Syllabus of M. Sc.

Revised M. Sc. (Ag.) courses for Department of Agricultural Meteorology and Physics, Faculty of Agriculture, B. C. K. V., Mohanpur.

AGM 501 FUNDAMENTALS OF METEOROLOGY 3+0

Objective

To impart theoretical knowledge of physical processes occurring in atmosphere.

Theory

UNIT I

Earth and its atmosphere in relation to sun and seasons; solar radiation; heat balance of earth and atmosphere; radiation in the atmosphere-energy balance at different surfaces and significance of different components and their estimation; Angstrom equation and estimation of radiation parameters; nature of radiation, physical and physiological processes important to radiation; laws of radiation: Planck's law, Stefan-Boltzmann's law, Wien's displacement law, Kirchoff's law, Beer's law and Lambert's cosine law; theories of transmissivity; extinction coefficient; length of day; albedo of a surface; atmospheric and astronomical factors affecting depletion of solar radiation received on the earth; selective absorption by constituents of atmosphere; Rayleigh and Mie scattering; direct and diffuse radiation; heat transfer: conduction, convection and radiation; concept of latent and sensible heat; radiant flux and flux density.

UNIT II

Temperature in the atmosphere: distribution of temperature in time and space, variation in temperature with height; subdivisions of the atmosphere: troposphere, stratosphere; atmospheric dynamics-atmospheric motion under balanced forces.

UNIT III

Gas laws; pressure gradient, isobars, hydrostatic equation and its application; coriolis force; geostrophic, gradient and cyclostrophic winds; pressure systems, cyclonic and anticyclonic motions, trough, ridge, col, thermal wind, contour charts, variation in pressure with height.

UNIT IV

Concepts of specific heats at constant volume and pressure; first and second laws of thermodynamics and their applications to atmosphere; vertical stability of atmosphere, virtual temperature and potential temperature; moist and dry adiabatic processes; atmospheric stability and DALR and SALR stability criteria for atmosphere-conditional instability and auto convective stability.

UNIT V

Meteorological temperatures: dew point temperature, wet bulb temperature, equivalent temperature and equivalent potential temperature; thermodynamic diagrams and their uses; dynamics of atmosphere and general circulation; equations of motion; turbulence, vorticity and atmospheric waves.

Suggested Readings

Barry RG & Richard JC. 2003. *Atmosphere, Weather and Climate*. Tailor & Francis Group.
Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.
Ghadekar SR. 2001. *Meteorology.* Agromet Publ.
Mcllveen R. 1992. *Fundamentals of Weather and Climate*. Chapman & Hall.
Petterson S. 1958. *Introduction to Meteorology*. McGraw Hill.

Trewartha Glenn T. 1954. *An Introduction to Climate*. McGraw Hill.

AGM 502 FUNDAMENTAMENTAS OF CLIMATOLOGY 3+0

Objective

To impart theoretical knowledge of climatology.

UNIT I

Air masses and their properties: source regions, processes determining the characteristics of air masses, properties of air masses, classification of air masses, air masses and fronts, important air masses over India; models of secondary circulation in the atmosphere; intratropical convergence zone, mountain and valley breezes, land and sea breezes, sand and dust whirls due to thermal circulation; Fohn and Chinook winds, extra tropical cyclones, tropical cyclones and their structures.

UNIT II

Water vapour or humidity in the atmosphere-various humidity parameters: vapour pressure, specific humidity, relative humidity, mixing ratio, absolute humidity, dew point, wet bulb temperature, saturation deficit, and their interrelationships; psychrometric equation, and stability and instability conditions in the atmosphere; entrophy-tephigram; condensation and precipitation processes-physical basis of atmospheric condensation-growth by coalescence and ice nucleation; lapse rates-ascent of dry and moist air; condensation process-artificial rain making, Bergeron-Findeisen theory; condensation forms-dew, fog, mist, frost, cloud, haze, rain, hail, dust storm and thunderstorms; clouds and their description and classification; evaporation and rainfall; hydrologic cycle.

UNIT III

Effects of earth's rotation on zonal distribution of radiation, rainfall, temperature and wind; the trade winds, equatorial trough and its movement; the SE Asian monsoon, mechanisms of Indian monsoon, monsoon circulation, monsoon break, role of physiography on rainfall distribution; EL Nino, La Nina and ENSO.

