Syllabus details from UASD

Additional relevant topics on climate change to strengthen the existing courses

UAS Dharwad has already several UG and PG level courses related to climate change. However based on the training of ten faculty/scientists from UAS Dharwad, it is proposed to strengthen these courses with the addition of a few relevant topics on climate change. The proposed additional topics are highlighted in bold and italics background.

UG level courses:

1) AGR 102 - Introductory Agrometeorology & Climate Change (1+1)
2) AEC 201 - Farm Management, Production and Resource Economics (1+1)
3) BTH 302 - Fundamentals of Plant Biotechnology (2+0)

PG level courses:

1) MBB 555 - Introduction to Bioinformatics (1+1)
2) AGR 505 - Agrometeorology and Crop Weather Forecasting (2+1)
3) GPB 509 - Biotechnology for Crop Improvement (2+1)
4) SOL 515 - Land Degradation and Restoration (1+0)
5) SAF 206 - Agroforestry Systems and Management (2+1)
6) CPH 504 - Physiological and Molecular Responses of Plants to Abiotic Stresses (2+1)

Under-Graduate courses

1) AGR 102 - Introductory Agrometeorology & Climate Change (1+1)

Theory:

Earth atmosphere- its composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze; Nature and properties of solar radiation, solar constant, depletion of solar radiation, short wave, long wave and thermal radiation, net radiation, albedo; Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, Energy balance of earth; Atmospheric humidity, concept of saturation, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; Artificial rainmaking. Monsoon- mechanism and importance in Indian agriculture, Weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave. Agriculture and weather relations; Modifications of crop microclimate, climatic normals for crop and livestock production. Weather forecasting- types of weather forecast and their uses. Climate change, climatic variability, ***greenhouse effect and*** global warming, causes of climate change and its impact on regional and national Agriculture; ***Climate-***

smart agriculture (CSA) – concept, scope and importance; CSA practices for adaptation and mitigation of climate change.

Practicals:

1. Visit and study of Agrometeorological Observatory, site selection of observatory, exposure of instruments and weather data recording.
2. Measurement of total, shortwave and long wave radiation, and its estimation using Planck's intensity law.
3. Measurement of albedo and sunshine duration, computation of Radiation Intensity using BSS.
4. Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis.
5. Measurement of soil temperature and computation of soil heat flux.
6. Determination of vapor pressure and relative humidity.
7. Determination of dew point temperature.
8. Measurement of atmospheric pressure and analysis of atmospheric conditions.
9. Measurement of wind speed and wind direction, establishment of windrows.
10. Measurement, tabulation and analysis of rain.
11. Measurement of open pan evaporation and evapotranspiration.
12. Computation of PET and AET. Agromet advisory services.

To be engaged:

Dr. S. B. Patil, Scientist (Agronomy), AICRP on Dry land Agriculture, RARS, Vijaypur, UAS, Dharwad.

(Instructor participated in the 4-Workshop training of AdaptNET)

2) AEC 201 - Farm Management, Production and Resource Economics (1+1)

Theory:

Farm Management: Meaning, definitions and Concepts of farm management: Nature and scope, objectives and relationship with other sciences, decisions making process; Meaning and definition of farms sizes: Based on holding and ownership, Types of farming and their characteristics, factors determining types and size of farms; Production economics and farm management principles: Meaning definition of production economics, concept of production function and its types, use of production function in decision-making on a farm, factor-product, factor-factor and product-product relationships. Law of equi-marginal returns or principles of opportunity cost and law of comparative advantage; Cost principle: Meaning and concept of costs, types of costs-Seven costs and applied cost concepts, and their interrelationships, importance of cost in managing farm business; Farm records: Types and importance of farm records and accounts in managing a farm; Farm planning and budgeting: Meaning and importance of farm planning and budgeting, partial and complete budgeting, steps in farm planning and budgeting-linear programming; Risk and uncertainty: Concept of risk and uncertainty in agriculture production, types/sources of risks and their management strategies. Crop/livestock/machinery insurance: Weather based crop insurance (WBCIS) and Pradhan Mantri Fasal Bhima Yojana (PMFBY), their features; Resource economics: Meaning of resource economics, differences between NRE and agricultural economics, unique properties of natural resources, positive and negative externalities in agriculture, inefficiency and welfare loss, solutions, management of

common property resources of land, water, pasture, fishery and forest resources. ***Climate Resilient Agriculture (CRA) through management of Natural Resource Economics (NRE): Concept, Scope and Importance***.

