PG Degree Programme Syllabus as per BSMA, ICAR

M.Sc.(Agri.) Seed Science and Technology

M.S. Swaminathan School of Agriculture
Centurion University of Technology and Management
Alluri Nagar, P.O. - R Sitapur, Via- Uppalada, Paralakhemundi
Dist: Gajapati – 761211
Odisha, India
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Preamble

The proposed curriculum of Seed Science and Technology discipline is designed with the view to improve the existing syllabus and to make it more contextual and pertinent to cater the needs of students in terms of global competitiveness and employability. In the present state, students aspire for overseas admissions for education and employment, or even in India they seek placements in seed corporations and multinational seed companies. In order to facilitate easier transitions for post-graduate degree courses and job prospects overseas, there is a need to upgrade the post-graduate syllabus to international standards. Therefore, the present syllabus needs revision so as to prepare the students to cope with current professional scenario with relevance to practical needs and skill requirements. The BSMA (Plant Sciences) committee examined the existing syllabus of Seed Science and Technology and analyzed carefully in terms of content, relevance, quality and pattern and then synthesized the present proposed syllabus.

By intensive discussion with the core faculty, experts and based on the feedback from seed industry professionals, the entire syllabus was restructured with the improvement in existing courses as well as addition of new courses. The syllabus was suitably finalized with the view to equip the students to gain knowledge and skills sets and to prepare themselves for global competitiveness to meet out their goals.

Seed quality is vital for sustainable crop production and food security. Seed enhancement includes physical, physiological and biological treatments to overcome germination constraints, to maintain uniform plant stands, earlier crop development and better yields. Seed enhancement techniques are designed in such a way to reduce emergence time of seed by earlier start of metabolic activities and resource mobilization for better emergence and seedling vigour. The knowledge of molecular pathways elucidating mode of action of priming agents, reduced longevity of primed seeds, efficiency of physical and biological agents for seed treatments and market availability of high-quality seeds are some of the challenges for scientists and seed industry.

Seed dormancy allows seeds to overcome periods that are unfavourable for seedling establishment and significant role in adaptation and evolution of seed plants, and therefore it is important for plant ecology and agriculture. Seed ecology is the study of ecological strategiesby which plants ensure their reproduction by seed. Understanding the dynamics of seed bank, environmental conditions that impose dormancy and induce germination, and factors that influence successful seedling establishment is utmost important. The knowledge on seed dormancy and seed ecology will enhance the effectiveness in planning for control of weeds, successful propagation of native economically important trees, shrubs, vines and grasses, and also reclamation of damaged agro-ecosystems.

Organic seed system when viewed as an alternative to the dominant seed system helps to address the bigger problems in agriculture. Expanding organic seed systems can also increase economic opportunities for farmers who successfully produce organic seed in their farm. Knowledge on the practices of organic seed production, certification and distribution will focus our production system on the present day needs for quality life.

Contents

Framework of the courses

The following nomenclature and Credit Hrs. need to be followed while providing the syllabus for all the disciplines

Courses	M.Sc. (Agri.) Credits
Major courses	20
Minor courses	08
Supporting courses	06
Common courses	05
Seminar	01
Thesis	30
Total	70

M.Sc. (Agri.) Seed Science and Technology

Couse Code	Course Title	Credit	Page No.
	Major Courses		
MSST 0501*	Seed Developmental Biology	1+1	6
MSST 0502	Seed Dormancy and Germination	1+1	8
MSST 0503*	Seed Production Principles and Techniques in Field Crops	2+1	10
MSST 0504*	Seed Production Principles and Techniques inVegetable Crops	2+1	13
MSST 0505	Seed Production Techniques in Fruits, Flowers, Spices, Plantation and Medicinal Crops	2+1	15
MSST 0506	Seed Production Techniques in Forage, Pasture and Green Manure Crops	1+1	17
MSST 0507*	Seed Legislation and Certification	2+1	19
MSST 0508*	Post Harvest Handling and Storage of Seeds	2+1	21
MSST 0509*	Seed Quality Testing and Enhancement	1+1	23
MSST 0510	Seed Technology of Tree Species	1+1	26

MSST 0511	Seed Industry and Marketing Management	1+1	28
MSST 0512	Seed Health Testing and Management	1+1	30
Minor Courses			
MMBB 0501	Principles of Biotechnology	3+0	33
MMBB 0504	Techniques in MolecularBiology-I	0+3	34
MMBB 0509	Plant Tissue Culture	2+1	35
MMBB 0517	Stress Biology and Genomics	2+0	36
Supporting Courses			
STAT 0502	Statistical Methods for Applied Sciences	3+0	37
STAT 0511	Experimental Designs	2+1	39
Common Courses			
PGSS 0501	Library and Information Services	1+0	40
PGSS 0502	Technical Writing and Communications Skills	1+0	41
PGSS 0503	Intellectual Property and its Management in agriculture	1+0	42
PGSS 0504	Basic concepts in laboratorytechniques	1+0	43
PGSS 0505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0	44

***Indicates core course which is compulsory course for M.Sc.(Agri.)**

M.Sc. (Agri.) Seed Science and Technology Syllabus

MAJOR COURSES

Course Code: MSST 0501
Credit Hours: 1+1
Course Title: Seed Developmental Biology*

Objective: To acquire knowledge on development and maturation of essential structures of seed and their influence on seed quality.

Theory

UNIT I

Floral biology – types of pollination, mechanisms; sporogenesis – micro and mega sporogenesis; gametogenesis – development of male and female gametes and their structures; pollination and fertilization – mode of pollination, double fertilization, factors affecting pollination, fertilization; self-incompatibility and male sterility.

UNIT II

Embryogenesis – development of monocot and dicot embryos, embryo plane formation, development of endosperm, cotyledons and seed coat – hard seed, apomixis – identification, classification, significance and its utilization; polyembryony – types and significance; haplontic and diplontic sterility system, causes ofembryo abortion, embryo rescue technique; somatic embryogenesis.

UNIT III

Seed development – source of assimilates – mechanism of translocation; chemical composition, synthesis and deposition of storage reserves – starch, protein, fat andsecondary metabolites – hormonal regulation.

UNIT IV

Maturation drying – Orthodox and recalcitrant seeds – desiccation tolerancemechanism – structural changes during desiccation – role of LEA protein.

UNIT V

Seed maturity indices – physiological and harvestable maturity; biotic and abiotic factors influencing seed development – development of hard seeds.

Practical

- Study on floral biology of monocot
- Study on floral biology of dicot plants
- Study on pollen morphology of different crops; Pollen germination andviability test in major crops

- Seed embryo and endosperm development in monocots
- Seed embryo and cotyledon development in dicots, Anatomy and morphology of seed coat during development; Hard seed coat development
- Study on external and internal structures
- Seed development and maturation in agricultural crops – physical and physiological changes
- Seed development and maturation in horticultural crops – physical and physiological changes
- Study of biochemical changes during seed development and maturation in agricultural crops; Study of biochemical changes during seed development and maturation in horticultural crops
- Study on physiological and harvestable maturity and maturity indices in different crops
- Study on acquisition of seed dormancy and germination at different stages of maturity
- Preparation of seed album and identification of seeds.

Teaching methods: Classroom teaching with AV aids, group discussion, assignment and class discussion

Learning outcome: Successful completion of this course enable student to take up advanced research on seed developmental biology and understanding on fundamental aspects of gametogenesis, seed development and maturity.

Suggested Reading

Adkins SW, Ashmore SE and Navi SC. 2007. *Seeds: Biology, Development and Ecology*. CABInternational, Oxford shire, UK.

Bewley JD and Black M. 1994. *Seeds: Physiology of Development and Germination*. Springer, NewYork.

Bewley JD, Bradford KJ, Hilhorst HWM and Nanogaki H. 2013. *Seeds: Physiology of Development, Germination and Dormancy*. Springer, New York.

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Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plants*. Department of Plant Breeding, CCSHAU, Hisar.

Copeland, LO and McDonald MB. 2001. *Principles of Seed Science and Technology*. 4th Ed. Kluwer Academic publishers, USA.

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

Hesse MH, Haidemarie R, Zettler M, Webber R, Buchner AR, Radivo and Ulrich S. 2009. *Pollen Terminology. An illustrated hand book*. Springer Verlag, New York. Press Inc., New York.

Maiti RK, Sarkar NC and Singh VP. 2006. *Principles of Post Harvest Seed Physiology and Technology*.Agrobios, Jodhpur, Rajasthan.

Suggested e-book

https://www.springer.com/in/book/9783642810619
https://www.springer.com/in/book/9780792373223
https://www.springer.com/gp/book/9780792346456
https://www.cabi.org/bookshop/book/9780851997230 https://www.worldcat.org/title/seed-development-and-germination/oclc/44954614
https://books.google.co.in/books/about/Seeds.html?id= Zbzr1F_z74C&redir_

Course Code: MSST 0502
Credit Hours: 1+1
Course Title: Seed Dormancy and Germination

Objective: To impart knowledge on significance, mechanism of dormancy, induction and release of seed dormancy and germination, types and factors influencing germination and their management.

Theory

UNIT I

Seed dormancy – definition, concept and theories – significance – evolution; classification and mechanism of dormancy – ecological significance.