UNIT IV

Weather and climate. Climatic elements and their diurnal, seasonal and annual variation; climatic classification-Koppen, Thornthwaite, Gaussen and Emberger systems, etc.; agroclimatic zones and agro-ecological regions of West Bengal and India; climatology of West Bengal and India-principal weather phenomena occurring in four seasons of West Bengal and India; western disturbances, Nor'wester, heat and cold waves.

Suggested Readings

Barry RG & Richard JC. 2003. *Atmosphere, Weather and Climate*. Tailor & Francis Group.
Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.
Lenka, D. 1998. *Climate, Weather and Crops in India.* Kalyani Publishers.
Ghadekar SR. 2001. *Meteorology.* Agromet Publ.
Lal, DS. 1995. *Climatology.* Chaitanya Publishing House, Allahabad.
Mcllveen R. 1992. *Fundamentals of Weather and Climate*. Chapman & Hall.
Petterson S. 1958. *Introduction to Meteorology*. McGraw Hill.
Trewartha Glenn T. 1980. *An Introduction to Climate*. McGraw Hill.

AGM 503 FUNDAMENTALS OF AGRICULTURAL METEOROLOGY 2+1

Objective

To impart the theoretical and practical knowledge of physical processes occurring in relation to plant and atmosphere with advanced techniques.

Theory

UNIT I

Meaning and scope of agricultural meteorology; components of agricultural meteorology; roles and responsibilities of agricultural meteorologists; importance of meteorological parameters in agriculture; important meteorological processes to agriculture-importance of various micro environment on plant growth and development.

UNIT II

Radiation balance as applied to agriculture-radiation as a forcing function for physical and physiological processes in plants and animals; energy exchange at air-earth interface; energy balance in atmosphere and crop canopy; energy balance over agriculturally important surfaces; evaluation of energy balance components; radiation instruments; advanced techniques for measurement of radiation and energy balance; empirical methods for estimation of short wave, long wave and net radiation; radiation charts-Moller, Elassasser, Kew and Yamamoto charts; radiation interaction with plant environment; spectral properties of vegetation; net radiation profiles and light distribution within plant communities as affected by leaf area index, leaf arrangement and leaf transmissibility; extinction coefficient; meteorological factors in photosynthesis, respiration and net assimilation; radiation utilization during successive stages of plant development and its efficiency; efficiency of solar energy conversion into dry matter production.

UNIT III

Effects of thermal environment on growth and yield of crops; cardinal temperatures, thermoperiodism, photo-nycto temperatures, Vant Hoff's law and phenology of crops; heat unit concepts and related parameters-HTU, PTU, TIR, SMGDD; leaf temperature- transfer processes between leaf surface and adjoining air; latent heat and sensible heat transfer in air-various approaches to evaluate evaporation and sensible heat fluxes, principles of similarity and Bowen ratio concepts; soil temperature and soil heat flux; heat conduction and thermal diffusivity in soil.

Practical

- Estimation and measurement of solar radiation
- Estimation and measurement of net radiation
- Soil heat flux by using of soil heat flux plates
- Determination of Bowen ratio
- Determination of albedo of bare, irrigated and cropped fields
- Measurement of leaf temperature
- Instruments for direct measurements of soil heat fluxes and thermal properties of soils
- Computation of heat flux from soil temperature profiles
- Measurement and evaluation of radiation components
- Measurement of wind and temperature profiles near the ground

Suggested Readings

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.
Hillel, D. 1998. *Environmental Soil Physics*. Academic Press.
Kakde JR. 1985. *Agricultural Climatology*. Metropolitan Book Co.
Lenka, D. 1998. *Climate, weather and Crops in India.* Kalyani Publishers.
Lowry, WP. 1969. *Weather and Life.* Academic Press.

Rosenberg NJ, Blad BL and Verma SB. 1983. *Microclimate-The Biological Environment.* A Wiley-Interscience Publication, John Wiley & Sons.
Varshneya MC & Pillai PB. 2003. *Text Book of Agricultural Meteorology*. ICAR.
Venkataraman, S. and Krishnan, A. 1992. *Crops and Weather*. ICAR.

AGM 504 SOIL WATER BALANCE AND EVAPOTRANSPIRATION 2+1

Objective

To impart the theoretical and practical knowledge of water balance and ET estimation and measurements.

Theory

UNIT I

Energy concept of soil water, hydraulic conductivity and soil water flux; theory on hydraulic conductivity in saturated and unsaturated soils; physical factors concerning water movement in soil; concepts on evaporation, evapotranspiration, potential and actual evapotranspiration.

