Mission

Aims to impart Education, Research and Extension for Sustainable Agricultural Development.

Vision

- To develop excellent human resources and innovative technological services to farming community
- To create environment for research knowledge in agriculture and allied fields. .
- To develop culture of continuous improvement, skill development and team work.

PROGRAMME OBJECTIVES:

- To gain knowledge of different streams of agriculture like agronomy, entomology, plant breeding, plant pathology, soil science etc. in practice.
- To study the competent professionally with ethical responsibility as an individual as well as in multidisciplinary teams with positive attitude.
- To devise communication and extension methodologies for transfer of Agricultural Technologies.
- To identify, critically analyzes, formulate and solve agriculture economics and marketing problems to benefit farmers.
- To able to design a system and process to meet desired needs of food and nutrition with the knowledge of protected cultivation and Post-Harvest Technology.

PROGRAMME OUTCOMES

- Agriculture programme is designed to prepare graduates to attain the following outcomes:
- An ability to apply knowledge of different streams of agriculture in practice.
- An ability to critically analyzes and solve marketing problems.
- An ability to design a system to meet desired needs of food and nutrition.
- An ability to devise and conduct experiments, interpret data and provide well informed conclusions.
- An ability to understand the practical problems faced by farmers and to find a proper solution for it.

AMSS 501	FLORAL BIOLOGY, SEED DEVELOPMENT AND MATURATION	1+1

Objective

To refresh the basic knowledge of seed development and structures and apprise students with its relevance to production of quality seed.

Theory

UNIT I

Floral types, structure and biology in relation to pollination mechanisms; sporogenesis: microsporogenesis and megasporogenesis; gametogenesis - development of male and female gametes and their structures; effect of environmental factors on floral biology.

UNIT II

Fertilization – embryo sac structure, process, barriers to fertilization, incompatibility and male sterility, factors affecting fertilization.

UNIT III

Embryogenesis - development of typical monocot and dicot embryos; endosperm development, modification of food storage structures with reference to crop plants.

UNIT IV

Different types of embryos, endosperm andcotyledons; development and their structure in representative crop plantswith reference to food storage; external and internal features of monocotand dicot seed; seed coat structure and development in representative cropplants.

UNIT V

Apomixis – identification, classification, significance and its utilization indifferent crops for hybrid seed production; Polyembryony - types andsignificance; haplontic and diplontic sterility, causes of embryo abortion,embryo rescue and synthetic seeds.

Practical

1. Study of floral biology of monocots and dicots
2. microsporogenesis andmegasporogenesis
3. study of pollen grains - pollen morphology
4. pollengermination and pollen sterility
5. types monocot and dicot embryos
6. externaland internal structures of monocot and dicot seeds

7. seed coat structure
8. preparation of seed albums and identification.

Suggested Readings

Bhojwani SS & Bhatnagar SP. 1999. *The Embryology of Angiosperm*. Vikas Publ.

Black M, Bewley D & Halmer P. 2006. *The Encyclopedia of Seeds: Science, Technology and Uses*. CABI.

Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plants*.Deptt. of Plant Breeding, CCS HAU, Hisar.

Copeland LO & McDonald MB. 2001. *Principles of Seed Science and Technology*. 4th Ed. Chapman & Hall.

Frankel R & Galun E. 1977. *Pollination Mechanisms, Reproduction and Plant Breeding*. Springer Verlag.

AMSS 502	PRINCIPLES OF SEED PRODUCTION	2+0

Objective

To introduce the basic priciples of quality seed production.

Theory

UNIT I

Introduction : Seed as basic input in agriculture; seed development in cultivated plants; seed quality concept and importance of genetic purity in seed production; types of cultivars, their maintenance and factors responsible for deterioration; seed production in self and cross pollinated crops.

UNIT II

Mode of pollination and reproduction in crop plants and their modification in relation to hybrid seed production. Principles of hybrid seed production, isolation distance, synchronization of flowering, roguing etc. male sterility and incompatibility system in hybrid seed production, role of pollinators and their management.

UNIT III

Seed multiplication ratios, seed replacement rate, demand and supply; suitable areas of seed production and storage, agronomy of seed production – agro climatic requirements and their influence on quality seed production; generation system of seed multiplication; maintenance of Nucleus seed, production of Breeder, Foundation and Certified seed– criteria involved; life span of a variety and causes for its deterioration; certification standards for self and cross pollinated and vegetatively propagated crops.

UNIT IV

Hybrid Seed - Methods of development of hybrids; use of male sterility and self-incompatibility and CHA in hybrid seed production; one, two and three line system; maintenance of parental lines of hybrids; planning and management of hybrid seed production technology of major field crops and vegetables.

