spatial-temporal variations of the hydroclimatic extremes: Multi-resolution analysis, ensemble methods, uncertainty quantification through Bayesian neural networks and Monte Carlo dropout, spatiotemporal ensembles. Modeling change of pattern in agriculture in terms of climate change. Groundwater vulnerability and risk mapping.

reoccurrence by historical examples. Extreme events in terms of climate change. Modelling of the spatial-temporal variations of the hydroclimatic extremes. Use of Remote Sensing and GIS in risk analysis, modeling and management. Combining Remote Sensing & GIS Technology for Risk Management in Agribusiness. Modeling change of pattern in Agriculture in terms of climate change. Natural Hazard risk assessment using remote sensing and GIS. Modeling of flood and drought phenomenon. Modelling Flood & Drought Events- Adaptation, Mitigation, and Management, etc.	
Practical : ▪ Calculation of the extreme distributions parameters using Maximum Likelihood and L-Moments. ▪ Calculation of Poisson distribution and Gumbel & Fisher Typette Type-II distributions. ▪ Tools and techniques for prediction of extreme events. ▪ Study of modelling techniques for the spatial-temporal variations of the hydroclimatic extremes. ▪ Basic Econometric analyses such as linear regression and heteroskedasticity ▪ Study of different modeling techniques for floods and droughts. ▪ Case studies on use of Remote Sensing and GIS in risk analysis, modeling and management.	**Practical :** ▪ L-Moment based extreme value analysis of different hydroclimatic variables. ▪ Groundwater zone mapping using AHP-MCDM, remote sensing and GIS techniques ▪ Tools and techniques for prediction of extreme climate events. ▪ Application of artificial neural networks in flood forecasting. ▪ Application of artificial neural networks in drought forecasting. ▪ Development of an interface for trend analysis of hydro-meteorological data. ▪ Study of different modeling techniques for floods and droughts using AI/ML techniques. Flood and drought vulnerability assessment and mapping. ▪ Assessment of land use and land cover changes on soil erosion in semi-arid areas using cloud-based google earth engine platform and GIS-based USLE model.