UNIT II

Theories of evapotranspiration and their comparison; aerodynamic, eddy correlation, energy balance, water balance and other methods, their application under different agroclimatic conditions; concepts of potential, reference and actual evapotranspiration-modified techniques; individual and combined influence of soil, plant and meteorological factors on evapotranspiration; crop coefficient-its concepts and application; water extraction pattern by plant roots.

UNIT III

Climatic and water budgeting approach; evapotranspiration models: aerodynamic approaches such as Dalton's equation, Thornthwaite-Holtzman equation, Pasquill's approach, eddy correlation, energy balance methods, Bowen ratio approach, combination of approaches of Penman, Slatyer and Mcilroy, Van Bavel, Monteith and Tanner and empirical formulae of Thornthwaite, Blaney-Criddle, Makkink, Turc, Budyco, Papadakis; advantages and limitations of different methods.

UNIT IV

Basic principles of water balance in ecosystems; soil water balance models of Thornthwaite and Mather, Shaw, Robertson and Baier, linear models, log and exponential models of soil moisture decay curves; calculation of water surplus and deficit; advection and its effect on water use by crops; water and yield relationships; water production function; yield functions; relationships between water use and dry matter production; dry matter yield ET functions.

UNIT V

Consumptive use, water use and water use efficiency; influence of microclimatic, plant, soil and cultural factors on ET by crops; techniques of lysimetry in measuring actual evapotranspiration; water use efficiency and scheduling of irrigation based on evapotranspiration; water use efficiency and antitranspirants, computation of Kc values and their use; irrigation scheduling based on climatological approaches.

Practical

- Estimation of evaporation, evapotranspiration and crop coefficient
- Determination and use of crop factors in evapotranspiration studies
- Evaluation of hydraulic conductivity vs. soil moisture relationship by water balance approach

- Determination of indices of moisture adequacy and length of growing period in different soil climatic zones
- Determination of aridity indices and water requirement satisfaction index by different methods for appraisal of water stress of crops, water use and yield production functions
- Soil moisture measurement by different methods
- Measurement of soil matric potential by tensiometric studies.
- Computation and comparison of evapotranspiration by different methods-energy balance method, aerodynamic method, Penman method, and other methods.
- Soil moisture retention characteristics by pressure plate method.

Suggested Readings

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.
Burman R & Pochop LO. 1994. *Evaporation, Evapotranspiration and Climatic Data*. Elsevier.
Frere, M. and Popov, GF. 1979. *Agrometeorological Crop Monitoring and Forecasting*. FAO Plant Production and Protection Paper No. 17.
Grace J.1983. *Plant Atmospheric Relationships: Outline Studies in Ecology*. Chapman & Hall.
Hillel, D. 1998. *Environmental Soil Physics*. Academic Press.
Mather, JR. 1974. *Climatology: Fundamentals and Applications*. McGraw-Hill.
Mavi HS & Graeme J Tupper 2004. *Agrometeorology: Principles and Applications of Climate Studies in Agriculture.* The Haworth Press.
Murthy VRK. 2002. *Basic Principles of Agricultural Meteorology*. BS Publ.
Ram Niwas, Diwan Singh & Rao VUM. 2000. *Practical Manual on Evapotranspiration*. Dept. of Agril. Meteorology, CCS HAU Hisar.
Rosenberg NJ, Blad BL & Verma SB. 1983. *Microclimate – The Biological Environment*. John Wiley & Sons.

AGM 505 WEATHER MODIFICATIONS FOR AGRICULTURE 2+0

Objective

To impart the theoretical knowledge of weather modification techniques and management strategies.

Theory

UNIT I

Definition and scope; historical reviews of weather modification, present status of weather modification for agriculture; atmospheric composition and green house effect.

UNIT II

Theories of weather modification; modification of macroclimate: scientific advances in clouds and electrical behavior of clouds; modification of frost intensity and severe storms; wind barriers, protection of plants against climatic hazards; air and water pollution; meteorological conditions in artificial and controlled climates - green, plastic, glass and animal houses etc.; modification of weather hazards; weather modification for agriculture; modification of clouds and cloud systems: cloud seeding, artificial rain making and hail suppression; dissipation of fog and stratus clouds; modification of severe storms and electric behavior of clouds.