UNIT V

Planning of seed production for different classes of seeds for self and crosspollinated crops, Seed quality control system and organization, seed village concept; Seed production agencies, seed industry and custom seed

production in India.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.
Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plants*. Dept. of Plant Breeding CCS HAU, Hisar.
Desai BB. 2004. *Seeds Handbook*. Marcel Dekker.
Kelly AF. 1988. *Seed Production of Agricultural Crops*. Longman.
McDonald MB Jr & Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.
Musil AF. 1967. *Identification of Crop and Weed Seeds*. Handbook No. 219, USDA, Washington, DC, USA.
Poehlman JM & Sleper DA. 2006. *Breeding Field Crops*. Blackwell.
Singh BD. 2005. *Plant Breeding: Principles and Methods*. Kalyani.
Singhal NC. 2003. *Hybrid Seed Production in Field Crops*. Kalyani.
Thompson JR. 1979. *An Introduction to Seed Technology*. Leonard Hill.
Tunwar NS & Singh SV. 1985. *Handbook of Cultivars*. CSCB, GOI.

AMSS 503 SEED PHYSIOLOGY 2+1

Objective

To provide an insight into physiological processes governing seed quality and its survival.

Theory

UNIT I

Physiology of seed development and maturation; chemical composition, synthesis and accumulation of seed reserves, induction of desiccation tolerance, hormonal regulation of seed development.

UNIT II

Seed germination; factors affecting germination; role of embryonic axis; growth hormones and enzyme activities, effect of age, size and position of seed on germination. Physiological processes during seed germination.

UNIT III

Seed respiration, breakdown of stored reserves in seeds, mobilization and interconversion pathways. Seed dormancy- types, significance, mechanism, endogenous and exogenous factors regulating dormancy, role of phytochrome and PGR, genetic control of dormancy.

UNIT IV

Seed viability and longevity, pre and post-harvest factors affecting seed viability ; seed ageing ; physiology of seed deterioration ; lipid peroxidation and other viability theories; means to prolong seed viability; mechanism of desiccation sensitivity and recalcitrance with respect to seed longevity.

UNIT V

Seed vigour and its concept, vigour test methods, factors affecting seed vigour, physiological basis of seed vigour in relation to crop performance and yield. Seed invigoration and its physiological and molecular control.

Practical

1. Proximate analysis of chemical composition of seed;

2. Methods of testing viability.

3. Kinetics of seed imbibition and solute leakage;

4. Seed germination and dormancy breaking methods;

5. Seed invigoration and priming treatments; accelerated ageing and controlled deterioration tests;

6. Enzymatic activities and respiration during germination and effect of accelerated
   ageing

7. Vigour testing methods etc.

Suggested Readings

Agrawal PK & Dadlani M. (Eds.). 1992. *Techniques in Seed Science and Technology*. South Asian Publ.

Baskin CC & Baskin JM. 1998. *Seeds: Ecology, Biogeography andEvolution of Dormancy and Germination*. Academic Press.

Basra AS. 2006. *Handbook of Seed Science and Technology*. Food ProductPress.

Bench ALR & Sanchez RA. 2004. *Handbook of Seed Physiology*. FoodProduct Press.

Bewley JD & Black M. 1982. *Physiology and Biochemistry of Seeds inRelation to Germination*. Vols. I, II. Springer Verlag.

Bewley JD & Black M. 1985. *Seed: Physiology of Seed Development andGermination*. Plenum Press.

Copeland LO & Mc Donald MB. 1995. *Principles of Seed Science andTechnology*. 3rd Ed. Chapman & Hall.

Khan AA. 1977. *Physiology and Biochemistry of Seed Dormancyand Germination*. North Holland Co.

Kigel J & Galili G. (Eds.). *Seed Development and Germination*. MarcelDekker.

Murray DR. 1984. *Seed Physiology.* Vols. I, II. Academic Press.

Sadasivam S & Manickam A. 1996. *Biochemical Methods*. 2nd Ed. NewAge.

AMSS 504 Seed Entomology 1+1

Objective

To apprise about the role of insects in seed production and their effect on seed quality during storage.

Theory

UNIT I

Principles of seed entomology; pollinator insects, insect pests and their classification based on mode of infestation etc.

UNIT II

Principles of insect pollination, role of pollinators in seed Production. Augmenting quality seed production through honeybee pollination in crucifers and forage legumes. Plant protection measures in bee pollinated crops. Management of pollinators for hybrid seed production.

UNIT III

Major insect pests of principal crops and their management practices. Methods of insect pest control. Classes of pesticides, their handling and safe use on seed crops.

UNIT IV

Storage insect pests infecting seeds, their development and economic importance. Storage losses due to pests, control of storage pests, Management of storage insects pests, mites and rodents, seed sampling and loss estimation.