UNIT II

Induction of dormancy during development – hormonal, physiological, molecularand genetic control of dormancy – maternal and paternal contribution;environmental factors influencing dormancy induction and release – seasonal influence – winter and summer annuals – secondary dormancy induction mechanism; artificial induction of dormancy and release; soil seed bank – natural release of dormancy and its mechanism; dormancy breaking – principles and methods.

UNIT III

Seed germination–types and phases of germination; imbibition–pattern and water kinetics–events of germination–physical, physiological, biochemical changes: aerobic and anaerobic respiration quiescent.

UNIT IV

Physiological and biochemical changes

Enzyme activation – mechanism – factors affecting enzyme activation, breakdown of stored materials – starch, protein and fat – energy generation, mobilization of storage reserves – changes in phenolic compounds.

UNIT V

Molecular and genetic mechanisms

Molecular and genetic control of seed germination – auto tropism; factors affecting germination – media – temperature – light – gases; *in-situ* and viviparous germination,

causes and mechanism – pattern of seed germination – tri-phasic curve.

Practical

- Seed dormancy – identification of dormancy
- Estimation of ABA and GA in dormant and non-dormant seeds
- Study on artificial induction of dormancy
- Dormancy breaking methods – scarification and stratification
- Dormancy breaking methods – hormonal and chemical treatments
- Dormancy breaking methods – after ripening and leaching of inhibitors.
- Dormancy breaking methods – combined treatments.
- Assessing the period of natural release of seed dormancy
- Seed germination – studying the pattern of imbibition
- Studying the pattern of seed germination in different media
- Study on influence of light and temperature on germination and seedlingdevelopment
- Estimation of hydrolytic enzyme – amylase in different species
- Estimation of hydrolytic enzyme – protease
- Estimation of hydrolytic enzyme – lipase
- Estimation of dehydrogenase enzyme and respiratory quotient in seeds
- Estimation of food reserve composition during seed germination.

Teaching methods: Classroom teaching with AV aids, group discussion, assignment and class discussion

Learning outcome: By learning this course, students will understand the fundamental theories and mechanism underlying in seed dormancy and germination which will be useful for both basic research and development.

Suggested Reading

Baskin C and Baskin JM. 2014. Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination. Academic Press, Cambridge, UK.

Bewley J and Black M. 1994. Physiology of Development and Germination. Springer, New York.

Bewley JD, Bradford KJ, Hilhorst HWM and Nanogaki H. 2013. Seeds: Physiology of Development, Germination and Dormancy. Springer, New York. Bewley JD and Black M. 1982. Physiology and Biochemistry of Seeds in

Relation to Germination.Volume 2: Viability, Dormancy and Environmental Control. SpringerLink, New York, USA.

Benech-Arnold R and Rodolfo S. 2004. Handbook of Seed Physiology: Applications to agriculture. CRC Press., Florida, USA.

Black M and Bewley JD. 2000. Seed Technology and its Biological Basis. CRC Press. Florida, USA.

Bradbeer JW. 1988. Seed Dormancy and Germination. Chapman and Hall, New York, USA.

David R. Murray. 1985. Seed Physiology. Volume 2: Germination and Reserve Mobilisation. Academic Press, London, UK.
Heydecker W. 1985. Seed Ecology. Pennsylvania State University Press,USA.
Khan AA. 1977. The Physiology and Biochemistry of Seed Dormancy and Germination. North Holland Publishing Company, USA.
Kozlowski TT. 2012. Seed Biology: Importance, Development and Germination. (Vol. I). Academic Press Inc., New York.
Maiti RK, Sarkar NC and Singh VP. 2012. Principles of Post Harvest SeedPhysiology and Technology. Agrobios, Jodhpur.
Maiti RK, Sarkar NC and Singh VP. 2006. Principles of Post Harvest SeedPhysiology and Technology. Agrobios, Jodhpur, Rajasthan.
Mayer AM and Mayber AP. 1963. Germination of Seeds. Pergamon Press,
OXford, New York**.** Prakash M. 2011. Seed Physiology of Crops. Satish SerialPublishing house. Azadpur. New Delhi.
Roberts EH. 1972. Viability of seeds. Springerlink, New York, USA**.**

Suggested e-book

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https://www.elsevier.com/books/seeds/baskin/978-0-12-416677-6
https://books.google.co.in/books/about/Physiology_and_Biochemistry_of_Seeds_in.html ?id=91nsCAAAQBAJ&printsec=frontcover&source=kp_read_ button&redir _esc=y#v= onepage&q&f=false
https://books.google.co.in/books/about/The_Germination_of_Seeds.html?id=aV62A gAAQBAJ& printsec=frontcover&source=kp_ read_button&redir_ esc=y#v=onepage&q&f=false
https://books.google.co.in/books/about/Seed_Dormancy_and_Germination.

Suggested Website

https://agriinfo.in/botany/18/https:/sproutnet.com/seed-dormancy/
https://www.britannica.com/science/germination http://www.biologyreference.com/Re-Se/Seed-Germination-and-Dormancy.html
https://www.intechopen.com/books/advances-in-seed-biology/seed-dormancy

Course Code: MSST 0503
Credit Hours: 2+1
Course Title: Seed Production Principles and Techniques in Field Crops*

Objective: To impart knowledge on principles and practices involved in quality seed production of field crops.

Theory
UNIT I

Importance of seed – seed quality concept – factors influencing seed production; generation system of seed multiplication – classes of seed, stages of seed multiplication in

varieties and hybrids – seed multiplication ratio (SMR) – seed replacement rate (SRR) – seed renewal period (SRP) – varietal replacement rate (VRR).

UNIT II

Genetic and agronomic principles of variety and hybrid seed production; methods and techniques of seed production in varieties and hybrids of important cereals and millets – wheat, oat, rice, maize, sorghum and pearl millet; varietal seed production in small millets, finger millet, fox tail millet, little millet, kodo millet, proso millet and barnyard millet.

UNIT III

Methods and techniques of varietal seed production in major pulses – black gram, green gram, cowpea, chickpea, horse gram, soybean and lentil – varietal and hybrid seed production in red gram.

UNIT IV

Methods and techniques of seed production in major oil seed crops – groundnut, sesame, varietal and hybrid seed production in sunflower, castor and mustard; varietal seed production in minor oilseed crops (safflower, linseed, Niger) – varietal and hybrid seed production in cotton – varietal seed production in jute.

UNIT V

Seed production planning for varieties and hybrids of major crops; participatory seed production – seed hubs, seed village concept and community seed bank.

Practical

- Seed selection – quality of seed on field establishment
- Sowing and nursery management techniques
- Planting – age of seedling on crop establishment – rice and pearl millet
- Isolation distance and border rows in hybrid seed production field – space and barrier isolation; modifying isolation based on border rows in maize
- Planting design for hybrid seed production – rice, maize, pearl millet, cotton, red gram, sunflower
- Practicing breeding tools for hybrid seed production – detasseling – emasculation and dusting
- Study on methods of achieving synchronization – rice, bajra, sunflower
- Practicing supplementary pollination – rice and sunflower
- Study on foliar nutrition and influence on seed yield
- Practicing rouging operation – identification of off-types, pollen shedders, shedding tassels, partials, selfed bolls
- Pre- and post-harvest sanitation operations – cereals, millets and pulses
- Estimation of shattering and shattering loss; study on in situgermination and loss
- Visit to seed production fields
- Visit to seed industry
- Seed production planning and economics of seed production – varieties

- Seed production planning and economics of seed production – hybrids.

Teaching methods: Classroom teaching with AV aids, group discussion, assignment and class discussion

Learning outcome: Successful completion of this course enable student to take up seedproduction venture in scientific manner to ensure seed quality and profitability.

Suggested Reading:

Agrawal RL. 2019. *Seed Technology*. Oxford & IBH Publishing Company Pvt. Ltd., New Delhi. Hebblethwaite PD. 1980. *Seed Production*. Butterworth Heinemann Ltd., London, UK.
Joshi AK and Singh BD. 2004. *Seed Science and Technology*. Kalyani Publishers, New Delhi. Kulkarni GN. 2011. *Principles of Seed Technology*. Kalyani Publishers, New Delhi.
Maiti RK, Sarkar NC and Singh VP. 2006. *Principles of Post Harvest Seed Physiology and Technology*. Agrobios, Jodhpur, Rajasthan.
McDonald MB and Copeland L. 1998. *Seed Production Principles and Practices*. CBS Publishers, New Delhi.
Mondal SS, Saha M and Sengupta K. 2009. *Seed Production of Field Crops*. New India Publishing Agency, New Delhi.
Singhal NC. 2003. *Hybrid Seed Production in Field Crops*. Kalyani Publications, New Delhi.Sen S and Ghosh N. 2010. *Seed Science and Technology*. Kalyani Publishers, New Delhi.
Singhal NC. 2010. *Seed Science and Technology*. Kalyani Publishers, New Delhi.

Suggested e-book

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https://www.springer.com/in/book/9780412075513
https://www.nipabooks.com/info/9788190723763/seed-production-of-field-crops
https://www.amazon.in/Production-Field-Crops-Brajesh-Tiwari/dp/9380179405
https://www.cambridge.org/core/journals/journal-of-agricultural-science/article/seed-production-
of-agricultural-crops-by-kelly-a-f-227-pages-harlow-longman-1988-price-2500- hard-covers-isbn-0-582- 40410-X/8BE3C99DFDC0F02D48E CB53418504D10

Suggested Website

https://agriinfo.in/botany/18/
http://www.fao.org/3/a-e8935e.pdf
http://www.agriquest.info/seed_production.php
http://agritech.tnau.ac.in/seed_certification/seedtech_indeX.html

Course Code: MSST 0504
Credit Hours: 2+1
Course Title: Seed Production: Principles and Techniques in Vegetable Crops*

Objective: To impart knowledge on principles and practices involved in quality seed production of vegetable crops.

