



# Mahatma Phule Krishi Vidyapeeth Rahuri-413 722, Dist. Ahmednagar (MS)

## Master's Programme in Agricultural Meteorology

### Course Layout

#### Minimum Credit Requirements

Sr. No.	Subject	Minimum credit(s)
1.	Major	20
2.	Minor	09
3.	Supporting	05
4.	Seminar	01
5.	Research	20
	<b>Total Credits</b>	<b>55</b>
	Compulsory Non Credit Courses	06

Sr. No.	Course Number	Course Title	Credits
<b>A) Major subjects (Min. 20 credits)</b>			
1	AGM 501	Fundamentals of Meteorology And Climatology	2+1=3
2	AGM 502	Fundamentals of Agricultural Meteorology	2+1=3
3	AGM.503	Micrometeorology	2+1=3
4	AGM 504	Agro-Meteorological Measurements and Instrumentation	1+2=3
5	AGM 505	Soil Water Balance Climatology	2+1=3
6	AGM 506	Crop Weather Models	1+2=3
7	AGM 509	Applied Agricultural Climatology	1+2=3
<b>B) Minor Subjects (Min. 9 credits)</b>			
1	AGM 510	Aerobiometeorology	2+1=3
2	AGRON 505	Agrometeorology and Crop Weather Forecasting	2+1=3
3	AGM 507	Weather Modification and Risk Managemant Strategies	2+1=3

<b>C) Supporting Subjects (Min. 6 credits)</b>			
1	STAT 511	Stastical Methods for Applied Sciences	2+1=3
2	STAT 512	Experimental Design	2+1=3
<b>D) Seminar (1 credit)</b>			
1	AGM 591	Masters Seminar	1+0=1
<b>E) Master's Research (20 credits)</b>			
1	AGM 599	Master's Research	20
<b>F) Non Credit Compulsory Courses</b>			
1	PGS 501	Library and Information Services	0+1=1
2	PGS 502	Technical Writing and Communication Skills	1+0=1
3	PGS 503	Intellectual Property and its Management in Agriculture	1+0=1
4	PGS 504	Basic Concepts in Laboratory Techniques	0+1=1
5	PGS 505	Agricultural Research Ethics and Rural Development Programme	1+0=1
6	PGS 506	Disaster Management	1+0=1

## Course Contents

### A) Major Subjects:

#### 1. AGM 501: FUNDAMENTALS OF METEOROLOGY AND CLIMATOLOGY 2+1

##### Theory:

##### UNIT I

Solar radiation and laws of radiation; greenhouse effect, albedo, and heat balance of the earth and atmosphere; variation of pressure and temperature with height, potential temperature, pressure gradient, cyclonic and anticyclonic motions; geostrophic and gradient winds; equations of motion; general circulation, turbulence, vorticity, atmospheric waves.

##### UNIT II

Gas laws, laws of thermodynamics and their application to atmosphere; water vapour in the atmosphere, various humidity parameters and their interrelationships; vapour pressure, psychrometric equation, saturation deficit, stability and instability conditions in the atmosphere.

##### UNIT III

Lapse rates-ascent of dry and moist air, condensation; clouds and their classification; evaporation and rainfall; the hydrological cycle; precipitation processes, artificial rainmaking, thunderstorms and dust storm; haze, mist, fog, and dew; air masses and fronts; tropical and extra-tropical cyclones.

##### UNIT IV

Effect of earth's rotation on zonal distribution of radiation, rainfall, temperature, and wind; the trade winds, equatorial trough and its movement; the SE Asia monsoon.

##### UNIT V

Crop weather charts, calendars and diagrams; weather forecasting importance, types, tools, and modern techniques of weather forecasting; El Nino, la Nino and ENSO.

##### UNIT VI

Instruments for measurement of meteorological elements; agromet observatory; measures of central tendency and dispersion, correlation, regression, moving average probability and their distribution function; water budgeting; synoptic, numerical, graphical, spatial analysis of weather systems and charts technique.

##### Practical:

- Agromet observatory- different classes of observatories (A, B, C)
- Site selection and installation procedures for meteorological instruments
- Measurement of weather parameters.
- Reading and recording, calculation of daily, weekly, monthly means.
- Totals of weather data.

- Climatic normals, weather chart preparation and identification of low pressure systems and ridges.
- Statistical technique for computation of normals, moving average, marton chain model etc.

### **Suggested Readings:**

- Barry RG & Richard JC. 2003. *Atmosphere, Weather and Climate*. Tailor & Fransics Group. 170
- Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.
- Ghadekar SR. 2001. *Meteorology*. Agromet Publ.
- McIlveen 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.

## **2. AGM 502: FUNDAMENTALS OF AGRICULTURAL METEOROLOGY**

### **2+1**

### **Theory**

#### **UNIT I**

Meaning and scope of agricultural meteorology; components of agricultural meteorology; role and responsibilities of agricultural meteorologists.