UNIT V

Principles of fumigation and their use, effect of different fumigants; preservatives and seed protectants on seed quality; Type of storage structures – domestic and commercial.

Practicals

1. Collection and identification of insect-pollinators, collection and identification of important pests of stored seeds.
2. Detection and estimation of pest infestation vis- a- vis loss of seed quality.
3. Safe handing and use of fumigants and insecticides; safety measures in fumigating and disinfecting, exposure period, aeration etc. the storage structures.
4. Plant protection equipments, their operation and maintenance.
5. Pesticides, its dose determination, preparation of solution and its application.

Suggested Readings

- Agarwal, N.A. and Girish, G.K. 1977. *An Introduction to Action Programme to Regress on Farm Storage Losses in India*. FAO/NORAD Seminar on Farm Storage Grain in India, Nov. 29-Dec. 8, 1977.
- Anderson, J.A. and Aleock, A.W. 1954. *Storage of Cereal Grain & their Products*. American Assoc. Cereal Chemists, St. Pauls, Minn.
- Cottong, R.T. 1963. *Insect Pests of Stored Grain and Grain Products*. Burgess Publ. Co., Minneopolis, Minn., USA.
- Monro. 1969. *Manual of Fumigation for Insect Control*. FAO Rome Agril. Studies No. 79.

- Subramanyam, B. and Hagstrum, D.W. 1995. *Interrelated Management of Insects in Stored Products*. Marcel Dekker.

AMSS 505	SEED PRODUCTION IN FIELD CROPS	2+1

Objective

To impart a comprehensive knowledge of seed production in field crops with adequate practical training.

Theory

UNIT I

Basic principles in seed production and importance of quality seed. Floral structure, breeding and pollination mechanism in self-pollinated cereals and millets viz, wheat, barley, paddy, ragi etc.

UNIT II

Floral structure, breeding and pollination mechanism in cross-pollinated cereals and millets viz maize, sorghum, bajra etc ; methods and techniques of quality seed production incross-pollinated cereals and millets.

UNIT III

Floral structure, breeding and pollination mechanism; methods and techniques of seed production in pulses (pigeon pea, chick pea, green garm, black garm, field beans, peas etc.).

UNIT IV

Floral structure, breeding and pollination mechanism; methods and techniques of seed production in major oil seeds (groundnut, castor, sunflower, safflower, rape and mustard, linseed, sesame etc.).

UNIT V

Floral structure, breeding and pollination mechanism; methods and techniques of seed production in commercial fibers (cotton, jute, mesta etc) and vegetatively propagated crops like sugar cane, potato etc.

Practical

1. Planning of Seed Production, requirements for different classes of seeds in
   field crops - unit area and rate;
2. Seed production in cross pollinated crops with special reference to land, isolation, planting ratio of male and female lines,

3. synchronization of parental lines and methods to achieve synchrony; supplementary pollination, pollen storage, hand emasculation and pollination in Cotton,
4. detasseling in Corn, identification of rogues and pollen shedders; Pollen collection, storage, viability and stigma receptivity; gametocide application and visits to seed production plots etc.

Suggested Readings

Kelly AF. 1988. *Seed Production of Agricultural Crops*. John Wiley.
McDonald MB Jr & Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.
Singhal NC. 2003. *Hybrid Seed Production in Field Crops*. Kalyani.

AMSS 506	SEED LEGISLATION AND CERTIFICATION	2+1

Objective

To apprise students with the legislative provisions and processes and the mechanisms of seed quality control.

Theory

UNIT I

Historical development of Seed Industry in India; Seed quality: concept and factors affecting seed quality during different stages of production, processing and handling; seed quality control- concept and objectives; Central Seed Certification Board (CSCB).

UNIT II

Regulatory mechanisms of seed quality control- organizations involved in seed quality control programmes; seed legislation and seed law enforcement as a mechanism of seed quality control; the Seed Act (1966), Seed Rules (1968), Seed (Control) Order 1983; Essential Commodities Act (1955); Plants, Fruits and Seeds Order (1989); National Seed Development Policy (1988) and EXIM Policy regarding seeds, plant materials; New Seed Bill-2004 etc. Introduction, objectives and relevance of plant quarantine, regulations and plant quarantine set up in India.

UNIT III

Seed Certification- history, concept and objectives of seed certification; seed certification agency/organization and staff requirement; legal status and phases of seed certification; formulation, revision and publication of seed certification standards; Indian Minimum Seed Certification Standards (I.M.S.C.S.)- general and specific crop standards including GM varieties, field and seed standards; planning and management of seed certification programmes- eligibility of a variety for certification, area assessment, cropping history of the seed field, multiplication system based on limited generation concept, isolation and land requirements etc.