UNIT III

Modification of microclimate; inadvertent and advertent modification of climate; modification of fluxes at the top of the crop surface: man-made fog, wind machines, light control, photoperiod control, prevention of fog, frost protection-radiation control, soil heat control, latent heat control, sensible heat control and direct heating; modification of advective fluxes: windbreak and shelter

effects and their effect on modification on climate: wind and turbulence effects, energy and water balances and climatic effects and applications; shelter effect-radiation balance, air and humidity, site selection, shape of plant beds; modification of fluxes at the crop surface: albedo modification, geometry control; sprinkling for heat stress reduction, sprinkling and irrigation for frost and cold protection, direct heating for frost protection, mulching: soil moisture and temperature control-pulverized soil, straw mulch, plastic mulch, asphalt or petroleum mulch, antitranspirants; modification of solar radiation and evaporation; modification of cold weather-warming irrigation water, frost prevention, modification of advected cold wind.

UNIT IV

Modification of microclimate due to cultural practices, intercropping; influence of topography on microclimate; microclimates within forest and climatic influences of forest, influence of forest on precipitation; microclimatology and topoclimatology; microclimates of low plant cover; microclimate of meadows and grain fields; influences of kind, colour and condition of soil on microclimates.

Suggested Readings

Anonymous 2003. *Critical Issues in Weather Modification Research Board of Atmoshperic Science and Climate*. National Research Council, USA.

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Chritchfield HJ. 1994. *General Climatology*. Prentice Hall.

Geiger, R. 1965. *The Climate near the Ground.* Harvard University Press.

Lenka D. 1998. *Climate, Weather and Crops in India*. Kalyani.

Mavi HS & Graeme J Tupper 2004. *Agrometeorology: Principles and Applications of Climate Studies in Agriculture.* The Haworth Press.

Mavi HS. 1994. *Introduction to Agrometeorology*. Oxford & IBH.

Menon PA. 1989. *Our Weather.* National Book Trust.

Oke, T. R. 1987. *Boundary Layer Climates.* Methuen, London.

Pearce RP. 2002. *Meteorology at the Millennium*. Academic Press.

Rosenberg NJ, Blad BL & Verma SB. 1983. *Microclimate – The Biological Environment.* John Wiley & Sons.

Samra JS, Pratap Narain, Rattan RK & Singh SK. 2006. *Drought Management in India*. Bull. Indian Society of Soil Science 24, ISSS, New Delhi.

Wegman & Depriest 1980. *Statistical Analysis of Weather Modification Experiments*. Amazon Book Co.

WMO. 1975. *Drought and Agriculture.* Technical Note No. 138, WMO NO. 392, WMO, Switzerland.

AGM 506 AGRICULTURAL CLIMATOLOGY 3+1

Objective

To impart the theoretical and practical knowledge of computation of different bio-parameters and their applications in the agriculture.

Theory

UNIT I

Phenology and seasonal changes of weather conditions; crop climatology-thermoperiodism, photoperiodism, heat unit concepts and its applications; thermal indices and phenology: cardinal temperatures; heat unit and growing degree day concepts for crop phenology, crop growth and development; insect-pest development; agroclimatic requirement of crops.

UNIT II

Hydrological cycle: precipitation intensity, evaporation, infiltration, runoff, soil storage and hydrological balance; climatic water budgeting techniques and its applications in evaluation of moisture availability periods within crop growing seasons; planning of multiple cropping pattern for different soil climatic zones on India; potential and actual evapotranspiration and their computation; calculation of water surplus and deficit; computation of daily and monthly water budget and their applications; assessment of dry and wet spells, available soil moisture, moisture adequacy index and their applications.

UNIT III

Influence of agrometeorological factors on incidence of pests and diseases and timing and effectiveness of control measures; special weather forecast: frost, insect, pest and disease, drought, high winds, heat waves, rainfall and monsoon onsets; crop protection from weather hazards: protection from frosts, forest fire, meteorological aspects of forest fires and their control, drought, flood, wind breaks and shelter belts; principles of cloud seeding; insect-pest development.

UNIT IV

Weather forecasting: importance, types, tools and modern techniques of weather forecasting; crop weather charts, calendars and diagrams; weather forecasting and agroadvisories; crop weather calendar; general forecasting: short, medium and long range forecasting for agriculture; use of satellite cloud imageries and synoptic approach to weather forecasting.

UNIT V

Bioclimatic concepts: evaluation of human comfort, comfort indices (temperature, humidity index and wind chill) and clothing insulation; climate, housing and site orientation; climatic normal for animal production.