Practical:

Basic concepts in production economics & farm management; Study and visit to different farm layouts and appraisals of farm resources; Analysis of costs and revenue concepts; Computation of depreciation cost of farm assets; Determination of most profitable level of input use in a farm production process; Determination of least cost combination of inputs; Selection of most profitable enterprise combination; Application of equimarginal returns/opportunity cost principle in allocation of farm resources; Application of the principle of comparative advantage; Estimation of cost and returns using CACP cost concepts for crop, horticulture and livestock enterprises; Farm inventory analysis; Preparation of optimum farm plan using budgeting technique using partial and complete budgeting; Visit to farms to study farm records and accounts; Preparation of profit and loss accounts and balance sheet; Study of farm efficiency measures; Determinants of compensation for crop loss; Collection and analysis of data on various resources in India; Practical Examination.

To be engaged:

Dr. Basavraj Jamakhandi, Assistant Professor, Dept. of Agril. Economics, College of Agriculture, Vijaypur, UAS, Dharwad.
(Instructor participated in the 4-Workshop training of AdaptNET)

3) BTH 302 - Fundamentals of Plant Biotechnology (2+0)

Unit I: Introduction to Recombinant DNA Technology

Introduction and history Concepts and applications of plant biotechnology: Historical events in biotechnology; Scope and Importance, Importance in Agriculture: Importance in Industry: Cell: Plant cell structure, Nucleus, mitochondria, chloroplast and other cell organelles and their functions DNA structure and function: structure of nucleic acid-DNA/RNA, the DNA double helical structure - Watson and Crick, Structure of RNA, Differences between DNA and RNA, Properties of genetic materials Gene cloning steps: Common enzymes and vectors used in molecular cloning, transformation of *E. coli* and selection of recombinants, construction of genomic, cDNA libraries, isolation and cloning of coding parts of eukaryotic genes

Unit II: Application of Genetic Engineering in Crop Improvement

Gene transfer methods: Direct (Particle gun or Biolistic, Silicon carbide fibres, Electroporation, Chemically stimulated DNA uptake by protoplasts, Liposomes, Microinjection, Sonication) and indirect DNA transfer methods (*Agrobacterium tumefacians* mediated transformation) Transgenics and its importance: GMO, some example from plants and animals. Principles and applications of gene editing methods using zinc finger nucleases (ZFNs), TALENs and CRISPR-Cas. Biosafety measures and intellectual property rights as related to transgenic crops.

Unit III: Introduction to Marker-Assisted Breeding in Crop Improvement

Molecular markers, RAPD, RFLP, SSR, SNP etc, and their applications Genomic DNA isolation, PCR, gel electrophoresis (Agarose and PAGE), hybridization techniques. Working principles, advantages, disadvantages and applications of different molecular markers such as: RAPD, RFLP, SSR and SNP markers. Comparison of different marker systems.

Unit IV: Plant Tissue Culture for Crop Improvement

Concept of tissue culture: Terminology – Explant, differentiation, de-differentiation and re-differentiation. Callus, suspension culture. Definition, advantages and disadvantages, general applications. Embryo rescue and its significance: Events of embryogenesis, types of embryo culture (mature and immature), nutritional requirement of embryo culture, embryo rescue for abortive hybrid embryos, embryo nurse endosperm technique, applications

Micropropagation: Definition, stages of micropropagation, different routes of in-vitro clonal propogation – axillary buds/apical shoots, multiplication of adventitious shoots, organogenesis, somatic embryogenesis, differences between them.

Somaclonal variation and its use in crop improvement: Basic features of SCV, mechanism of SCV, causes of SCV, isolation of soma clones- with and without selection pressure.

Synthetic seeds and their significance: Somatic hybridization, cybrids and cryo-preservation

Use of tissue culture in biotechnology (transgenics and gene editing).

Use of biotechnology including transgenic approach to develop climate resilient crops.

To be engaged:

Dr. Basavraj Bagewadi, Assistant Professor, Dept. of Biotechnology, College of Agriculture, UAS, Dharwad.