UNIT IV

Field Inspection- principles, phases and procedures; reporting and evaluation of observations; pre and post-harvest control tests for genetic purity evaluation (grow-out tests); post harvest inspection and evaluation; seed sampling, testing,

labeling, sealing and grant of certificate; types and specifications for tags and labels; maintenance and issuance of certification records and reports; certification fee and other service charges; training and liaison with seed growers. OECD seed certification schemes.

UNIT V

Introduction to WTO and IPRs; Plant Variety Protection and its significance; UPOV and its role; DUS testing- principles and applications; essential features of PPV & FR Act, 2001 and related Acts.

Practical

1. General procedure of seed certification ;
2. Identification of weed and other crop seeds as per specific crops;
3. Field inspection at different stages of a crop and observations recorded on contaminants and reporting of results;
4. Inspection and sampling at harvesting/threshing, processing and after processing for seed law enforcement;
5. Testing physical purity, germination and moisture;
6. Specifications for tags and labels to be used for certification purpose;
7. Srow-out tests for pre and post-harvest quality control;
8. Visits to regulatory seed testing laboratory, including plant quarantine lab and seed certification agency.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. Oxford & IBH.

Anonymous 1992. *Legislation on Seeds*. NSC Ltd., Department of Agriculture and Cooperation, Ministry of Agriculture, New Delhi.

Nema NP. 1986. *Principles of Seed Certification and Testing*. Allied Publs.

Tunwar NS & Singh SN. 1988. *Indian Minimum Seed Certification Standards*. CSCB, Ministry of Agriculture, New Delhi.

AMSS 507	SEED PROCESSING AND STORAGE	2+1

Objective

To impart knowledge on the principles and techniques of seed processing for quality upgradation and of storage for maintenance of seed quality.

Theory

UNIT I

Introduction: Principles of seed processing; methods of seed drying including dehumidification and its impact on seed quality. Relative humidity and equilibrium moisture content of seed; Thumb rules of seed storage; loss of viability in important agricultural and horticultural crops, viability equations and application of nomograph.

UNIT II

Seed cleaning equipment and their functions: Preparing seed for processing; functions of scalper debearder, scarifier, huller, seed cleaner and grader. Screen cleaners, specific gravity separator, indented cylinder, velvet-spiral-disc separators, colour sorter, delinting machines; seed blending.

UNIT III

Assembly line of processing and storage, receiving, elevating and conveying equipments, plant design and layout, requirements and economic feasibility of seed processing plant.

UNIT IV

Seed treatments-methods of seed treatment, seed treating formulations and equipments, seed disinfestations, identification of treated seeds; Packaging: principles, practices and materials; bagging and labeling.

UNIT V

Seed storage: Seed drying and storage; drying methods-importance and factors affecting it, changes during storage, concepts and significance of moisture equilibrium, methods of maintaining safe seed moisture content. Methods to minimize the loss of seed vigour and viability; factors influencing storage losses. Storage methods and godown sanitation. Storage structures. Storage problems of recalcitrant seeds and their conservation.

Practical

1. Operation and handling of mechanical drying equipments;

2. effect of drying temperature and duration on seed germination and storability with particular reference to oil seeds;
3. seed extraction methods;
4. seed processing equipments;
5. seed treating equipments;
6. visit to seed processing plant and commercial controlled and uncontrolled Seed Stores;.
7. seed quality upgradation; measurement of processing efficiency;
8. seed blending, bag closures; study of orthodox, intermediary and recalcitrant seeds;
9. evaluating seed viability at different RH and temperature levels and packaging
   materials;
10. prediction of storability by accelerated ageing controlled deterioration tests.

Suggested Readings

Agrawal RL. 1996. *Seed Technology*. Oxford Publ.

Barton LV. 1985. *Seed Preservation and Longevity*. International Books and Periodicals Supply Service, New Delhi.

Hall CW. 1966. *Drying of Farms Crops*. Lyall Book Depot.

Justice OL & Bass LN. 1978. *Principles and Practices of Seed Storage*. Castle House Publ. Ltd.

Mathews RK, Welch GB, Delouche JC & Dougherty GM. 1969. *Drying, Processing and Storage of Corn seed in Tropical and Subtropical Regions*. Proc. Am. Agric. Eng.

St. Joseph, Mich. Paper No. 69-67. Sahay KM & Singh K K. 1991. Unit Operations in Food Engineering. Vikas Publ.

Virdi SS & Gregg BG. 1970. *Principles of Seed Processing*. National Seed Corp., New Delhi.