Theory

UNIT I

Importance and present status of vegetable seed industry – factors influencing vegetable seed production; varietal and hybrid seed production techniques in major solanaceous vegetable crops – tomato, brinjal, chilli; malvaceous vegetable crop – seed production techniques of bhendi.

UNIT II

Varietal and hybrid seed production techniques in important cucurbitaceous vegetables – gourds and melons, cole crops – cauliflower, cabbage, knol-khol, root vegetables – carrot, beetroot, turnip, radish and other temperate/ hilly vegetable crops.

UNIT III

Varietal seed production techniques in major leguminous vegetables – peas and beans; seed production techniques in leafy vegetables – amaranthus, palak, spinach and lettuce.

UNIT IV

Seed production techniques in tuber crops – potato, sweet potato, colocasia, tapioca and yam, seed-plot technique in potato – true potato seed (TPS) Production techniques – seed production techniques in bulb crops – onion,garlic.

UNIT V

Vegetative and clonal multiplication – methods, merits and demerits; clonal multiplication – potato, sweet potato, colocasia,tapioca and yam.

Practical

- Identification of vegetable seeds
- Study on sowing and nursery management
- Study on transplanting and age of seedling on crop establishment
- Studying floral biology of solanaceous, malvaceous and cucurbitaceous vegetable crops
- Studying floral biology of other vegetable crops
- Practicing planting design for hybrid seed production
- Modification of sex ratio in cucurbits
- Practicing emasculation and pollination methods
- Practicing rouging operations – identification of off-types – selfed fruits
- Harvesting methods – single and multiple harvesting method

- Practicing seed extraction methods – wet methods – tomato, brinjal, other cucurbitaceous fruits
- Seed extraction – dry methods – chillies, bhendi, cucurbitaceous
- Visit to seed production fields
- Visit to private seed industry
- Planning and economics of varietal seed production
- Planning and economics of hybrid seed production.

Teaching methods: Classroom teaching with AV aids, group discussion, assignment and class discussion

Learning outcome: Successful completion of this course enable student to gain confidence and to become seed entrepreneur in high value low volume vegetable crops.

Suggested Reading

Agarwal RL. 2012. *Seed Technology*. OXford & IBH Publishing Company Pvt. Ltd., New Delhi. Chadha KL. 1995. *Advances in Horticulture*. Volume 1 to 13. Malhothra Publishing House, New Delhi.
George RAT. 1985. *Vegetable Seed Production*. Lonhman Inc., New York. Hebblethwaite PD. 1980. *Seed Production*. Butterworth Heinemann Ltd, London, UK.Kulkarni GN. 2011. *Principles of Seed Technology*. Kalyani Publishers, New Delhi.
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Sen S and Ghosh N. 2010. Seed Science and Technology. Kalyani Publishers, New Delhi.Singhal NC. 2010. *Seed Science and Technology*. Kalyani Publishers, New Delhi.
Vanangamudi K, Natarajan N, Srimathi P, Natarajan K, Saravanan T, Bhaskaran M, Bharathi A, Natesan P and Malarkodi K. 2006. *Advances in Seed Science and Technology*. Vol. 2. *Quality Seed Production in Vegetables*. Agro bios, Jodhpur.

Suggested e-book

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http://203.64.245.61/fullteXt-pdf/EB/1900-2000/eb0021.pdf
http://www.worldseed.org/wp-content/uploads/2017/01/Seed-Production-Good-practice-10.01.17- final.pdf
https://trove.nla.gov.au/work/6862691?q&sort=holdings+desc&1541066209257&versionId=45008917+251246346

Suggested Website

https://agriinfo.in/botany/18/
http://agritech.tnau.ac.in/seed_certification/seedtech_indeX.html

http://www.yspuniversity.ac.in/vgc/caft/Compendium2017-18.pdf
https://www.hort.vt.edu/Welbaum/seedproduction/Principles5.html
http://www.agrimoon.com/wp- content/uploads/Seed-Production-of-Vegetable.pdf
http://www.ciks.org/downloads/seeds/4.%20Seed%20Production%20Technique s %20for% 20Vegetables.pdf

Course Code: MSST 0505
Credit Hours: 2+1
Course Title: Seed Production Techniques in Fruits, Flowers, Spices, Plantation and Medicinal Crops

Objective: To impart comprehensive knowledge on seed production techniques in fruits, flowers, spices, plantation and medicinal crops.

Theory
UNIT I
Scope for seed production in fruits, flowers, spices, plantation and medicinal crops; factors influencing seed production and quality; propagation methods – seed and clonal propagation; seed and seedling standards; propagation and seed production techniques in major tropical, sub-tropical and temperate fruit crops; seed orchards– seed collection, extraction processing and storage techniques.

UNIT II
Seed production techniques in commercially important flower crops – nursery management, clonal propagation, planting, seed crop management, post-harvest seed handling and storage techniques.

UNIT III
Seed production techniques in commercially important seed spices and other spices – nursery management, sowing, seed crop management and post-harvest seed handling and storage techniques

UNIT IV
Seed production in commercially important plantation crops – mother tree selection – criteria– nursery management, elite seedling production, planting, plantation management, post- harvest handling and storage techniques.

UNIT V
Methods of quality seed production in commercially important medicinal plants – nursery management, sowing, seed crop management, post-harvest handling and storage methods.

Practical

- Study on the floral biology and pollination mechanism
- Identification of seeds of fruits, flowers, spices, plantation and medicinal crops
- Selection of mother plants and trees – phenotypic characters and genotypic characters
- Study on different types of clonal and vegetative propagules
- Seed and clonal standards of vegetatively propagating crops
- Germination improvement treatments for seeds and vegetative propagules
- Study on selection of planting materials and sowing methods
- Nursery management practices for elite seedling production
- Seed extraction methods – wet method and dry method
- Post-harvest seed handling – seed grading, upgrading techniques
- Study of seed storage techniques
- Practicing seed germination enhancement techniques in fruits, spices, and plantation crops
- Practicing seed germination enhancement techniques in flowers and medicinal crops
- Planning for seed production – economics of seed production in flower crops
- Visit to mother tree orchard
- Visit to plantation and orchard.

Teaching methods: Classroom teaching with AV aids, group discussion, assignment, class discussion and visit.

Learning outcome: Successful completion of this course enables the students to take up eliteseed and seedling production on commercial scale.

Suggested Reading

Chadha KL. 1995. *Advances in Horticulture*. (Volume 1 to 13). Malhotra Publishing House, New Delhi.

Hartman HT and Kester DE. 2000. *Plant Propagation: Principles and Practices*. Prentice Hall, New Jersey, USA.

Singh SP. 2001. *Seed Production of Commercial Vegetables*. Agrotech, New Delhi.

Vanangamudi K and Natarajan K. 2008. *Advances in Seed Science and Technology. Quality Seed Production in Spices, Plantation, Medicinal and Aromatic crops* (Vol. 5). Agrobios. Jodhpur.

Vanangamudi KM Prabu and Lakshmi S. 2012. *Advances in Seed Science and Technology Vol. Flower Seed Production*. Agrobios, Jodhpur.

Suggested book

http://www.worldseed.org/wpcontent/uploads/2017/01/Seed-Production-Good final.pdf

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4233836/

https://www.academia.edu/35629702/Hybrid_Seed_Production_and_Flowers

http://www.agrimoon.com/horticulture-icar-ecourse-pdf-books/

https://cbp.icar.gov.in/EBook.aspX

Suggested Website

www.cimap.res.in/english/indeX.php www.dmapr.org.in/amprs.kau.in/basic-page/publicationshttp://ecoursesonline.iasri.res.in/course/view.php?id=153
http://ecoursesonline.iasri.res.in/course/view.php?id=612
http://www.celkau.in/Crops/Plantation%20Crops/Rubber/production.aspX
http://sbc.ucdavis.edu/Courses/Seed_Production/

Course Code: MSST 0506
Credits Hours: 1+1
Course Title: **Seed Production Techniques in Forage, Pasture and Green Manure Crops**

Objective: To impart knowledge on basic principles and methods of quality seedproduction in forage and green manure crops.

Theory

UNIT I

Scope and importance of seed production in forage, pasture and green manure crops, factors influencing seed production – seasonal influence;
problems and constraints in seed production – seed set, shattering and seed dormancy; vegetative and clonal propagules and apomictic seed.

UNIT II

Quality seed production techniques in major fodder crops – lucerne, hedgelucerne, leucaena, fodder sorghum, fodder maize and oats.

UNIT III

Seed and planting material production techniques of major forage grasses –bajra-napier grass, guinea grass, deenanath grass and *Cenchrus* sp.; forage legumes *Stylosanthus*, cowpea and berseem.

UNIT IV

Seed production techniques in major green manure crops – *Glyricidia*, *Sesbania* sp., sunnhemp, daincha, jute and *Tephrosia* sp.

