Ph. D. Courses under the Programme: Ph. D. in Agriculture, Rural and Tribal Development

Major Courses under Research Areas of Horticulture with specialization in Vegetable Science and Agricultural Extension

AREA	CODE	COURSE TITLE	CREDITS
Major/Minor	ARTD-R-101	ORGANIC VEGETABLE PRODUCTION TECHNOLOGY	1+1
	ARTD- R -102	ADVANCES IN VEGETABLE PRODUCTION	2+1
	ARTD- R -103	ADVANCES IN BREEDING OF VEGETABLE CROPS	2+1
	ARTD-R-104	PROTECTED CULTIVATION OF VEGETABLE CROPS	1+1
	ARTD-R-105	BIOTECHNOLOGY OF VEGETABLE CROPS	2+1
	ARTD-R-106	SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS	2+1 (Revised Credit as on 25.08.2017: 2 +2= 4)
	ARTD-R-107	SEED CERTIFICATION, PROCESSING AND STORAGE OF VEGETABLE CROPS	1+1
	ARTD-R-117	PRODUCTION TECHNOLOGY OF UNDEREXPLOITED VEGETABLE CROPS	2+1
	ARTD-R-108	EMERGING SCENARIO IN RURAL SECTORS	3+1
	ARTD-R-109	EMERGING THOUGHTS AND TECHNIQUES IN EXTENSION	3+1
	ARTD-R-110	SUSTAINABLE RURAL LIVELIHOODS	2 + 2
	ARTD-R-111	ADVANCES IN TRAINING TECHNOLOGY	2 + 1
	ARTD-R-112	TRANSFER OF TECHNOLOGY IN AGRICULTURE	2 + 1
	ARTD-R-113	DIFFUSION AND ADOPTION OF INNOVATIONS	2 + 1
Compulsory/ Supporting	ARTD-R-151	REVIEW OF LITERATURE	1 +1
	ARTD-R-152	ADVANCED RESEARCH METHODOLOGY	2 + 2
	ARTD-R-153	APPLICATION OF COMPUTER IN RESEARCH	0 + 2
Compulsory	ARTD- 950	DOCTORAL SEMINAR-I	1+0
	ARTD- 951	DOCTORAL SEMINAR-II	1+0
	ARTD- 999	DOCTORAL RESEARCH	0+45

ARTD-R-101 ORGANIC VEGETABLE PRODUCTION TECHNOLOGY 1+1

Objective

To educate principles, concepts and production of organic farming in vegetable crops.

Theory

UNIT I

Importance, principles, perspective, concept and component of organic production of vegetable crops.

UNIT II

Organic production of vegetables crops, *viz.*, solanaceous crops, cucurbits, cole crops, root and tuber crops.

UNIT III

Managing soil fertility, pests and diseases and weed problems in organic farming system; crop rotation in organic horticulture; processing and quality control for organic foods.

UNIT IV

Methods for enhancing soil fertility, mulching, raising green manure crops. Indigenous methods of compost, Panchagavvya, Biodynamics, preparation *etc.* Pest and disease management in organic farming; ITK's in organic farming. Role of botanicals and bio-control agents.

UNIT V

GAP and GMP- Certification of organic products; organic production and export - opportunity and challenges.

Practical

Method of preparation of compost, vermicomposting, biofertilizers, soil solarization, bio pesticides in horticulture, green manuring, mycorrhizae and organic crop production, waste management, organic soil amendment for root disease, weed management in organic horticulture. Visit to organic fields and marketing centers.

Suggested Readings

Dahama AK. 2005. *Organic Farming for Sustainable Agriculture*. 2nd Edition Agrobios.

Gehlot G. 2005. *Organic Farming; Standards, Accreditation Certification and Inspection*. Agrobios.

Palaniappan SP & Annadorai K. 2003. *Organic Farming, Theory and Practice*. Scientific Publication.

Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*. New India Publ. Agency.

Shivashankar K. 1997. *Food Security in Harmony with Nature*. 3rd IFOAMASIA, Scientific Conf. 1- 4 December, 1997, UAS, Bangalore.

ARTD-R-102 ADVANCES IN VEGETABLE PRODUCTION 2+1

Objective

To keep abreast with latest developments and trends in production technology of vegetable crops.

Theory

Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing of:

UNIT I

Tomato, brinjal, chilli, sweet pepper and potato

UNIT II

Cucurbits, cabbage, cauliflower and knol-khol

UNIT III

Bhendi, onion, peas and beans, amaranthus and drumstick

UNIT IV

Carrot, beet root and radish

UNIT V

Sweet potato, tapioca, elephant foot yam and taro

Practical

Seed hardening treatments; practices in indeterminate and determinate vegetable growing and organic gardening; portrays and ball culture; diagnosis of nutritional and physiological disorders; analysis of physiological factors like anatomy; photosynthesis; light intensity in different cropping situation; assessing nutrient status, use of plant growth regulators; practices in herbicide application; estimating water requirements in relation to crop growth stages, maturity indices; dryland techniques for rainfed vegetable production; production constraints; analysis of different cropping system in various situation like cold and hot set; vegetable waste recycling management; quality analysis; marketing survey of the above crops; visit to vegetable and fruit mals and packing houses.