AMSS 508	SEED QUALITY TESTING	2+1

Objective

To provide a comprehensive knowledge on all aspects of seed quality evaluation and their relevance to crop performance.

Theory

UNIT I

Introduction: Structure of monocot and dicot seeds; seed quality: objectives, concept and components and their role in seed quality control; instruments, devices and tools used in seed testing. ISTA and its role in seed testing. Seed Sampling: definition, objectives, seed-lot and its size; types of samples; sampling devices; procedure of seed sampling; sampling intensity; methods of preparing composite and submitted samples; sub-sampling techniques, dispatch, receipt and registration of submitted sample in the laboratory, sampling in the seed testing laboratory.

UNIT II

Physical Purity: definition, objective and procedure, weight of working samples for physical purity analysis; components of purity analysis and their definitions and criteria; pure seed definitions applicable to specific genera and families; multiple seed units; general procedure of purity analysis; calculation and reporting of results, prescribed seed purity standards; determination of huskless seeds; determination of weed seed and other seed by number per kilogram; determination of other distinguishablevarieties (ODV); determination of test weight and application ofheterogeneity test.

UNIT III

Seed moisture content: importance of moisture content; equilibriummoisture content; principles and methods of moisture estimation - types,instruments and devices used; pre-drying and grinding requirements,procedural steps in moisture estimation; calculation and reporting ofresults.Germination: importance; definitions; requirements for germination,instrument and substrata required; principle and methods of seedgermination testing; working sample and choice of method; generalprocedure for each type of method; duration of test; seedling evaluation;calculation and reporting of results; dormancy: definition, importance,causal mechanisms, types and methods for breaking dormancy.

UNIT IV

Viability and Vigour Testing: definition and importance of viability tests;different viability tests; quick viability test (TZ- test) - advantages,principle, preparation of seeds and solutions, procedure, evaluation andcalculation of test results. Vigour testing: concept, historical development,definitions, principles and procedures of different methods used for testingvigour.Genetic purity testing : objective and criteria for genetic purity testing;types of test; laboratory, Growth Chamber and field testing based on seed ,seedling and mature plant morphology; principles and procedures ofchemical, biochemical and molecular tests.

UNIT V

Seed health Testing: field and seed standards ; designated diseases,objectionable weeds - significance of seed borne disease vis-a-vis seedquality - seed health testing and detection methods for seed borne fungi,bacteria, viruses and nematodes.Testing of GM seeds and trait purity, load of detection (LOD).Preparation and dispatch of seed testing reports; storage of guard samples;application and use of seed standards and tolerances.

Practical

1. Structure of monocot and dicot seeds of important plant species;
2. Identification and handling of instruments used in seed testing laboratory;
3. Identification of seeds of weeds and crops; physical purity analysis of samples of different crops;
4. Estimation of seed moisture content (ovenmethod);
5. Seed dormancy breaking methods requirements for conductinggermination test, specifications and proper use of different substrata forgermination;
6. Seed germination testing in different agri-horticultural crops;
7. Seedling evaluation; viability testing by tetrazolium test in different crops;
8. Seed and seedling vigour tests applicable in various crops; species &cultivar identification;
9. Genetic purity testing by chemical, biochemical andmolecular methods;
10. Seed health testing for designated diseases, blottermethods, agar method and embryo count methods; testing coated/pelletedseeds.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. Oxford & IBH.
Agrawal PK & Dadlani M.1992. *Techniques in Seed Science andTechnology*. 2nd Ed. South Asian Publ.
Agrawal PK. (Ed.). 1993. *Handbook of Seed Testing*. Ministry ofAgriculture, GOI, New Delhi.
Copland LO & McDonald MB. 1996. *Principles of Seed Science andTechnology*. Kluwer.
ISTA 2006. *Seed Testing Manual*. ISTA, Switzerland.
Martin C & Barkley D. 1961. *Seed Identification Manual*. Oxford & IBH.
Tunwar NS & Singh SV. 1988. *Indian Minimum Seed CertificationStandards*. Central Seed Certification Board, Ministry ofAgriculture, New Delhi

AMPB 503 Principles of Plant Breeding 2+1

Objective

To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.

Theory

UNIT I

History of Plant Breeding (Pre and post-Mendelian era); Objectives of plant breeding, characteristics improved by plant breeding; Patterns of Evolution in Crop Plants- Centres of Origin-biodiversity and its significance.Genetic basis of breeding self- and cross - pollinated crops including mating systems and response to selection - nature of variability, components of variation;

UNIT II

Heritability and genetic advance, genotype environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plantbreeding. Pure line theory, pure line selection and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding in self-pollinated crops (diallel selective mating approach).