UNIT V

Post-harvest seed handling – processing, threshing, grading and upgrading; dormancy breaking and germination improvement – quality standards for seed and vegetative propagules.

Practical

- Seed collection and identification of seeds
- Estimation of seed setting and shattering loss
- Maturity indices – determination of physiological and harvestable maturity

- Seed extraction and threshing methods
- Separation of ill filled seeds – practicing different methods
- Study of seed and clonal materials – standards
- Quality of planting material and vegetative propagules on crop establishment
- Seed quality analysis in forage and fodder crops – tiller wise quality analysis
- Seed quality analysis in determinate and indeterminate crops
- Study on effect of ratooning on seed quality
- Practicing seed quality enhancement techniques
- Practicing different seed extraction and dormancy breaking treatments
- Preparation of vegetative propagules and planting
- Planning for seed production in fodder and green manure crops
- Economics of seed production in fodder, forage crops and green manure crops
- Visit to forage and fodder seed production farms.

Teaching methods: Classroom teaching with AV aids, group discussion, assignment class discussion and field visit.

Learning outcome: After completion of course the students gain confidence to start a seed venture on forage and green manure crops.

Suggested Reading

FAO. 2007. *Quality Declared Seed System*. FAO Plant Production and Protection Publication,FAO, Rome.
Farity DT and Hampton JC. 1997. *Forage Seed Production*. Vol. I. *Temperate Species*. CABInternational Publications. UK.
Froma J. 1997. *Temperate Forage Legumes*. CAB International Publications. UK.
Gutterridge RG. 1997. *Forage Tree Legumes in Tropical Agriculture*. CAB International Publications, UK.
Masilamani S and Sivasubramanian K. 2016. *Seed Production in Green Manures*. Kalyani Publications, New Delhi.

Suggested e-book

https://www.cabi.org/bookshop/book/9780851992143
https://cgspace.cgiar.org/handle/10568/49375
http://www.fao.org/docrep/009/a0503e/a0503e00.htm
http://www.igfri.res.in/pdf/old_bulletins/tropical_pasture.pdf
https://cgspace.cgiar.org/bitstream/handle/10568/4479/Seed.pdf?sequence= 1&isAllowed=y

Suggested Website

www.igfri.res.in/
https://cgspace.cgiar.org/handle/10568/4479 https://www.euroseeds.eu/grasses- and-clovers
https://www.sare.org/learning-center/green-manures
www.ndri.res.in/ndri/Design/forageres_mag_cen.html
http://orgprints.org/30588/1/Sort%20Out%20Your%20Soil.pdf

Course Code: MSST 0507
Credit Hours: 2+1
Course Title: Seed Legislation and Certification*

Objective: To impart knowledge on seed legislation in relation to seed certification and quality control systems.

Theory

UNIT I

Genesis of seed Industry in India; seed quality control – concept and objectives; regulatory mechanisms – Seed Act (1966) – Seed Rules (1968) – statutory bodies– Central Seed Committee – Central Seed Certification Board.

UNIT II

Seed Control Order (1983) – New Policy on Seed Development (1988) – Exim Policy – National Seed Policy (2002) – Plant Quarantine Act.

UNIT III

Introduction to WTO and IPR – UPOV and its role – OECD seed certification schemes – PPV & FR Act (2001) and Rules (2003) – Seed Bill (2004 and 2011): Seed certification system in SAARC countries, Europe, Canada, Australia and USA.

UNIT IV

Seed certification – history and objectives; general and specific crop standards, field and seed standards; seed certification agency – role of certification agency/ department and seed certification officers, phases of seed certification; field inspection – counting procedures – liable for rejection (LFR) – downgrading and partial rejection – reporting.

UNIT V

Post-harvest inspection – construction of seed lot number; seed sampling – testing – labeling, sealing and grant of certificate – types and specifications for tags and labels; seed lot validity and revalidation; appellate authority, stop sale order, penalties records and registers to be maintained by seed processing units and seed dealers – verification procedures, role of seed analyst and seed inspector in quality regulation.

Practical

- Preparation of sowing report – varieties – transplanted and direct sown crops and hybrids
- Verification of sowing report – seed certification procedures
- Field inspection – estimation of area and isolation distance, stages of inspection forvarieties and hybrids – procedures
- Practicing field counting procedures – methods for row planting, broadcasted –varieties
- Practicing field counting procedures – direct sown and transplantedcrop varieties

- Study on field counting procedures – hybrids – planting design, planting ratioand block method and double count
- Identification of contaminants –genetic and physical contaminants, procedure to remove partials, pollen shedders and shedding tassels
- Assessing and calculation of field standards for important crops
- LFR, partial rejection and downgrading –reasons, procedures andpreparation of reports
- Yield estimation – single and multiple harvest crops
- Post-harvest inspection – groundnut, cotton, pulses
- Inspection and maintenance (license and renewal) of records in processing unit –Visit to seed certification agency/ department
- Visit to grow-out test field
- Visit to seed retail shop – procedures followed by Seed Inspector, verification of records and reporting
- Procedure to issue tag, specification, bagging, tagging, labelling andsealing.

Teaching methods: Classroom teaching with AV aids, group discussion, assignment class discussion and field visit.

Learning outcome: This course will be useful to develop human resource on seed certification and legislation. Successful completion of this course enables students to become a Seed Certification Officer and Seed Inspector.

Suggested Reading

Agarwal RL. 2012. *Seed Technology*. Oxford & IBH Publishing Company Pvt. Ltd., New Delhi. Anon. 2016. *Manual of Seed Certification Procedures*. Directorate of Seed Certification, Coimbatore, Tamil Nadu.

Chakrabarthi SK. 2010. *Seed Production and Quality Control*. Kalyani Publishers,New Delhi.

Mishra DK, Khare D, Bhale MS and Koutu GK. 2011. *Handbook of Seed Certification*. Agrobios, Jodhpur, Rajasthan.

Neema NP. 1986. *Principles of Seed Certification and Testing*. Allied Publishers, New Delhi Ramamoorthy K, Sivasubramaniam K and Kannan M. 2006. *Seed Legislation in India*. Agrobios, Jodhpur, Rajasthan.

Renugadevi J, Srimathi P, Renganayaki PR and Manonmani V. 2012. *A Handbook of Seed Testing*. Agrobios, Jodhpur, Rajasthan.

Sharma P. 2008. *Seed Legislation*. Gene-tech Book Publishers, New Delhi.

Trivedi PC. 2011. *Seed Technology and Quality Control*. Pointer Publications, Jaipur, Rajasthan. Tunwar NS and Singh SV. 2003. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, Ministry of Agriculture, GOI, New Delhi.

Suggested e-book

http://cms.tn.gov.in/sites/default/files/documents/seed-certification-0.pdf

http://odishaseedsportal.nic.in/SeedPortalData/Resource%20Material/INDIAN- MINIMUM-SEED-CERTIFICATION-STANDARDS.pdf

https://www.india.gov.in/my-government/documents/e-books
https://books.google.co.in/books/about/Principles_of_Seed_Certification_and_
Tes.html?id=SQWHAAAACAAJ&redir_esc=y
https://dl.sciencesocieties.org/publications/books/tocs/cssaspecialpubl/theroleofseedce

Suggested Website
www.fao.org
www.agri.nic.in
www.agricoop.nic.in
www.gov.mb.ca
http:/agritech.tnau.ac.inwww.betterseed.org
www.oecd.org/india/
http://www.tnagrisnet.tn.gov.in/
https://pir.sa.gov.au/_data/assets/pdf_file/0003/148134/SeedCertification Manual.pdf

Course Code: MSST 0508
Credit Hours: 2+1
Course Title: Post Harvest Handling and Storage of Seeds*

Objective: To impart knowledge on principles, techniques and methods of seed processing, treatment, and storage.

Theory
UNIT I
Seed processing – objectives and principles; processing sequence – threshing, shelling, ginning, extraction methods; drying – principles and methods; seed cleaning, grading, upgrading – methods – machineries and equipment – scalper, pre-cleaner, cleaner cum grader, specific gravity separator, indented cylinder, disc separator, spiral separator, velvet separator, magnetic separator, electronic colour sorter – working principles and functions.

UNIT II
Online seed processing – elevators and conveyers – processing plant – specifications, design and layout; mechanical injury – causes and detection – management.

UNIT III
Seed treatment – methods – pre and mid storage seed treatments, seed treating formulations and equipments; packaging materials – types – bagging and labeling; seed blending – principle and methods.

UNIT IV
Seed storage – purpose and importance – factors affecting storage, optimum condition for storage of different seeds; storage principles – Harrington's thumb rule – concepts and significance of moisture equilibrium – maintenance of safe seed moisture – physical, physiological, biochemical and molecular changes during seed storage – storage behavior

of orthodox and recalcitrant seeds –
prediction of viability – viability nomograph.

UNIT V

Methods of seed storage – modified atmospheric storage – ultra dry storage – vacuum storage – cryopreservation – germplasm storage – gene banks – NBPGR, IPGRI and National seed storage laboratory; seed storage godown – structure – maintenance – sanitation.