Practical

- Calculation of heat units for different crops.
- Water balance computation by book keeping method and evaluation of growing period for multiple cropping.
- Assured rainfall analysis.
- Computation of moisture availability indices by Hargreave's method.
- Preparation of crop weather calendars for major crops.
- Preparation of agroadvisories based on medium range weather forecasts.
- Determination of onset and withdrawal of monsoon in west Bengal.
- Estimation of agro-meteorological variables using historical records.
- Evaluation of radiation, wind and shading effects in site selection and orientation.
- Study of weather-pest and disease interactions, calculation of continentality factors; calculation of comfort indices and preparation of climograph.

Suggested Readings

Anonymous 1980. *ICRISAT Climatic Classification – A Consultation Meeting*. ICRISAT.

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Lal DS. 1989. *Climatology*. Chaitanya Publ. House.

Lenka, D. 1998. *Climate, weather and Crops in India.* Kalyani Publishers.

Mather JR. 1977. *Work Book in Applied Climatology*. Univ. of Delware, New Jersey.

Mavi HS & Tupper Graeme J. 2004. *Agrometeorology: Principles and Applications of Climate Studies in Agriculture*. The Haworth Press.

Raj Singh, Diwan Singh & Rao VUM. 2006. *Manual on Applied Agricultural Climatology*. Dept of Agril Meteorology, CCS HAU Hisar, India.
Subramaniam VP. 1977. *Incidence and Spread of Continental Drought*. WMO/IMD Report No. 2, WMO, Geneva, Switzerland.
Thompson R. 1997. *Applied Climatology: Principles and Practice*. Routledge.
Walter J Saucier 2003. *Principles of Meteorological Analysis*. Dover Phoenix Eds.

AGM 507 MICROMETEOROLOGY 3+1

Objective

To impart the theoretical and practical knowledge of physical processes occurring in lower atmosphere.

Theory

UNIT I

Meaning and scope of micrometeorology; concepts of micro, meso and macro meteorology; independent and dependent microclimate; importance of lower regions of atmosphere; micrometeorological processes near bare ground and crop surfaces; atmosphere near the ground; distribution of important meteorological parameters in the boundary layers.

UNIT II

Properties of atmosphere near the earth's surface; exchange of mass momentum and energy between surface and overlaying atmosphere, exchange coefficient, similarity hypothesis, shearing stress, forced and free convection**.**

UNIT III

Atmospheric diffusion; fluxes of different gases from vegetation and their influence in global climate change; molecular and eddy transport of heat, water vapour and momentum, frictional effects, eddy diffusion, mixing; boundary layer, friction velocity, roughness length and zero-plane displacement; temperature instability, air pollution; microclimate near the bare ground, unstable and inversion layers, variation in microclimate under irrigated and rainfed conditions, soil moisture and temperature variation with depth; Richardson number, laminar and turbulent conditions, Reynold’s analogy, exchange coefficient relationships application of turbulent transfer processes to agricultural phenomenon such as photosynthesis under field condition; wind profile near the ground; remote sensing in relation to micrometeorology.

UNIT IV

Micrometeorology of plant canopies; distribution of temperature, humidity, vapour pressure, wind and carbon dioxide profiles in the crop canopies; fluxes of water vapour, CO_2, and heat inversion and its effect on smoke plume distribution; instruments and measuring techniques in micrometeorology.

UNIT V

Spectral properties of vegetation: light interception by crop canopies as influenced by leaf area index, leaf arrangement and leaf transmissibility, extinction coefficient; effects of ambient weather conditions on growth, development and yield of crops; measurement of global and diffuse radiation; measurement of albedo over natural and cropped surfaces; net radiation measurement at different levels; PAR distribution in plant canopies and interception; wind, temperature and humidity profiles in short crops and tall crops; energy balance over crops and LAI and biomass estimation; radiation distribution and utilization by plant communities, leaf temperature and its biological effects; influences of slopes and topography on insolation, temperature and wind.

Practical

- Micrometeorological measurements in crop canopies and to fit the observed parameters in aerodynamic and energy balance equation.
- Determination of roughness parameters and zero-plane displacement.
- Determination of Reynold and Richardson Number to understand stability conditions of the atmosphere.
- Methods of measuring energy transfer.
- Use of micrometeorological instruments like pyranometer, albedometer, net radiometer, pyrheliometer, pyrgeometer, quantum sensor, psychrometer etc.
- Profile measurement of different micrometeorological parameters in crop and soil.
- Quantification of crop microclimate.