UNIT III

Breeding methods in cross pollinated crops; Population breeding-mass selection and ear-to-row methods; S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and

interpopulation improvement and development of synthetics and composites; Hybrid breeding - genetical and physiological basis of

heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreds.

UNIT IV

Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonalselection. Self-incompatibility and male sterility in crop plants and their commercial exploitation; Concept of plant ideotype and its role in crop improvement; Transgressivebreeding.

UNIT V

Special breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses. Cultivar development- testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

Practical

1. Floral biology in self and cross pollinated species,
2. Selfing and crossing techniques.
3. Selection methods in segregating populations and evaluation of breeding material;
4. Analysis of variance (ANOVA); Estimation of heritability and genetic advance;
5. Maintenance of experimental records;
6. Learning techniques in hybrid seed production using male-sterility in fieldcrops.

Suggested Readings

Allard RW. 1981. *Principles of Plant Breeding*. John Wiley &

Sons. Chopra VL. 2001. *Breeding Field Crops*. Oxford & IBH.

Chopra VL. 2004. *Plant Breeding*. Oxford & IBH.

Gupta SK. 2005. *Practical Plant Breeding*.

Agribios.

Pohlman JM & Bothakur DN. 1972. *Breeding Asian Field Crops*. Oxford & IBH.

Roy D. 2003. *Plant Breeding, Analysis and Exploitation of Variation*. Narosa Publ. House.

Sharma JR. 2001. *Principles and Practice of Plant Breeding*. Tata McGraw-Hill.

Simmonds NW. 1990. *Principles of Crop Improvement*. English Language Book Society.

Singh BD. 2006. *Plant Breeding*. Kalyani.

Singh P. 2002. *Objective Genetics and Plant Breeding*.

Kalyani. Singh P. 2006. *Essentials of Plant Breeding*. Kalyani.

Singh S & Pawar IS. 2006. *Genetic Bases and Methods of Plant Breeding*.

AMPB 506 Maintenance Breeding and Concepts of Variety Release and Seed Production 1+1

Objective

To apprise the students about the variety deterioration and steps to maintain the purity of varieties & hybrids and principles of seed production in self &cross pollinated crops.

Theory

UNIT I

Variety Development and Maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid, and population; Variety testing, release and notification systems in India and abroad.

UNIT II

DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding.

UNIT III

Factors responsible for genetic deterioration of varieties – safe guards during seed production; Maintenance of varieties in self and cross-pollination crops- isolation distance; Principles of seed production; Methods of nucleus and breeder seed production.

UNIT IV

Generation system of seed multiplication -nucleus, breeders, foundation, certified, - Quality seed production technology of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearlmillet, sorghum, maize and ragi etc.); Pulses (greengram,

blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil).

UNIT V

Quality seed production technology of self and cross- pollinated crop varieties viz.Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).; Seed certification procedures; Seed laws and plant variety protection regulations in India and internationalsystems.

Practical

1. Identification of suitable areas/locations for seed production;
2. Ear-to-row method and nucleus seed production.
3. Main characteristics of released and notified varieties, hybrids and parental lines.
4. Identification of important weeds/objectionable weeds.
5. Determination of isolation distance and planting ratios in different crops.
6. Seed production techniques of varieties indifferent crops.
7. Hybrid seed production technology of importantcrops.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.
Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plants*. Department of Plant Breeding. CCS HAU Hisar. Kelly AF. 1988. *Seed Production of Agricultural Crops*. Longman.

McDonald MB Jr & Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.
Musil AF. 1967. *Identification of Crop and Weed Seeds*. HandbookNo. 219, USDA, Washington, DC.

Poehlman JM & Borthakur D. 1969. *Breeding Asian Field Crops*. Oxford & IBH.
Singh BD. 2005. *Plant Breeding: Principles and Methods*. Kalyani.
Thompson JR. 1979. *An Introduction to Seed Technology*. Leonard Hill.
Tunwar NS & Singh SV. 1985. *Handbook of Cultivars*. ICAR.

AMPB 505Biotechnology for Crop Improvement 2+1

Objective

To impart knowledge and practical skills to use biotechnological tools incrop improvement.

Theory

UNIT I

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding. Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatichybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

UNIT II

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR,SNPs, ESTs etc.),mapping populations (F2s, back crosses, RILs, NILs and DH).

UNIT III

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, Genepyramiding. Marker assisted selection and molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding

for rapid introgression, Generation of EDVs.

UNIT IV

Recombinant DNA technology, transgenes, method of transformation,selectable markers and clean transformation techniques, vector-mediatedgene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.

UNIT V

Biotechnology applications in male sterility/hybrid breeding, molecular farming. 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 Bioinformatics & Bioinformatics tools. Nanotechnology and its applications in crop improvement programmes.