Dr. Spurthi Nayak, Assistant Professor, Dept. of Biotechnology, College of Agriculture, UAS, Dharwad

(Instructors participated in the 4-Workshop training of AdaptNET)

Post-Graduate Courses

1) MBB555 - Introduction to Bioinformatics (1+1)

Theory:

UNIT I: Introduction, biological databases – primary, secondary and structural, Protein and Gene Information Resources – PIR, SWISSPROT, PDB, Gen bank, DDBJ. Specialized genomic resources. ***Next generation sequencing and introduction to data analysis using bioinformatics tools.***

UNIT II: DNA sequence analysis, cDNA libraries and EST, EST analysis, pairwise alignment techniques, database searching, multiple sequence alignment

UNIT III: Secondary database searching, building search protocol, computer aided drug design – basic principles, docking, QSAR.

UNIT IV: Analysis packages – commercial databases and packages, GPL software for Bioinformatics, web-based analysis tools.

Practical:

- Use of MS excel and access for database development
- Usage of NCBI resources
- Retrieval of sequence/structure from databases
- Visualization of structures
- BLAST exercises

- Primer designing
- Microsatellite marker development
- Phylogenetic/ diversity analysis
- Gene prediction
- ORF finding
- Other online software usage
- ***Examples of climate change (drought, heat, salinity) related data analysis***

To be engaged:
Dr. Spurthi Nayak, Assistant Professor, Dept. of Biotechnology, College of Agriculture, UAS, Dharwad
(Instructor participated in the 4-Workshop training of AdaptNET)

2) AGR 505 - Agrometeorology and Crop Weather Forecasting (2+1)

Theory:
Agro-meteorology - aim, scope and development in relation to crop environment; composition of atmosphere, distribution of atmospheric pressure and wind. Characteristics of solar radiation; energy balance of atmosphere system; radiation distribution in plant canopies, radiation utilization by field crops; photosynthesis and efficiency of radiation utilization by field crops; energy budget of plant canopies; environmental temperature: soil, air and canopy temperature, cardinal temperatures. Temperature profile in air, soil, crop canopies; soil and air temperature effects on plant processes; hydrological cycle, environmental moisture and evaporation: measures of atmospheric temperature and relative humidity; vapor pressure and their relationships; evapo-transpiration and meteorological factors determining evapotranspiration. Micro-climate, Modification of plant environment: artificial rain making, heat transfer, protection from cold, Earth's general circulation system, Rainfall types and forms, monsoon and their origin, characteristics of monsoon; onset, progress and withdrawal of monsoon; weather hazards, drought monitoring and planning for mitigation. Weather forecasting in India – short, medium and long range; aerospace science and weather forecasting; benefits of weather services to agriculture, remote sensing; application in agriculture and its present status in India; atmospheric pollution and its effect on climate and crop production; climate change and its impact on agriculture; ***climate change, greenhouse gases (GHGs), greenhouse effect and global warming; causes and impact of climate change on agriculture; climate-smart agriculture (CSA) – concept, scope and importance; CSA practices for adaptation and mitigation of climate change.***

Practical:
Visit to agro-meteorological observatory and to record sun-shine hours, wind velocity, wind direction, relative humidity, soil and air temperature, evaporation, precipitation and atmospheric pressure. Measurement of solar radiation outside and within plant canopy. Measurement/estimation of evapotranspiration by various methods. Measurement/estimation of soil water balance. Rainfall variability analysis. Study of isobars, isohyets and isotachs. Working out length of the growing period for different agro-climatic zones of State and agro-climatic regions of the country. Climatic classification by Thornthwaite and Mather. Determination of heat-unit requirement for different crops. Measurement of crop canopy temperature. Measurement of soil temperatures at different depths. Remote sensing and familiarization with agro-advisory service bulletins. Study of synoptic

charts and weather reports, working principle of automatic weather station. Visit to Class-I meteorological observatory and automatic weather station; ***estimation of climate change through trend analysis of rainfall and temperature.***

To be engaged:
Dr. S. B. Patil, Scientist (Agronomy), AICRP on Dry land Agriculture, RARS, Vijaypur, UAS, Dharwad.
Kumara, B. H., Scientist (Soil Science), AICRP on Dry land Agriculture, RARS, Vijaypur, UAS, Dharwad.
(Instructors participated in the 4-Workshop training of AdaptNET)