Suggested Readings

Arya S Pal. 1988. *Introduction to Micrometeorology*. Academic Press.
Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.
Gates DM. 1968. *Energy Exchange in the Biosphere*. UNESCO.
Goudriaan J. 1983. *Crop Micrometeorology: A Simulation Study*. Scientific Publ.
Grace J. 1983. *Plant Atmospheric Relationships: Outline Studies in Ecology*. Chapman & Hall.
Gupta PL & Rao VUM. 2000. *Practical Manual on Micrometeorology*. Dept. of Agril. Meteorology, CCS HAU Hisar, India.
Jones HG. 1992. *Plants and Microclimate*. Cambridge Univ. Press.
Lenka, D. 1998. *Climate, weather and Crops in India.* Kalyani Publishers.
Monteith, JL. (Ed.). 1972. *Instruments for Micrometeorology.* (IBP Handbook No. 22). Blackwells Scientific Publications.
Munn RE. 1970. *Biometeorological Methods*. Academic Press.
Rosenberg NJ. 1974. *Microclimate – The biological Environment*. John Wiley & Sons.
Sellers W. 1967. *Physical Climatology*. The University of Chicago Press.

AGM 510 AGROMETEOROLOGICAL MEASUREMENTS AND INSTRUMENTATIONS 1+2

Objective

To impart the theoretical and practical knowledge of instruments/equipments used for measurement of agrometeorological variables.

Theory

UNIT I

Agromet observatory: site selection, layout, kinds, instruments, order of observations, times of observations in IST and LMT, exposure, operation, care, maintenance, calibration, detection of defects and rectification; working principles of thermometers, grass minimum thermometer, open pan evaporimeter, soil thermometers, sunshine recorder, anemometer, anemograph, wind vane Duvdevani dew gauge, dew recorder; wind speed estimation by Beaufort Scale; routine measurements, computation and interpretation of all meteorological elements.

UNIT II

Fundamentals of measurement techniques; theory and working principles of radiation instruments: pyranometer, albedometer, photometer, spectro-radiometer, quantum radiation sensors, infrared thermometer, net radiometer, pressure bomb apparatus, porometer, photosynthesis system, leaf area meter, etc along with their descriptions, measurements, care, maintenance, calibration, detection of flaws and their repairs; soil heat flux plates; instruments

for measuring soil moisture. Automatic weather stations: data logger and sensors, computation and interpretation of data.

UNIT III

Theory and working principles of psychrometers, hair hygrograph, thermograph, self recording rain gauge, lysimeter, pyranograph, anemograph, barometer, barograph, etc along with their exposure, operation, measurements and interpretation.

Practical

- Working with the above instruments in the meteorological observatory and taking routine observations of relevant parameters and their interpretation.
- Computation of derived parameters and interpretation.
- Calibration of thermometer and to find out its correction factor.
- To study the lag coefficient of a thermometer.
- To prepare a thermocouple and to calibrate it.
- To get acquaintance with instruments in automatic weather station.
- Use of micrometeorological instruments: pyranometer, albedometer, net radiometer, pyrheliometer, pyrgeometer, heat flux plates, quantum sensor and luxmeter in the crop field.
- Use of psychrometers, hair hygrograph, thermograph, self recording rain gauge and lysimeter.
- Basic concepts of data logging, and introduction and use data loggers, and programming of data loggers.

Suggested Readings

Anonymous. 1987. *Instructions to Observers at Surface Observatories*. Part I, IMD, New Delhi.

Byers HR. 1959.*General Meteorology.* McGraw Hill.

Doorenbos, J. 1976. *Agro-meteorological Field Stations*. FAO.

Fritschen, LJ and Gay, LW. 1979. *Environmental Instrumentation.* Spriger-Verlag.

Ghadekar SR. 2002. *Practical Meteorology: Data Acquisition Techniques, Instruments and Methods*. Agromet Publ.

Middleton WE & Spilhaws AF. 1962. *Meteorological Department*. University of Toronto Press.

Monteith, JL. (Ed.). 1972. *Instruments for Micrometeorology.* (IBP Handbook No. 22). Blackwells Scientific Publications.

Tanner CB. 1973. *Basic Instrumentation and Measurements for Plant Environment and Micrometeology.* University of Wisconsin, Madison.

WMO. 1974. *Guide to Meteorological Practices.* WMO No. 134.

AGM 511 AGROMETEOROLOGICAL ASPECTS OF CROP PROTECTION 2+1

To impart knowledge on management and forecast of pests and diseases in relation to agrometeorological parameters.

Theory

UNIT I

Meteorological factors associated with incidence and development of crop pests and diseases such as rust diseases, potato blight, apple scab, ground nut red hairy caterpillar and other major pests and diseases of West Bengal.