Practical

- Seed Extraction – wet and dry methods
- Seed processing sequence for different crops
- Design of processing plant – equipments – estimation of processing efficiency
- Seed drying methods – principle and methods
- Practicing seed grading – upgrading techniques
- Delinting methods – assessment of mechanical damage
- Visit to seed processing unit
- Seed packaging – effect of packaging materials on seed longevity
- Prediction of viability during storage – viability nomograph and accelerated ageing test;
- Assessing physical changes during seed storage
- Assessing physiological changes during seed storage
- Assessing biochemical changes during seed storage
- Storage behaviour of recalcitrant seeds
- Pre-storage seed treatments – protectants – antioxidants – halogens
- Practicing seed blending methods
- Seed storage godown – sanitation, fumigation – visit to seed storage godown and coldstorage unit.

Teaching methods: Classroom teaching with AV aids, group discussion, assignment, class discussion and exposure and field visits

Learning outcome: The students will understand the principles and mechanism involved in seed processing, storage techniques and management practices to arrest the seed deterioration. Students will also acquire skill on seed handling and storage methods on commercial basis.

S**uggested Reading**

Barton LV. 1961. *Seed Preservation and Longevity*, (Vol. 1). Leonard Hill, London.

Gregg BR, Law AG, Virdi SS and Balis JS. 1970. *Seed Processing*. Avion printers, New Delhi.

Gupta D. 2009. *Seeds: their conservation principles and practices*. Sathish serial publishing house. New Delhi.

Justice OL and Bass LN. 1978. *Principles and Practices of Seed Storage*. Agriculture Hand Book No. 506, Castle House Publication Ltd., Washington.

Kulkarni GN. 2011. *Principles of Seed Technology*. Kalyani Publishers, New Delhi.

Maiti RK, Sarkar NC and Singh VP. 2006. *Principles of Post Harvest Seed Physiology and Technology*. Agrobios, Jodhpur, Rajasthan.
Padmavathi S, Prakash M, Ezhil Kumar S, Sathiyanarayanan G and Kamaraj A. 2012. *A Text book of Seed Science and Technology*, New India Publishing Agency, New Delhi.
Sen S and Ghosh N. 2010. *Seed Science and Technology*. Kalyani Publishers, New Delhi.Singhal NC. 2010. *Seed Science and Technology*. Kalyani Publishers, New Delhi.

Suggested e-book

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https://naldc.nal.usda.gov/download/CAT87208646/PDF
https://www.springer.com/in/book/9780792373223
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https://www.kopykitab.com/ebooks/2016/05/6997/sample/sample_6997.pdf
https://trove.nla.gov.au/work/6862691?q&sort=holdings+desc&-=1541066209257
&versionId=45008917+251246346
http://www.worldseed.org/wp-content/uploads/2017/01/Seed-Production-Good-practice-10.01.17-final.pdf

Suggested Website

http://www.fao.org/3/a-ah803e.pdf
agritech.tnau.ac.in/seed_certification/seedtech_indeX.html
http://ecoursesonline.iasri.res.in/mod/page/view.php?id=17806
http://www.bcseeds.org/wp-content/uploads/2015/01/Seed-Processing-2015-update.pdf
https://www.carolinafarmstewards.org/wpcontent/uploads/2012/05/Seed Processing and StorageVer_1pt3.pdf

Course Code: MSST 0509
Credit Hours: 1+1
Course Title: Seed Quality Testing and Enhancement*

Objective: To impart knowledge on principles, techniques and methods of seed testing and seed quality enhancement**.**

Theory
UNIT I

Seed testing – history and development; seed testing in India; ISTA and its role in seed testing; seed lot and size, types of seed and size, samples – sampling – intensity and methods, sampling devices, receipt and registration of submitted samples in the laboratory and sub sampling; purity analysis – components and procedure – determination of other distinguishable varieties (ODV) and test weight determination – application of heterogeneity test – method of testing coated and pelleted seeds; seed moisture estimation –principles and methods, application of tolerances.

UNIT II

Seed germination test – requirements, media and methods – seedling evaluation, tolerance and reporting results; viability test (TZ test) – principle, procedure and evaluation; vigour tests – concept of seed vigour and vigour test – types of vigour tests – direct and indirect tests – physical, physiological and biochemical tests – principles and methods; seed health test – principles and methods.

UNIT III

Genetic purity assessment – laboratory methods – physical, chemical, biochemical and molecular tests – growth chamber and field testing (Grow Out Test) methods; testing of GM seeds; storage of guard sample – referral test; application of tolerance in seed testing; advanced nondestructive techniques of seed quality analysis – soft X-ray imaging – hyper spectral imaging, thermal imaging – spectroscopy – e-nose and machine vision techniques.

UNIT IV

Seed quality enhancement techniques – history and development; classification – physical, physiological and protective seed treatments – special seed treatments; physical seed treatment – liquid floatation, specific gravity separation, irradiation, electric and electro-magnetic seed treatments – principles and methods – seed pelleting and coating principles, purpose and methods.

UNIT V

Physiological seed enhancement treatments – seed infusion, seed priming – principles and methods – physiological, biochemical and molecular mechanisms; pre-germination and fluid drilling techniques; biological seed treatments – microbial inoculation; organic seed treatment – integrated seed treatment – concept and methods of designer seed.

Practical

- Seed testing – sampling and dividing methods
- Determination of seed test weight and heterogeneity test
- Physical purity analysis – components, procedure, reporting results
- Seed moisture estimation – methods and equipments
- Conduct of seed germination test and seedling evaluation
- Conduct of quick viability (tetrazolium) test and evaluation
- Conduct of vigour tests – direct, indirect test and special tests
- Genetic purity assessment – laboratory and conventional methods – image analysis for seedquality
- Conducting different seed health tests to identify bacteria, fungi and insects
- Visit to seed testing laboratory
- Seed enhancement techniques – practicing physical treatments and water floatationtechniques
- Seed coating and pelleting – uses of adhesives and filler materials

- Performing seed priming – hydro, halo and bio-priming – solid matrix priming
- Practicing seed infusion and microbial inoculation treatments
- Practicing pre-germination technique
- Studying integrated seed treatment/ designer seed treatment.

Teaching methods: Classroom teaching with AV aids, group discussion, assignment class discussion and field visit.

Learning outcome: Successful completion of this course by the students will be useful to acquire technical skill on seed quality analysis which leads to the development of human resource on seed quality analysis.

Suggested Reading

Agrawal PK. 1993. *Hand book of Seed Testing*. Ministry of Agriculture, GOI,New Delhi
Agrawal RL. 1997. *Seed Technology*. OXford & IBH.
Agrawal PK and Dadlani M. 1992. *Techniques in Seed Science and Technology*. 2nd Ed. South Asian Publications.
Chakrabarthi SK. 2010. *Seed Production and Quality Control*. Kalyani Publishers. New Delhi. Chalam GV Singh A and Douglas JE. 1967. *Seed Testing Manual*. ICAR and United States Agency for International Development, New Delhi.
Copeland LO and McDonald MB. 2001. *Principles of Seed Science and Technology*. 4th Ed. Kluwer Academic publishers, USA.
International Seed Testing Association. 2018. *Handbook on Seedling Evaluation*, 4th Edition, Published by ISTA, Zurichstr, Switzerland.
International Seed Testing Association. 2019. *International Rules for Seed Testing* 2019. Published by ISTA, Zurichstr, Switzerland.
ISTA. 1999. *Seed Science and Technology*, 27th supplement.
Renugadevi J, Srimathi P, Renganayaki PR and Manonmani V. 2012. *A Hand book of Seed Testing*. Agrobios. Jodhpur, Rajasthan.
Tridevi PC. 2011. *Seed Technology and Quality Control*. Pointer Publication. Jaipur, Rajasthan. Vasudevan SN, Doddagowder SR, Rakesh CM and Patil SB. 2013. *Seed Testing and Quality Control*. Agrotech Publications, Udaipur, Rajasthan.

Suggested e-book

http://odishaseedsportal.nic.in/SeedPortalData/Resource%20Material/INDIAN MINIMUM SEED CERTIFICATION STANDARDS.pdf.
www.kopykitab.com/Seed-Testing-and-Quality-Control-by-Vasudevan-SN
https://www.jstor.org/stable/10.14321/j.ctt7zt51m
https://link.springer.com/chapter/10.1007/978-1-4615-1619-4_13
https://www.researchgate.net/publication/269694458_QUALITY_SEED_ PRODUCTION_ITS TESTING_AND_CERTIFICATION_STANDARD
https://www.seedtest.org/upload/cms/user/ISTAMethodValidationforSeed Testing-V1.01.pdf
https://www.intechopen.com/books/new-challenges- in-seed-biology-basic-and-translational-

research-driving-seed- technology/recent-advances-in-seed-enhancements

Suggested Website

http://agritech.tnau.ac.in/seed/Seed_seedtesting.html
https://core.ac.uk/download/pdf/85210907.pdf https://www.betterseed.org/resources/seed-testing-accreditation-schemes/
http://sbc.ucdavis.edu/About_US/Seed_Biotechnologies/Seed_Enhanceme
nt/ https://www.seedtest.org/en/international-rules-for-seed testing-content-1-1083. html

Course Code: MSST 0510
Credit Hours: 1+1
Course Title: Seed Technology of Tree Species

Objective: To make the students gain knowledge on seed production and handling techniques of various tree species.

Theory

UNIT I

Importance of tree seeds – seed quality in plantation establishment – scope of seed production in tree species; seed structure and its significance in natural regeneration of forest species.