Practical

1. Requirements for plant tissue culture laboratory-Techniques in plant tissue culture
2. Media components and media preparation
3. Aseptic manipulation of various explants - observations on the contaminants occurring in media –interpretations - Inoculation of explants;
4. Callus induction and plant regeneration - Plant regeneration;
5. Standardizing the protocols for regeneration;
6. Hardening of regenerated plants;
7. Establishing a greenhouse and hardening procedures - Visit to commercial micropropagation unit.
8. Transformation using *Agrobacterium* strains, GUS assay in transformed cells / tissues.

9. DNA isolation, DNA purity and quantification tests, gelelectrophoresis of proteins and isozymes,
10. PCR- based DNA markers, gelscoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computersoftware.

Suggested Readings

Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology: Concepts, Methods and Applications*. Oxford & IBH.

Gupta PK. 1997. *Elements of Biotechnology*. Rastogi Publ.

Hackett PB, Fuchs JA & Messing JW. 1988. *An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation.* 2nd Ed. Benjamin Publ. Co.

Sambrook J & Russel D. 2001. *Molecular Cloning* - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Lab. Press.

Singh BD. 2005. *Biotechnology, Expanding Horizons*. Kalyani

SUPPORTING COURSES

AMST 101 STATISTICAL METHODS FORAPPLIEDSCIENCES

3+1

Objective

This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data,Probability distributions, parameter estimation, tests of significance, regression and ultivariate analyticaltechniques.

Theory

UNITI

Classification, tabulation and graphical representation of data. Box-plot, Descriptive statistics. Exploratory data analysis; Theory of probability. Random variable and mathematicalexpectation.

UNIT II

Discrete and continuous probability distributions Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distributions. Large sampletheory.

UNITIII

Introduction to theory of estimation and confidence-intervals. Correlation

and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients. Coefficient of determination. Polynomial regression models and their fitting. Probit regression analysis by least squares and maximum likelihoodmethods, confidence interval for sensitivity; Testing for heterogeneity.

UNITIV

Non-parametric tests - sign, Wilcoxon, Mann-Whitney U-test, Wald Wolfowitz run test, Run test for the randomness of a sequence. Median test, Kruskal- Wallis test, Friedman two-way ANOVA by ranks. Kendall's coefficient of concordance.

UNITV

Introduction to multivariate analytical tools- Hotelling's T^2 Tests of hypothesis about the mean vector of a multinormal population. Classificatory problems and discriminant function, D^2 -statistic and its applications; Cluster analysis, principal component analysis, canonical correlations and Factoranalysis.

Practical

1. Exploratory data analysis, Box-Cox plots;
2. Fitting of distributions ~ Binomial, Poisson, Negative Binomial,
3. NormalLarge sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F.
4. Confidence interval estimation and point
5. Estimation of parameters of binomial, Poisson and Normal distribution.
6. Correlation and regression analysis, fitting of orthogonal polynomial regression.
7. Applications of dimensionality reduction and discriminant function

analysis.

8. Application of Nonparametric tests.

Suggested Readings

Anderson TW. 1958. An Introduction to Multivariate Statistical Analysis. John Wiley. Dillon WR & Goldstein M. 1984. Multivariate Analysis - Methods and Applications. John Wiley.

Goon AM, Gupta MK & Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. The WorldPress.

Goon AM, Gupta MK & Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press.

Hoel PG. 1971. Introduction to Mathematical Statistics. John Wiley.

Hogg RV & Craig TT. 1978. Introduction to Mathematical Statistics. Macmillan. Morrison DF. 1976. Multivariate Statistical Methods. McGraw Hill.

Siegel S, Johan N & Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. John Wiley.

AMST 201 EXPERIMENTALDESIGNS 2+1

Objective

This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimentaldata.

Theory

UNITI

Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and localcontrol.

UNITII

Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin squaredesign.

UNITIII

Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with controltreatment.

UNITIV

Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designsand

their applications ~ Lattice design, alpha design-concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

UNITV

Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potencyestimation.

Practical

1. Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law;
2. Analysis of data obtained from CRD, RBD, LSD;
3. Analysis of factorial experiments without and with confounding;
4. Analysis with missing data; Split plot and strip plot designs;
5. Transformation of data; Analysis of resolvable designs;
6. Fitting of response surfaces.

Suggested Readings

Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley. Dean AM & Voss D. 1999. Design and Analysis of

Experiments. Springer. Federer WT. 1985. Experimental Designs. MacMillan.

Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.

Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.

Pearce SC. 1983. The Agricultural Field Experiment A Statistical Examination of Theory and Practice. John Wiley.

Design Resources Server www.iasri.res.in/design.

NON-CREDIT COURSES
AMNC 101 LIBRARY AND INFORMATIONS SERVICES 0+1

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information+- search.