3) GPB 509 - Biotechnology for Crop Improvement (2+1)

Theory:
Unit I: Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding.
Unit II: Tissue culture- History, callus, suspension cultures; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.
Unit III: Techniques of DNA isolation, quantification and analysis; Sequencing techniques; Vectors, vector preparation and cloning, c DNA library, BAC library
Unit IV:
Morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F2s, back crosses, RILs, NILs and DH). Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding. Marker Assisted Selection and molecular breeding. Biotechnology applications in male sterility/hybrid breeding, molecular farming. Marker-assisted backcross breeding for rapid introgression. ***Breeding for abiotic stress tolerance, Biotechnological interventions and molecular genetics/ genomics-based approaches for development of climate smart crops.***
Unit V:
Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Generation of EDVs.
Unit VI:
Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases. GMO for abiotic stress/biotic stress.
Unit VII:
GMOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights
Unit VIII:
Bioinformatics & Bioinformatics tools.
Unit IX:

Nanotechnology and its applications in crop improvement programmes.

To be engaged:
Dr. Malagouda Patil, Assistant Professor, Department of Biotechnology, College of Agriculture, Vijaypur, UAS, Dharwad.
Dr. Arati Yadawad, Principal Investigator, DST WOS-A, Department of Biotechnology, College of Agriculture, UAS, Dharwad.
(Instructors participated in the 4-Workshop training of AdaptNET)

4) SOL 515 - Land Degradation and Restoration (1+0)

Theory:
Unit I: Type, factors and processes of soil/land degradation and its impact on soil productivity, including soil fauna, biodegradation and environment.
Unit II: Land restoration and conservation techniques - erosion control, reclamation of salt-affected soils; mine land reclamation, afforestation, organic products.
Unit III: Extent, diagnosis and mapping of land degradation by conventional and modern RS-GIS tools; monitoring land degradation by fast assessment, modern tools, land use policy, incentives and participatory approach for reversing land degradation; global issues for twenty first century.
Unit IV: ***Biophysical aspects of carbon sequestration, Carbon sequestration: challenges and opportunities, management, policy and economics, Carbon sequestration through land-use changes, Soil carbon management index-a tool for soil quality and its sustainability, Ex-ante carbon-balance tool, Introduction and importance of global carbon sequestration related schemes/projects: Convention to Combat Desertification (CCD), Convention of Climate Change (CCC), Clean Development Mechanism of the Kyto protocol, Bonn and Marrakech Agreements, Marrakech Accords, Carbon trading, Carbon Accounting and Verification, Carbon Funds, Biocarbon Fund, Community Development Carbon Fund, Global Environment Facility Adoption Fund and Prototype Carbon Fund.***

To be engaged by:
Kumara, B. H., Scientist (Soil Science), AICRP on Dry land Agriculture, RARS, Vijaypur, UAS, Dharwad.
(Instructor participated in the 4-Workshop training of AdaptNET)

5) SAF 206 - Agroforestry Systems and Management (2+1)

Theory:
Classification of agroforestry system - structural, functional, socioeconomic, and ecological basis. Traditional agroforestry systems: shifting cultivation, taungya, homegardens. Agroforestry systems in different agro climatic zones, components, production and management techniques. Alley cropping- functional and structural attributes of alley cropping, Structural and functional attributes, soil management, choice of species and system productivity of various Agroforestry systems. High-density short rotation plantation systems, silvicultural woodlots/energy plantations. Different types of Pastoral siviculture and silvopastoral systems Silvoagriculture systems- Agrosilviulture, Pastoral silviculture, Silvopastoral and Agrosilvopastoral systems and their management; agrihortisilviculture,

silvihorticulture, hortipastoral , aquaforestry, shelterbelts and windbreaks - design, aerodynamics and management; live fences; fodder trees and protein banks. Agroforestry for wasteland development. Agroforestry component management Canopy management - lopping, pruning, pollarding, and hedging. Spatial arrangement. Tree density management. Diagnosis and design methods and approaches. Non-wood forest products based agroforestry. People's participation, rural entrepreneurship through Agroforestry and industrial linkages. Financial and socio-economic analysis of Agroforestry systems. Evaluation of tangible and intangible benefits. ***Climate smart Agroforestry-developing resilient Agroforestry model in changing climatic scenario.***