UNIT II

Meteorological aspects of protection against plant diseases, weeds and insect pests with special reference to locust and other insect pests with long range migration. Locust meteorology.

UNIT III

Application of weather forecast and weather advisories to operational crop protection. Preparation and dissemination of weather based information and warning of pest and disease control. Economic importance of agrometeorological input to operational crop protection.

UNIT IV

Aerobiometeorology-its role in integrated disease and pest management, insect movement in atmosphere-effect of temperature, humidity, wind and rain on the dispersal, immigration and emigration of pests and pathogens.

UNIT V

Role of agrometeorology in forecasting disease and pest outbreak. Climatological models for forecasting of pests and diseases. Meteorological data requirement for crop protection.

Practical

- Effects of meteorological factors on growth and development of pests and diseases.
- Sampling, measurement and population studies.
- Analysis and modeling of pest and disease-operational graphical models for monitoring of pest and disease development using routine weather observation.
- Weather based modeling of pests outbreak and recommendations.
- Weather based modeling of disease outbreak and their recommendations.

Suggested Readings

Lenka, D. 1998. *Climate, weather and crops in India*. Kalyani Publishers.

Pedgley, D. E. 1980. *Weather and Airborne Organisms.* WMO- No. 562, WMO, Geneva, Switzerland.

Venkataraman, S. and Krishnan, A. 1992. *Crops and Weather.* I. C. A. R.

WMO. 1988. *Agrometeorological aspects of operational crop protection*. Technical Note NO. 192, WMO-No. 687, WMO.

AGM 513 CROP WEATHER MODELS 2+1

Objective

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

Theory

UNIT I

Principles of crop production; evaluation of crop responses to weather elements; impact of natural and induced variability of climate on crop production.

UNIT II

Introduction and application of crop modeling, types of models, concepts of mechanistic and deterministic models; empirical and statistical crop weather models and their application with examples; regression models-incorporating weather, soil, plant and other environmental related parameters and remote sensing inputs; growth and yield prediction models; general features of dynamic and statistical modeling techniques; measures of central tendency and dispersion, correlation, regression moving average, probability and their distribution function; weather data and physiology-based approaches to modeling of crop growth and yield; stochastic models; advantages and limitation of modeling.

UNIT III

Crop simulation models, e.g. CERES, WOFOST, SPAW, RESCAP, WTGROW, ect; use of crop simulation model in determining climatic change, green house effect, CO_2 increase, global warming and their impact on agriculture; verification, calibration and validation of models.

Practical

- Working with statistical and simulation models, DSSAT models, BRASSICA, RESCAP etc.
- To develop linear regression models involving weather data and yield of principal crops.
- To develop nonlinear regression models involving weather data and yield of principal crops.
- To determine the impact of elevated CO_2 scenarios on principal crops.
- To determine the impact of elevated temperature scenarios on principal crops.
- To develop relationships between PAR and photosynthetic rate.

Suggested Readings

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Setlik, I. (ED.). 1970. *Prediction and Measurement of Photosynthetic Activity.* Proc. Int. Biological Programme/Plant Physiology Tech. Meeting, Trebon, PUDOC, Wageningen.

Baker, DN. (Ed.). 1973. *The Application of Systems Methods to Crop Production.* Mississippi State Univ, Mississipi, USA.

Frere M & Popav G F. 1979. *Agrometeorological Crop Monitoring and Forecasting*. FAO.

Hanks RJ. 1974. Model for Predicting Plant Yield as Influenced by Water Use. *Agron. J.* 66: 660-665.

Keulen H Van & Seligman NG. 1986. *Simulation of Water Use, Nitrogen Nutrition and Growth of a Spring Wheat Crop.* Simulation Monographs. PUDOC, Wageningen.

AGM 514 CLIMATE RISK MANAGEMENT 2+0

Objective

To impart the theoretical knowledge and techniques of climate risk management strategies.

Theory

UNIT I

Risks in agricultural production, history of weather and climate as accepted risk factors in agriculture in the continent/region/country/sub-region concerned and the related documented risk concepts; history and trends of defense strategies towards such risks in the same continent region/country/sub-region; preparedness for weather and climate risks.

UNIT II

Risks of droughts; monitoring, prediction and prevention of drought; drought proofing and management; modern tools including remote sensing and GIS in monitoring and combating droughts.

UNIT III

Risk characterization - definitions and classification of risks; characterization of weather and climate related risks in agriculture; water related risks; radiation/heat related risks; air and its movement related risks; biomass related risks; social and economic risk factors related to weather and climate.