#### **UNIT II**

Importance of meteorological parameters in agriculture; efficiency of solar energy conversion into dry matter production; meteorological factors in photosynthesis, respiration and net assimilation; basic principles of water balance in ecosystems; soil-water balance models and water production functions.

#### **UNIT III**

Crop weather calendars; weather forecasts for agriculture at short, medium and long range levels; agromet advisories, preparation, dissemination and economic impact analysis; use of satellite imageries in weather forecasting; synoptic charts and synoptic approach to weather forecasting.

#### **UNIT IV**

Concept, definition, types of drought and their causes; prediction of drought; crop water stress index, crop stress detection; air pollution and its influence on vegetation.

#### **UNIT V**

Meteorological aspects of forest fires and their control; concepts of mechanistic and deterministic models; general features of dynamical and statistical modeling techniques; weather data and phenology-based approaches to crop modeling; validation and testing of models.

## UNIT VI

Climatic change, green house effect, CO<sub>2</sub> increase, global warming and their impact on agriculture; concept and types of drought; climate classification, agro-climatic zones and agro-ecological regions of India.

### Practical:

- Preparation of crop weather calendars
- Development of simple regression models for weather, pest and disease relation in different crops.
- Preparation of weather based agro-advisories
- Use of automated weather station (AWS)

### Suggested Readings:

- Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.
- Kakde JR. 1985. *Agricultural Climatology*. Metropolitan Book Co. 171
- Varshneya MC & Pillai PB. 2003. *Text Book of Agricultural Meteorology*. ICAR.

## 3. AGM 503: MICROMETEOROLOGY 2+1

### Theory:

#### UNIT I

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 II

Molecular and eddy transport of heat, water vapour and momentum, frictional effects, eddy diffusion, mixing; 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, Raymonds analogy, Exchange coefficients.

#### UNIT III

Micrometeorology of plant canopies; distribution of temperature, humidity, vapour pressure, wind and carbon dioxide; modification of microclimate due to cultural practices, intercropping; radiation distribution and utilization by plant communities, leaf temperature and its biological effects; influence of topography on microclimate; shelter belts and wind breaks, microclimate in low plant area of meadows and grain fields, microclimate within forests, glass house and plastic house climates; instruments and measuring techniques in micrometeorology.

#### UNIT IV

Effects of ambient weather conditions on growth, development and yield of crops; measurement of global and diffuse radiation; measurement of albedo over natural surfaces and cropped surfaces; net radiation measurement at different levels; PAR

distribution in plant canopies and interception; wind, temperature and humidity profiles in (a) short crops and (b) tall crops; energy balance over crops and LAI and biomass estimation; remote sensing in relation to micrometeorology.

**Practical:**

- Micrometeorological measurements in crop canopies
- Quantification of crop microclimate
- Determination of ET and its computation by different methods

**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. 172
- 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.
- 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.

**4. AGM 504: AGRO-METEOROLOGICAL MEASUREMENTS AND INSTRUMENTATION 1+2**

**Theory:**

**UNIT I**

Fundamentals of measurement techniques; theory and working principles of barometers, thermometers, psychrometers, hair hygrometer, thermo- hygrograph; exposure and operation of meteorological instruments/ equipments in agromet observatories.

**UNIT II**

Radiation and temperature instruments: working principles of albedometer, photometer, spectro-radiometer, sunshine recorder, dew recorder, quantum radiation sensors, pressure bomb apparatus, thermographs, and infra-red thermometer.

**UNIT III**

Precipitation and dew instruments: working principles of rain gauge, self recording rain gauge, Duvdevani dew gauges.

**UNIT III**

Wind instruments: working principles of anemometer, wind vane, anemograph.

#### **UNIT IV**

Evapotranspiration and photosynthesis instruments: working principles of lysimeters, open pan evaporimeters, porometer, photosynthesis system, leaf area meter.

#### **UNIT V**

Soil thermometers, soil heat flux plates, instruments for measuring soil moisture.

#### **UNIT VI**

Automatic weather station – data logger and sensors, nano-sensors for measurement of weather variables; computation and interpretation of data.

#### **Practical:**

- Working with the above instruments in the meteorological observatory taking observations of relevant parameters
- Computation interpretation of the data

#### **Suggested Readings:**

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

Byers HR. 1959. *General Meteorology*. McGraw Hill. 173

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

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

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

### **5. AGM 505 SOIL WATER BALANCE CLIMATOLOGY 2+1**

#### **Theory:**

##### **UNIT I**

Basic Laws of radiation; radiation interaction with plant environment; energy balance in atmosphere, crop canopy.

##### **UNIT II**

Atmosphere near the ground; laminar and turbulent flows; wind profile near the ground.

##### **UNIT III**

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.

##### **UNIT IV**

Influence of microclimatic, plant, soil and cultural factors; techniques of lysimetry in measuring actual evapotranspiration.