Practical:

Study the components, arrangement and functioning of various forest and agro-ecosystems- Collection of information on various tree and agricultural crops on their habitat, growth, tolerance to various climatic and edaphic factors and study their compatibility for integration- Study land capability classification of various topographic regions. Visit to problem sites such as wind prone, mined areas, degraded sites, flood prone areas etc and design suitable land use strategies

Study characteristics of trees/shrubs/grasses for agroforestry. Visit prominent agroforestry systems, other plantation crop combinations, homegardens, other integrated multitier agroforestry systems and study their structural and functional attributes. Volume and biomass estimation- C sequestration assessment- Crown measurement, light interception, leaf area index measurements in agroforestry systems. Annual crops/grass growth measurements and yield estimation. Diagnosis and design-methodology. Survey agroforestry practices in local/ adjoining areas. Multistoried cropping system and canopy architecture management.

To be engaged:

Dr. S. S. Inamati, Assistant Professor (Agroforestry), Department of Silviculture and Agroforestry, Forestry College, Sirsi, UAS, Dharwad.

Dr. Jagadeesh, M. R., Assistant Professor (Agroforestry), Department of Silviculture and Agroforestry, Forestry College, Sirsi, UAS, Dharwad.

(Instructors participated in the 4-Workshop training of AdaptNET)

6) CPH 504: Physiological and Molecular Responses of Plants to Abiotic Stresses (2+1)

Theory:

Abiotic stresses affecting plant productivity. Basic principles of a crop improvement programme under stress, Interactions between biotic and abiotic stresses. Drought-characteristic features, Water potential in the Soil-Plant air continuum. Development of water deficits, energy balance concept. Transpiration and its regulation – stomatal functions. Physiological processes affected by ***climate change and crop modeling under changing climatic scenario.*** Drought resistance mechanisms: Escape Dehydration postponement (Drought avoidance), Dehydration tolerance and characteristics of resurrection plants. Osmotic adjustment, osmoprotectants, stress proteins. Water use efficiency as a drought resistant trait. Molecular responses to water deficit: Stress perception, Expression of regulatory and functional genes and significance of gene products. Stress and hormones- ABA as a signaling molecule- Cytokinin as a negative signal. Oxidative stress: Reactive Oxygen Species (ROS). Role of scavenging systems (SOD and catalase etc.). High temperature stress: Tolerance mechanisms- role of membrane lipids in high temperature tolerance. Functions of HSP's. Chilling

stress: Effects on physiological processes. Crucial role of membrane lipids. Salinity: Species variation in salt tolerance. Salinity effects at – cellular and whole plant level, tolerance mechanisms. Salt tolerance in – Glycophytes and halophytes, Breeding for salt resistance. Heavy metal stress: Aluminium and cadmium toxicity in acid soils. Role of Phytochelatins (heavy metal binding proteins).

Practical:

Measurement of water status of plants, determination of osmotic potential by vapour pressure and freezing point depression, Determination of soil water potential and content by psychrometry and other systems. Stress imposition and quantification, Stress – stomatal conductance. Canopy temperature as a reflection of transpiration and root activity,Water use efficiency determination at whole plant and single leaf level. Root- shoot signals-ABA and cytokinin effect on stomatal behavior, Heat tolerance and membrane integrity. Sullivans heat tolerance test, chilling tolerance- Galactolipase and free fatty acid levels as biochemical markers for chilling damage, Cold induced inactivation of O2 evolution of chloroplasts- as a screening technique for chilling tolerance. PG Curricula and Syllabi of UAS, Dharwad 2009-10 (5 th Edition) (As amended up to August 2018) - 191 - Suggested Readings . Hopkins WG & Huner NPA. 2004. Introduction to Plant Physiology. John Wiley & Sons. Salisbury FB & Ross C. 1992. Plant Physiology. 4th Ed. Wadsworth Publ. Taiz L & Zeiger E. 2006. Plant Physiology. 4th Ed. Sinauer Associates.

To be engaged:

Dr. Kiran B. O., Scientist (Physiology), AICRP on Sorghum, RARS, Vijaypur, UAS, Dharwad.
(Instructor participated in the 4-Workshop training of AdaptNET)