UNIT II

Reproductive biology – angiosperms and gymnosperms – reproductive age – seasonal influence on flowering – reproductive efficiency; factors influencing seed set – pollination – pollinating agents – self incompatibility – seed dispersal –mode and mechanism of dispersal.

UNIT III

Seed stand – selection and delineation – seed production area – seed zone – selection criteria for candidate, plus and elite tree; seed orchards – definition – types – seedling and clonal seed orchard – pollen dilution zone – seed orchard
establishment and management; OECD certification programs for forest reproductive materials and seeds – ISTA certification standards for tree species.

UNIT IV

Physiological maturity – maturity indices – determining optimum harvestable maturity; seed collection – methods – factors influencing seed collection – precautions in collection of recalcitrant seeds; seed extraction – methods – wet, dry and cone extraction; drying – critical moisture content – seed processing; dormancy – types of dormancy in tropical, sub- tropical and temperate tree seeds – dormancy breaking treatments; recalcitrant seeds– mechanism.

UNIT V

Seed production and handling techniques in important tree borne oil seeds (*Madhuca*, *Pongamia*, *Azadirachta*, *Simaruba*, *Callophyllum*), timber (teak, sandal, pine, cedar, red

sanders, shisham), fuel wood (*Acacias*), pulp wood (Bambusa, *Ailanthus*, *Casuarina*, *Melia*, *Eucalyptus*), fodder (*Leucaena*, *Albizzia*) and ornamental (*Cassia*, *Delonix*) tree species.

Practical

- Study of tree seed structure – internal and external structures
- Study on phenology of different tree species
- Selection procedure of candidate and plus trees
- Assessment of seed set, physiological and harvestable maturity
- Assessing natural regeneration in different tree species
- Study on seed dispersal methods and dispersal distance in different species
- Seed collection techniques in important tree species – seed collection – Orthodox andrecalcitrant seeds – safety measures during collection
- Seed extraction methods – wet and dry extractions – fruits, pods, cones, etc.
- Study on different seed drying methods and precautions
- Practicing seed grading and upgrading techniques
- Practicing seed dormancy breaking methods
- Germination improvement treatments for elite seedling production
- Study on storage of recalcitrant seed
- Estimation of critical moisture content for safe storage
- Visit to seed production area and seed orchard
- Visit to tree seed processing unit.

Teaching methods: Classroom teaching with AV aids, group discussion, assignment, class discussion and field visit to seed orchard.

Learning outcome: Knowledge of the seed biology of a tree species enable to produce good quality seeds, handling and prevent loss of seeds. The knowledge on sexual life cycle enables them to plan for genetic improvement, production, collection, conditioning, storage, and planting of the seeds.

Suggested Reading

Dennis AJ, Schepp EN, Green RJ and West cott DA. 2007. *Seed Dispersal*. Agrobios, Jodhpur.Khanna LS. 1993. *Principles and Practices of Silviculture*. Khanna Bandhu, Dehradun, India. Lars Schmidt 2000. *Guide to Handling of Tropical and Sub Tropical Forest Seed*. Danida Forest
Seed Centre, Denmark.
Negi SS. 1998. *Forest Tree Seed*. International Book Distributors, Dehradun,India.
Ram Prasad and Khandya AK. 1992. *Handling of Forestry Seeds in India*. Associated Publishers, New Delhi.
Sivasubramaniam K, Raja K and Geetha R. 2012. *Recalcitrant Seeds – Causes and Effects*. Sathish Serial Publishing House. Azadpur, New Delhi.
Umarani R and Vanangamudi K. 2004. *An Introduction to Tree Seed Technology*. International Book Distributors, Dehradun.
Vanangamudi K, Natarajan K, Saravanan J, Natarajan N, Umarani R, Bharathi A and

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P. 2007. *Advances in Seed Science and Technology: Forest Tree SeedProduction* (Vol. 4). Agrobios,Jodhpur
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Suggested e-book

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http://www.fao.org/docrep/006/ad232e/ad232e00.htm
http://envis.nic.in/ifgtb/pdfs/Tree%20Seed%20Management.pdf
https://www.forestry.gov.uk/PDF/FCBU054.pdf/$FILE/FCBU054.pdf
https://www.forestry.gov.uk/PDF/FCBU059.pdf/$FILE/FCBU059.pdf

Suggested Website

www.ista.org.in
ifgtb.icfre.org/indeX.php
http://www.kfri.res.in/research.asp
http://www.fao.org/3/ad232e/AD232E21.htm
https://www.srs.fs.usda.gov/pubs/gtr/gtr_so107.pdf
http://www.sfri.nic.in/pdf_files/Seed%20Technology.pdf

Course Code: M SST 0511
Credit Hours: 1+1
Course Title: Seed Industry and Marketing Management

Objective: To empower the students to become seed entrepreneurs by imparting knowledge on seed industry management and marketing strategies.

Theory

UNIT I

Introduction to seed industry – genesis, growth and structure of seed industry – mission and objectives – present status of Indian and global seed industry – role of seed industry in Indian agriculture; government initiatives – seed hubs, seed villages and commUNITy seed production system.

UNIT II

Seed industry – organization set up and functions – public, private, MNC's, seed corporations; structure of small, medium and large seed industries, components of seed industry – public private partnership – custom seed production – risk management – human resource – infrastructure – processing UNIT – storage go down.

UNIT III

Seed production and distribution systems in state and central government; seed supply chain systems – seed production and distribution – planning, organization and coordination, staffing, assembling of resources; cost of seed production – overhead charges.

UNIT IV

Seed marketing – definition – importance – role of marketing; type of markets – domestic and global market – problems and perspectives; marketing policies – seed marketing schemes – marketing channels, responsibilities of dealers marketing mix.

UNIT V

Seed demand forecasting – purpose – methods and techniques; indenting and seed dispatch procedures and forms – seed store records – maintenance – missing link in seed supply chain; market intelligence – SWOT analysis; seed cost analysis; seed pricing – policy – components of seed pricing – factors – local market rate (LMR) – fixation of procurement and sale price of seed.

Practical

- Data collection on status of Indian and global seed industry
- Assessing the factors influencing farmers preference and assessment of seed demand and supply
- Planning for establishment of small, medium and large seed industry
- Planning for establishment of seed production and processing unit
- Economics of seed production – varieties and hybrids
- Seed pricings and cost analysis
- Exercise on fixing seed procurement and sale price
- Study of marketing channels – domestic and international
- Maintenance of carryover seeds – Assessing risk factors in seed industry and their management
- Survey and interaction with seed dealers and distributors
- Visit to state seed corporations
- Visit to MNCs and expert discussion
- Case studies and SWOT analysis
- Visit to modern seed processing unit and advanced seed storage complex
- Custom seed production, contract farming and procurement – procedures
- Planning and preparation of project proposal for setup of a seed industry

Teaching methods:

Classroom teaching with AV aids, group discussion, assignment, class discussion, Swot analysis and seed industry visit and interaction sessions

Learning outcome: On completion of this course students will gain knowledge and confidence to manage seed industry and able to address the problems in seed industry and seed marketing.

Suggested Reading

Acharya SS and Agarwal NL. 2004. *Agricultural Marketing in India*. 4th Ed. OXford and IBH. Broadway AC and Broadway A. 2003. *A Text Book of Agri- business Management*.
Kalyani Singh AK and Pandey S. 2005. *Rural Marketing*. New Age Publications.Kugbei S. 2008.
Seed Economics. Scientific Publishers, Jodhpur, Rajasthan.
Sharma P. 2008. *Marketing of Seeds*, Green-Tech Book Publishers, New Delhi.
Singh G and Asokan SR. 1991. *Seed Industry in India: A Management Perspective* OXford &IBHPublishing Co Pvt. Ltd., New Delhi.
Singh S. 2004. *Rural Marketing – Focus on agricultural Inputs*. Vikas Publishing House.

Suggested e-book

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http://www.fao.org/3/V4450E/V4450E00.htm
https://books.google.co.in/books?id=vPVlBos4WkYC
http://download.nos.org/srsec319new/319EL19.pdf
https://isengewant.de/Marketing-of-Seeds-By-Premjit-Sharma.pdf
https://www.kopykitab.com/A-Handbook-of-Seed-Processing-and-Marketing-by- Gaur-SC

Suggested Website

www.gov.mb.ca www.agricoop.nic.in www.agri.nic.in https://sathguru.com/seed/ http://www.fao.org/3/V4450E/V4450E03.htm https://www.seednet.gov.in/smis/SMIS-User%20Manual.pdf https://www.icrisat.org/seed-systems-models-lessons-learned/ https://www.bookdepository.com/Seed-Industry-India-Gurdev-Singh/

Course Code: MSST 0512
Credit Hours: 1+1
Course Title: Seed Health Testing and Management

Objective: To empower the students by imparting knowledge on seed testing management

Theory

UNIT I

History and economic importance of seed health in seed industry and plant quarantine important seed borne and seed transmitted pathogens – role of microorganisms in seed quality deterioration – storage and field fungi – effect of storage fungi on seeds – factors influencing storage fungi and management.

UNIT II

Transmission of pathogens – mode and mechanism – seed certification standards;mycotoxins – types and its impact on plant, animal and human health; seed health testing methods – direct examination, incubation, serological and molecular methods.