UNIT IV

Approaches and tools to deal with risks - history of methods for weather and climate related risk assessments in the continent/region/country/subregion concerned and their documented evidence of application to agricultural/farming systems; strategies dealing with risks- mitigating practices

before occurrence; preparedness for the inevitable; contingency planning and responses; disaster risk mainstreaming.

UNIT V

Perspectives for farm applications - farm applications not yet dealt with, such as making risk information products more client friendly and transfer of risk information products to primary and secondary users of such information; heterogeneity of rural people in education, income, occupation and information demands and consequences for risk information products and their transfer; livelihood-focused support, participation and community perspectives; challenges for developing coping strategies including transferring risks through insurance schemes.

UNIT VI

Challenges to coping strategies - combining challenges to disaster risk mainstreaming, mitigation practices, contingency planning and responses, basic preparedness; preparedness approaches reducing emergency relief necessities; the role that insurances can play in risk spreading and transfer; quantification of risk in agricultural systems associated with weather and climate; methods for risk assessment and application to agricultural systems of local and regional interest; application of risk management approaches to problems associated with weather and climate problems; application of methods that permit the incorporation of seasonal and long-term forecasts into the risk assessment models.

Suggested Readings

Anonymous 2003. *Critical Issues in Weather Modification Research Board of Atmoshperic Science and Climate*. National Research Council, USA.

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Chritchfield HJ. 1994. *General Climatology*. Prentice Hall.

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Mavi HS & Graeme J Tupper 2004. *Agrometeorology: Principles and Applications of Climate Studies in Agriculture.* The Haworth Press.

Mavi HS. 1994. *Introduction to Agrometeorology*. Oxford & IBH.

Menon PA. 1989. *Our Weather.* National Book Trust.

Pearce RP. 2002. *Meteorology at the Millennium*. Academic Press.

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AGM 512 AGROMETEOROLOGICAL DATA MANAGEMENT 1+2

Objective

To impart knowledge on management of agromet data and train the students in analysis and commercialization of agrometeorological data

Theory

UNIT I

Data and information; types of data; climate, soil and crop data; Importance of database management; data requirements; data collection and recording (Automatic and manual).

UNIT II

Data structure/format; quality control of data; techniques of climatic data generation; missing data; introduction to different software for database management.

UNIT III

Processing and analysis of data and data products; value addition of data and data products; data users, public, commercial, academic or research.

UNIT IV

Availability, accessibility and security of data; evaluating the cost of data; e-management of data.

UNIT V

Climatic statistics: measures of central tendency and variability, skewness, kurtosis, homogeneity, correlation, regression and moving averages; probability analysis using normal, binomial, Markov-chain and incomplete gamma distribution; parametric and non parametric tests; assessment of frequency of disastrous events.

UNIT VI

Probabilities of monthly and weekly rainfall; frequency and probability of dry and wet spells; onset and end of rainy seasons based on backward and forward accumulation of rainfall; relationship between bright sun shine hours and global radiation; calculation of length of growing season, surplus and deficit by Thornthwaite and Mather (1955) water balance method; calculation of water requirement, deficit and water requirement satisfaction index by FAO method.

Practical

- Types of instruments and data recording
- AWS data retrieval, storage and transfer
- Exposure to different software for Agromet data analysis; exposure to Statistical software
- Temporal and spatial analysis of data; exposure to GIS
- Value addition to data
- Introduction to internet protocols
- Uploading and downloading data, password and security of data
- E-management of data
- Application of data management tools in agroclimatic analysis.

Suggested Readings

Ghadekar R. 2002. *Practical Meteorology – Data Acquisition Techniques,Instruments and Methods*. 4th Ed. Agromet Publ.

IMD/ WHO. 1988. *Users Requirements for Agrometeorological Services*. IMD.

Mather, JR. 1974. *Climatology: Fundamentals and Applications*. McGraw-Hill.

Mather JR. 1977. *Work Book in Applied Climatology*. Univ. of Delware, New Jersey.

Miles MB & Huberman AM. 1994. *Qualitative Data Analysis*. Sage Publ.

Panse VG & Sukhatme PV. 1983. *Statistical Methods for Agricultural Workers,* ICAR.

Potter GB. 1994. *Data Processing: An Introduction*. Business Publ.

Ramakrishnan R. & Gehrke J. 2003. *Database Management System.* McGraw-Hill.

AMP 649 SEMINAR- I 0+1 3rd Semester

AMP 899 SEMINAR-II 0+1 4th Semester

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