## UNIT IV

Yield functions; water use efficiency and scheduling of irrigation based on evapotranspiration; water use efficiency and antitranspirants, Kc values and their use, dry matter yield ET functions; radiation instruments; advanced techniques for measurement of radiation and energy balance; computation of KC values and their use; estimation of evapotranspiration through satellite imageries – MODIS, TERRA, AQUA, AVHRR, NOVA etc.; modeling for potential ET & reference ET, and ET through remote sensing.

### Practical:

- Measurement and evaluation of radiation components
- Computation and comparison of evapotranspiration by different methods - energy balance method, aerodynamic method, Penman method, remote sensing and other methods
- Measurement of wind and temperature profiles near the ground

### Suggested Readings:

- Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.
- Burman R & Pochop LO. 1994. *Evaporation, Evapotranspiration and Climatic Data*. Elsevier.
- Grace J.1983. *Plant Atmospheric Relationships: Outline Studies in Ecology*.
- Mavi HS & Graeme J Tupper 2004. *Agrometeorology: Principles and Applications of Climate Studies in Agriculture*. The Haworth Press. 174
- 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.

## 6. AGM 506 : CROP WEATHER MODELS 1+2

### 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

Empirical and statistical crop weather models their application with examples; regression models- incorporating weather, soil, plant and other environmental related parameters and remote sensing inputs; growth and yield prediction models; crop simulation models, e. g. CERES, WOFOST, SPAW, RESCAP, WTGROW etc.; forecasting of pests and diseases; verification, calibration and validation of models.

### Practical

- Working with statistical and simulation models, DSSAT models, BRASSICA, RESCAP etc.

## Suggested Readings

- Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.
- DeWit CT, Brouwer R & de Vries FWTP. 1970. The Simulation of Photosynthetic Systems. pp. 7-70. In. *Prediction and Measurement of Photosynthetic Activity*. Proc. Int. Biological Programme Plant Physiology Tech. Meeting Trebon PUDOC. Wageningen.
- Duncan WG. 1973. SIMAI- A Model Simulating Growth and Yield in Corn. In: *The Application of Systems Methods to Crop Production* (D.N. Baker, Ed.). Mississippi State Univ. Mississippi.
- Frere M & Popav G. 1979. *Agrometeorological Crop Monitoring and Forecasting*. FAO.
- Hanks RJ. 1974. Mode 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.

## 6. AGM 509: APPLIED AGRICULTURAL CLIMATOLOGY 1+2

### Theory:

#### UNIT I

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 II

Hydrological cycle: precipitation intensity, evaporation, infiltration, runoff, soil storage and hydrological balance.

#### UNIT III

Climatic water budget: potential and actual evapotranspiration and their computation; measurement of precipitation, 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 IV

Thermal indices and phenology: cardinal temperatures; heat unit and growing degree day concepts for crop phenology, crop growth and development; insect-pest development; crop weather calendars; agroclimatic requirement of crops.

#### 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 normals for animal production.

## Practical:

- Use of statistical approaches in data analysis
- Preparation of climatic water budget
- Estimation of agro-meteorological variables using historical records
- Degree day concept and phenology forecasting and preparation of crop calendar
- 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.
- Mather JR. 1977. *Work Book in Applied Climatology*. Univ. of Delaware, 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. 179

## B) Minor Subjects:

### AGM 507: WEATHER MODIFICATION AND RISK MANAGEMENT STRATEGIES 2+0

#### Theory:

#### UNIT I

Historical reviews of weather modification, present status of weather modification for agriculture; atmo-spheric composition and green house effect.

#### UNIT II

Theories of weather modification; scientific advances in clouds and electrical behavior of clouds; hails suppression, dissipation of fog, modification of frost intensity and severe storms; shelter belts and wind breaks, mulches and anti-transpirants; protection of plants against climatic hazards; air and water pollution; meteorological conditions in artificial and controlled climates - green, plastic, glass and animal houses etc.

#### UNIT III

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 IV

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 VI**

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 VII**

Approaches and tools to deal with risks - history of methods for weather and climate related risk assessments in the continent/region/country/sub- region concerned and their documented evidence of application to agricultural/farming systems; strategies of dealing with risks- mitigating practices before occurrence; preparedness for the inevitable; contingency planning and responses; disaster risk mainstreaming.

#### **UNIT VIII**

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 IX**

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 Atmospheric Science and Climate*. National Research Council, USA.
- Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford BookCo.
- Chritchfield HJ. 1994. *General Climatology*. Prentice Hall. 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.
- 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.

**Theory:**

Definitions and structure of aerobiometeorology, Role of aerobiometeorology and biogeography in forecasting pests and diseases outbreak, Overall approach to insect problems in agriculture, Insect movement in the atmosphere, Effect of temperature, humidity, wind and rain as the dispersal, Immigrates and emigraties of pest and pathogens, Management of plant pathogens, Modification of plant canopy and its impact on plant diseases, Role of aerobiometeorology in integrated pest and diseases management programme. Effect of sudden weather changes on the population built up of pest and diseases, Swarma of locusts and other insects in relation to weather, Air pollution and Plant injury, acid rains.