Practical

- Introduction to library and its services;
- Role of libraries in education , research and technology transfer; Classification systems and organization of library;
- Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.)
- Tracing information from reference sources; Literature survey; Citation Online Public Access bibliography; Use of CD-ROM Databases,
- Online Public Access catalogue and other computerized library services;
- Use of Internet including search engines and its resources access methods.

AMNC 102 Technical Writing and communications skills 0+1

Objective

- To equip the students with skills to write dissertations, research paper, etc.

- To equip the students with skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical Writing –

- Various forms of scientific writings- theses, technical papers, reviews, manuals, etc;
- Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion);
- Writing of abstracts, summaries, précis citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; paginations, numbering of tables and illustrations;
- Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills –

- Grammar (Tenses, parts of speech, clauses, punctuation marks).
- Error analysis (Common errors); analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription.
- Accentual pattern: Weak forms in connected speech.
- Participation in group discussion.
- Facing an interview; presentation of scientific papers.

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India. Collins' Cobuild English Dictionary. 1995. Harper Collins.

Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart &

Winston.
Hornby AS. 2000. Comp. Osford Advanced Learner's Dictionary ofof Current English. 6th Ed. Oxford University Press.
James HS. 1994. Handbook for Technical Writing. NTC Business Books.
Joseph G. 2000. MLA Handbook for Writers of Research Papers. Sth Ed. Affiliated East-West Press.
Mohan K. 2005. Speaking English Effectively, MacMillan India.
Richard WS. 1969. Technical Writing, Barnes & Noble.
Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek
Sethi J &Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

AMNC 103 Intellectual property and its management in agriculture (1+0)

Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

UNIT I

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement.

UNIT II

Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs: Indian Legislations for the protection of various types of Intellectual Properties.

UNIT III

Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers rights and biodiversity protection.

UNIT IV

Protectable subject matters protection in biotechnology, protection of other biological materials ownership and period of protection.

UNIT V

National Biodiversity protection initiatives, Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

Erbisch FH & Maredia K. 1998 Intellectual Property Rights in Agricultural Biotechnology CABI Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy, McGraw-Hill. Intellectual Property Rights: Key to New Wealth Generation. 2001 NRDC & Aesthetic Technologies Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation Rothschild M &Scott N. (Ed) 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI Saha R. (Ed.). 2006 Intellectual Property Rights in NAM and

Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House The Indian Acts-Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999: The Copyright Act, 1957 and amendments: Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003 National Biological Diversity Act, 2003

AMNC 104BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1

Objective

To acquaint the students about the basics of commonly used techniques in laboratory

Practical

1. Safety measures while in Lab, Handling of chemical substances
2. Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware;
3. Drying of solvents chemicals. Weighing and preparation of solutions of different strengths and their dilution Handling techniques of solutions;
4. Preparation of different agro-chemical doses in field and pot applications;
5. Preparation of Neutralisation of acid and bases;
6. Preparation of buffers of different strengths and pH values.
7. Use and handling of microscope, laminar flow vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens incubators, sandbath, waterbath, oilbath; Electric wiring and earthing
8. Preparation of media and methods of sterilization; Seed viability testing testing of pollen viability: Tissue culture of crop plants;
9. Description of owering plants in botanical terms in relation to taxonomy tion of solutions of acids;

Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

Gabb MH &Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ.Co .

AMNC 105 AGRICULTURAL RESEARCH, RESEARCIH ETHICSAND RURAL DEVELOPMENT PROGRAMMES1+0

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government

Theory

UNIT I

History of agriculture in brief, Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment.

UNIT II

National Agricultural Research Systems NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centers (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels;

UNIT III

International fellowships for scientific mobilityResearch ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT IV

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme Special groupArea Specific Programme, Integrated Rural Development Programme (IRDP).

UNIT V

Panchayati Raj Institutions, Co- operatives, Voluntary Agencies/Non Govenmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture Four Decades of Development. Sage Publ. Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. Rural Development Strategies and Role of Institutions- Issues, Innovations and Initiatives. Mittal Publ.
Singh K. 1998. Rural Development Principles, Policies and Management. Sage Publ.

AMNC 106DISASTER MANAGEMENT 1+0

Objectives

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building

Theory

UNIT I

Natural Disasters Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic cruptions, Heat and cold waves.

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. oil fire, air pollution, water pollution, deforestation,

UNIT III

Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.Climatic change: Global warming, Sea level rise, Ozone depletion.

UNIT IV

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework financial arrangements; role of NGOs, Community-based organizations and media.

UNIT V

Central, state, district and local administration; Armed force in disaster response; Disaster response: Police and other organizations.

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.

Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.