UNIT III

Production of disease-free seeds in agricultural and horticultural crops; management of seed borne pathogens – plant quarantine – Indian system and networking, post- entry quarantine and international systems – Pest Risk Analysis (PRA); Sanitary and Phytosanitary System (SPS) – certificates; International Seed Health Initiative (ISHI) on seed health standards.

UNIT IV

Storage pests – insects, mites, rodents and their development – economic importance; insect infestation – factors influencing, sources and kinds, biochemical changes in stored seeds due to insect infestation; detection methods and estimation of storage losses; types of seed storage structures – domestic and commercial.

UNIT V

Fumigation – principles and techniques – type of fumigants; preservatives and seed protectants on seed quality – non-chemical methods for managing seed storage pests – controlled and modified atmospheric storage – trapping devices – IPM for seed storage.

Practical

- Detection of seed borne pathogens – direct examination
- Detection of seed borne pathogens – incubation methods
- Detection of seed borne pathogens – serological methods
- Detection of seed borne pathogens – molecular methods
- Study on seed transmission of seed borne fungi, bacteria and viruses
- Identification of storage fungi
- Management of seed borne pathogens – seed treatment methods
- Identification of storage insects – internal and external feeders influencing insects
- Study on the effect of pre harvest spray on field carryover storage pests
- Estimation of storage losses due to pests
- Methods of detection of insect infestation
- Management of storage pests – pesticides, dose determination, preparation of solution and application
- Management of storage pests – non-chemical management methods
- Demonstration of controlled atmospheric storage
- Safe handling and use of fumigants and insecticides
- Visit to seed storage godowns.

Teaching methods: Classroom teaching with AV aids, group discussion, assignment class discussion laboratory experiments and hands on training.

Learning outcome: Successful completion of this course will provide knowledge on

production ofhealthy seeds by timely detection and management of seed borne pathogens and storage pests to meet phyto-sanitary requirements.

Suggested Reading

Agarwal VK and Sinclair JB. 1996. *Principles of Seed Pathology*.Edition,CRC Press Inc. BocaRaton, FL.

Athanassiou CG and Arthur FH. 2018. *Recent advances in stored product protection*. Springer-Verlag, Germany

Cotton, RT. 2007. *Insect Pests of Stored grain and Grain products*. Burgess Publ. Co., Minneopolis, Minn., USA

Karuna V. 2007. *Seed Health Testing*. Kalyani Publishers, New Delhi. Karuna V. 2009. *Fundamentals of Seed Pathology*. Kalyani Publishers, New Delhi.Neergaard P. 1979. *Seed Pathology*. Vol. 1. The MacmillanPress Ltd.

Ranjeet K. 2017. *Insect Pests of Stored grain – Biology, Behaviour and Management Strategies.* Apple Academic Press, New York, USA.

Suggested e-book

https://link.springer.com/book/10.1007/978-1-349-02842-9

https://books.google.co.in/books/about/Seed_Pathology.html?id=lvVJAAAAYAA&redir_esc =y https://www.taylorfrancis.com/books/9781315365695 https://www.ebooks.com/en-us/610606/insects-of-stored- products/david-rees/

https://www.elsevier.com/books/insects-and-seed-collection-storage-testing-and-certification/ kozlowski/978-0-12-395605-7

Suggested Website

www.tnagrisnet.tn.gov.in/

www.storedgrain.com.au/ https://openlibrary.org/subjects/seed_pathology

http://ciat- library.ciat.cgiar.org/articulos_ciat/2015/12620.pdf www.grainscanada.gc.ca/en/

https://entomology.ca.uky.edu/ef145 http://www.fao.org/3/t1838e/T1838E00.htm#Contents

https://www.agric.wa.gov.au/pest-insects/insect-pests-stored-grain

MINOR COURSES

Course Code: MMBB 0501
Credit Hours: 3+0
Course Title: Principles of Biotechnology

Objectives: To understand the basics of Molecular biology, plant and microbial biotechnology, importance and applications in agriculture, case studies and success stories and public education, perception, IPR and related issues

Theory
UNIT I
History, scope and importance of Biotechnology; Specializations in Agricultural Biotechnology: Genomics, Genetic engineering, Tissue Culture, Bio-fuel, Microbial Biotechnology, Food Biotechnology etc. Basics of Biotechnology, Primary metabolic pathways, Enzymes and its activities.

UNIT II
Structure of DNA, RNA and protein, their physical and chemical properties. DNA function: Expression, exchange of genetic material, mutation. DNA modifying enzymes and vectors; Methods of recombinant DNA technology; Nucleic acid hybridization; DNA/RNA libraries; Applications of gene cloning in basic and applied research, Plant transformation: Gene transfer methods and applications of GM crops.

UNIT III
Molecular analysis of nucleic acids -PCR and its application in agriculture and industry, Introduction to Molecular markers: RFLP, RAPD, SSR, SNP etc, and their applications; DNA sequencing, different methods; Plant cell and tissue culture techniques and their applications. Introduction to genomics, transcriptomics, ionomics, metabolomics and proteomics. Plant cell and tissue culture techniques and their applications.

UNIT IV
Introduction to Emerging topics: Genome editing, gene silencing, Plant microbial interactions, Success stories in Biotechnology, Careers and employment in biotechnology. Public perception of biotechnology; Bio-safety and bioethics issues; Intellectual property rights in biotechnology.

Suggested Reading
Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M & Losick R (2014) Molecular Biology of the Gene, 7th edition, Cold Spring Harbor Laboratory Press,New York.
Brown, T. A. (2010) Gene Cloning and DNA analysis an Introduction 6th edition, WileyBlackwell.
Primrose, S. B. and Twyman, R. (2006) Principles of gene Manipulation 7th edition,Wiley

Blackwell.
Singh, B. D, Biotechnology: Expanding Horizons (2012) 4th edition, Kalyani publisher,New Delhi, India.

Course Code: MMBB 0504
Credit Hours: 0+3
Course Title: Techniques in Molecular Biology I

Objectives: To get a basic overview of molecular biology techniques, good lab practices and recombinant DNA technology. To get a hands on training in chromatography, protein analysis, nucleic acidanalysis, bacterial and phage genetics.

Practical

- Good lab practices, preparation of buffers and reagents.
- Principle of centrifugation and spectrophotometry.
- Growth of bacterial culture and preparation of growth curve, Isolation of Genomic DNAfrom bacteria.
- Isolation of plasmid DNA from bacteria.
- Growth of lambda phage and isolation of phage DNA.
- Isolation and restriction of plant DNA (e.g. Rice / Moong / Mango / Merigold).
- Quantification of DNA by (a) Agarose Gel electrophoresis and (b) Spectrophotometry
- PCR using isolated DNA.
- PAGE Gel electrophoresis.
- Restriction digestion of plasmid and phage DNA, ligation, Recombinant DNAconstruction.
- Transformation of E. coli and selection of transformants
- Chromatographic techniques
- TLC
- Gel Filtration Chromatography
- Ion exchange Chromatography
- Affinity Chromatography
- Dot blot analysis, Southern hybridization, and Northern hybridization.
- Western blotting and ELISA.
- Radiation safety and non-radio isotopic procedure

Suggested Reading

Sambrook, J., and Russell, R.W (2001) Molecular cloning: A laboratory manual 3rd Edition, Cold spring harbor laboratory press, cold spring harbor, New York.
Wilson, K., and Walker, J., (2018) Principles and Techniques of Biochemistry and Molecular Biology 8th edition, Cambridge University Press.
Ausubel, F. M., Brent, R., Kingston, R. E., Moore, D. D., Seidman, J. G., Smith, J. A.,&Struhl, K., (2002) Short Protocols in Molecular Biology 5th edition, Current Protocols publication.

Course Code: MMBB 0509
Credit Hour: 2+1
Course Title: Plant Tissue Culture

Objectives: To provide insight into principles of plant cell culture and genetic transformation. To get a hands-on training in basic plant tissue culture techniques, callusing, micropropagation and analysis.

Theory

UNIT I

History of plant tissue culture, principle of Totipotency; Tissue culture media; Plant hormones and morphogenesis; Direct and indirect organogenesis; Direct and indirect somatic embryogenesis; Applications of plant tissue culture; National certification and Quality management of TC plants; Genetic Fidelity testing and Virus indexing methods – PCR, ELISA.

UNIT II

Micropropagation of field and ornamental crops; Virus elimination by meristem culture, meristem tip culture and micrografting; Androgenesis and gynogenesis - production of androgenic and gynogenic haploids - diploidization; Protoplast culture - isolation and purification; Protoplast culture; Protoplast fusion; Somatic hybridization - Production of Somatic hybrids and Cybrids; ,Wide hybridization - embryo culture and embryo rescue techniques; Ovule, ovary culture and endosperm culture.

UNIT III

Large-scale cell suspension culture - Production of alkaloids and other secondary metabolites- techniques to enhance secondary metabolite production, Somaclonal and gametoclonal variations – causes and applications; Callus culture and in vitro screening for stress tolerance; Artificial seeds, In vitro germplasm storage and cyro-preservation. Commercial Tissue Culture: Case studies and success stories, Market assessment; project planning and preparation, economics, government policies

Practical

- Preparation of stocks - macronutrients, micronutrients, vitamins and hormones,filter sterilization of hormones and antibiotics. Preparation of Murashige and Skoog medium.
- Micro-propagation of plants by nodal and shoot tip culture.
- Embryo culture to overcome incompatibility, Anther culture for haploid production.
- Callus induction in tobacco leaf discs, regeneration of shoots, root induction,role ofhormones in morphogenesis.
- Acclimatization of tissue culture plants and establishment in greenhouse.6.Virus indexing in tissue culture plants. (Using PCRand ELISA).

- Plan of a commercial tissue culture UNIT.

Suggested Reading

Razdan, M. K. (2003) Introduction to plant tissue culture, 2nd edition, Oxfordpublications group

Butenko, R. G. (2000) Plant Cell Culture University Press of Pacific

Herman, E. B., (2008) Media and Techniques for Growth, Regeneration and Storage, Agritech Publications, New York, USA.

Bhojwani, S.S and Dantu, P. 2013. Plant Tissue Culture – An Introductory Text. SpringerPublications

Gamborg, O.L and G.C.Philips (eds.). 2013. Plant Cell, Tissue and Organ culture-LabManual. Springer Science & Business media.

Course Code : MMBB 0517
Credit Hours : 2+0
Course Title : Stress Biology and Genomics

Objectives: To provide advanced knowledge on genomics with reference to abiotic stress tolerance and biotic stress resistance in plants tolerance.

Theory

UNIT I

Different kinds of stresses (biotic and abiotic) and adaptation strategies: Plant cell as a sensor of environmental changes; role of cell membranes in signal perception; Ways of signal transduction in cells and whole plants as a response to external factors. Abiotic stresses affecting plant productivity – Drought, salinity, water logging, temperature stresses, light stress and nutrient stress; Drought stress – Effects on plant growth and development; Components of drought resistance; Physiological, biochemical and molecular basis of tolerance mechanisms; Biotic stress (insect and pathogen) resistance mechanism.

UNIT II

Strategies to manipulate drought tolerance – Osmotic adjustment and Osmo protectants - synthesis of proline, glycine betaine, poly amines and sugars; ROS and antioxidants; hormonal metabolism - ABA signaling; signaling components – transcription factors. Water logging stress – effects on plant growth and metabolism; adaptation to water logging, tolerance mechanisms -hormones and flooding tolerance. Strategies for improving submergence tolerance. Salinity stress – effects on physiology and metabolism of plants, SOS pathways and ion homeostasis, Strategies to improve salinity tolerance in plants. Water logging stress – effects on plant growth and metabolism; tolerance mechanisms. Physiological and biochemical changes – High & Low temperature tolerance mechanisms- molecular basis of thermo tolerance. Morphological and physiological changes in plants due to high and low light stresses - photo oxidation -plastid development. Characters of heliophytes and sciophytes – solar tracking – sieve effect and light channeling. Heavy metal stress – Al and

Cd stress - effects on plant growth and development, biotech Strategies to overcome heavy metal stress Nutrient stress- effects on plant growth and development. Genetic manipulation strategies to overcome the stress effects.

UNIT III

Genomics; transcriptomes, small RNAs and epigenomes; functional genomics; transfer of tolerance/resistant genes to model plants and validation of gene function. Different techniques for the functional validation of genes. Signaling pathway related to defense gene expression, R proteins, RNAi approach and genes from pathogens and other sources, coat protein genes, detoxification genes, transgenic and disease management. Bt proteins, resistance management strategies in transgenic crops, ecological impact of field release of transgenic crops. Bioinformatics approaches to determine gene function and network in model plants under stress.

Suggested Reading

Buchanan, B. B., Gruissem, W. and Jones R, (2015) Biochemistry and Molecular Biology of Plants, 2nd edition, Wiley and Blackwell Publications.

Sarwat, M., Ahmad, A., Abdin, M.Z. (2013) Stress Signaling in Plants: Genomics andProteomicsPerspective, Volume 1, Springer.

HeribertHirt, (2010) Plant Stress Biology: From Genomics to Systems Biology,John Wiley.

Pandey, G. K., Elucidation of Abiotic Stress Signaling in Plants, Wiley.

SUPPORTING COURSES

Course Code: STAT 0502
Credit Hours: 3+1
Course Title: Statistical Methods for Applied Sciences

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 multivariate analytical techniques.

Theory

UNIT I

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

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 sample theory.

UNIT III

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 likelihood ethods, confidence interval for sensitivity;Testing for heterogeneity.

UNIT IV

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

UNIT V

Introduction to multivariate analytical tools- Hotelling's T2 Tests of hypothesis about the mean vector of a multinormal population. Classificatory problems and discriminant function, D2-statistic and its applications; Cluster analysis, principal component analysis, canonical correlationsand Factor analysis.

Practical

- Exploratory data analysis, Box-Cox plots
- Fitting of distributions Binomial, Poisson, Negative Binomial, Normal
- Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F
- Confidence interval estimation and point estimation of parameters of binomial, Poisson and Normal distribution
- Correlation and regression analysis, fitting of orthogonal polynomial regression Applications of dimensionality reduction and discriminant function analysis Nonparametric tests

Suggested Reading

Anderson TW. 1958. An Introduction to Multivariate Statistical
Analysis.John Wiley.Dillon WR & Goldstein M. 1984. Multivariate Analysis - Methods andApplications.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 WorldPress.
Hoel PG. 1971. Introduction to Mathematical Statistics. John Wiley.304
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.Learning Statistics: http://freestatistics.altervista.org/en/learning.php. Electronic

Statistics Text Book:
http://www.statsoft.com/textbook/stathome.html.

Course Code: STAT 0511
Credit Hours: 2+1
Course Title: Experimental Designs

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 experimental data.

Theory
UNIT I
Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.

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

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

UNIT IV
Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, cross over designs, balanced incomplete block design, resolvable designs and their applications ~ Lattice design, alpha design -concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

UNIT V

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

Practical

- Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law
- Analysis of data obtained from CRD, RBD, LSD
- Analysis of factorial experiments without and with confounding
- Analysis with missing data; Split plot and strip plot designs
- Transformation of data: Analysis of resolvable designs
- Fitting of response surfaces

Suggested Reading

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

COMMON COURSES

Course Code: PGSS 0501
Credit Hours: 0+1
Course Title: Library and Information Services

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 techniques/ Preparation of bibliography

- Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services
- Use of Internet including search engines and its resources; e- resources access methods

Course Code: PGSS 0502
Credit Hours: 0+1
Course Title: Technical Writing and Communications Skills

Objective: To equip the students/ scholars with skills to write dissertations, research papers, etc. To equip the students/ scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

- 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; pagination, 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), Concord, Collocation, Phonetic symbol s and transcription
- Accentual pattern: Weak forms in connected speech
- Participation in group discussion
- Facing an interview
- Presentation of scientific papers

Suggested Reading

Barnes and Noble. Robert C. (Ed.). 2005. *Spoken English: FlourishYourLanguage*.
Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
Collins' Cobuild English Dictionary. 1995.
Harper Collins. Gordon HM and Walter JA. 1970. *Technical Writing*. 3rd Ed.
Holt, Rinehart and Winston. Hornby AS. 2000. *Comp. Oxford Advanced Learner'sDictionary of 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*. 5th Ed.AffiliatedEast-West

Press.
Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
Richard WS. 1969. *Technical Writing*.
Sethi J and Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2ndEd.Prentice Hall of India.
Wren PC and Martin H. 2006. *High School English Grammar and Composition*.
S. Chand & Co.

Course Code: PGSS 0503
Credit Hours: 0+1
Course Title: Intellectual Property and its Management in Agriculture

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
Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rightsand biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; 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 Reading
Erbisch FH and 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. NRDCandAesthetic Technologies.
Ministry of Agriculture, Government of India. 2004. State of IndianFarmer.Vol.
V. Technology Generation and IPR Issues. Academic Foundation.
Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in AnimalBreeding and Genetics. CABI.
Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other DevelopingCountries: 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;

The Biological Diversity Act, 2002.

Course Code : PGSS 0504
Credit Hours : 0+1
Course Title : Basic Concepts in Laboratory Techniques

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

Practical

- Safety measures while in Lab
- Handling of chemical substances
- Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets
- Washing, drying and sterilization of glassware
- Drying of solvents/ chemicals
- Weighing and preparation of solutions of different strengths and their dilution
- Handling techniques of solutions
- Preparation of different agro-chemical doses in field and pot applications
- Preparation of solutions of acids
- Neutralization of acid and bases
- Preparation of buffers of different strengths and pH values
- Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath
- Electric wiring and earthing
- Preparation of media and methods of sterilization
- Seed viability testing, testing of pollen viability
- Tissue culture of crop plants
- Description of flowering plants in botanical terms in relation to taxonomy

Suggested Reading

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
Gabb MH and Latchem WE. 1968. A Handbook of Laboratory Solutions. ChemicalPubl. Co.

Course Code: PGSS 0505
Credit Hours: 1+0
Course Title: Agricultural Research, Research Ethics and Rural Development Programms

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

UNIT II
Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III
Concept and connotations of rural development, rural development policies andstrategies. Rural development programmes: CommUNITy Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co- operatives, Voluntary Agencies/ Non- Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementationof rural policies and programmes.

Suggested Reading
Bhalla GS and Singh G. 2001. Indian Agriculture - Four Decades ofDevelopment.Sage Publ.
Punia MS. Manual on International Research and Research Ethics.
CCSHaryanaAgricultural 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 andManagement. SagePubl.