Suggested Readings

Bose TK & Som NG. 1986. *Vegetable Crops of India*. Naya Prokash.

Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.

Brewster JL. 1994. *Onions and other Vegetable Alliums*. CABI.

FFTC. *Improved Vegetable Production in Asia*. Book Series No. 36.

Ghosh SP, Ramanujam T, Jos JS, Moorthy SN & Nair RG. 1988. *Tuber Crops*. Oxford & IBH.

Gopalakrishnan TR. 2007. *Vegetable Crops*. New India Publishing Agency.

Kallo G & Singh K. (Ed.). 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.

Kurup GT, Palanisami MS, Potty VP, Padmaja G, Kabeerathuma S & Pallai SV. 1996. *Tropical Tuber Crops, Problems, Prospects and Future Strategies*. Oxford & IBH.

Sin MT & Onwueme IC. 1978. *The Tropical Tuber Crops*. John Wiley & Sons.

Singh NP, Bhardwaj AK, Kumar A & Singh KM. 2004. *Modern Technology on Vegetable Production*. International Book Distr. Co.

Singh PK, Dasgupta SK & Tripathi SK. 2006. *Hybrid Vegetable Development*. International Book Distr. Co.

ARTD-R-103 ADVANCES IN BREEDING OF VEGETABLE CROPS 2+1

Objective

To update knowledge on the recent research trends in the field of breeding of vegetable crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance of:

UNIT I

Tomato, brinjal, chilli, sweet pepper and potato

UNIT II

Cucurbits, Cabbage, cauliflower and knol-khol

UNIT III

Bhendi, onion, peas and beans, amaranthus and drumstick

UNIT IV

Carrot, beet root and radish

UNIT V

Sweetpotato, tapioca, elephant foot yam and taro

Practical

Designing of breeding experiments, screening techniques for abiotic stresses, screening and rating for pest, disease and nematode resistance, estimation of quality and processing characters, screening for-quality improvement, estimation of heterosis and combining ability, induction and identification of mutants and polyploids, distant hybridization and embryo rescue techniques.

Suggested Readings

Acta Horticulture. Conference on Recent Advance in Vegetable Crops. Vol. 127.

Chadha KL, Ravindran PN & Sahijram L. 2000. *Biotechnology in Horticultural and Plantation Crops*. Malhotra Publ. House.

Chadha KL. 2001. *Hand Book of Horticulture*. ICAR.

Dhillon BS, Tyagi RK, Saxena S & Randhawa GJ. 2005. *Plant Genetic Resources: Horticultural Crops*. Narosa Publ. House.

Janick JJ. 1986. *Horticultural Science*. 4th Ed. WH Freeman & Co.

Kaloo G & Singh K. 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals and Book Publ. House.

Kaloo G. 1994. *Vegetable Breeding*. Vols. I-III. Vedams eBooks.

Peter KV & Pradeep Kumar T. 2008. *Genetics and Breeding of Vegetables*. (Revised Ed.). ICAR.

Ram HH. 2001. *Vegetable Breeding*. Kalyani Publishers.

ARTD-R-104 PROTECTED CULTIVATION OF VEGETABLE CROPS 1+1

Objective

To impart latest knowledge in growing of vegetable crops under protected environmental condition.

Theory

Crops: Tomato, capsicum, cucumber, melons and lettuce

UNIT I

Importance and scope of protected cultivation of vegetable crops; principles used in protected cultivation, energy management, low cost structures; training methods; engineering aspects.

UNIT II

Regulatory structures used in protected structures; types of greenhouse/polyhouse/nethouse, hot beds, cold frames, effect of environmental factors, *viz.* temperature, light, CO_2 and humidity on growth of different vegetables, manipulation of CO2, light and temperature for vegetable production, fertigation.

UNIT III

Nursery raising in protected structures like poly-tunnels, types of benches and containers, different media for growing nursery under cover.

UNIT IV

Regulation of flowering and fruiting in vegetable crops, technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, training and staking in protected crops, varieties and hybrids for growing vegetables in protected structures.

UNIT V

Problem of growing vegetables in protected structures and their remedies, insect and disease management in protected structures; soil-less culture, use of protected structures for seed production**.**

Practical

Study of various types of structures, methods to control temperature, CO_2 light, media, training and pruning, maintenance of parental lines and hybrid seed production of vegetables, fertigation and nutrient management, control of insect-pests and disease in greenhouse; economics of protected cultivation, visit to established green/polyhouse/net house/shade house in the region.

Suggested Readings

Anonymous 2003. Proc. All India Seminar on Potential and Prospects for Protective Cultivation. Organised by Institute of Engineers,

Ahmednagar. Dec.12-13, 2003.

Chandra S & SomV. 2000. Cultivating Vegetables in Green House. Indian Horticulture 45: 17-18.

Prasad S & Kumar U. 2005. Greenhouse Management for Horticultural Crops. 2nd Ed. Agrobios.

Tiwari GN. 2003. Green House Technology for Controlled Environment. Narosa Publ. House.

ARTD-R-105 BIOTECHNOLOGY OF VEGETABLE CROPS 2+1

Objective

To teach advances in biotechnology for improvement of vegetable crops.

Theory

Crops: Tomato, eggplant, hot and sweet pepper, potato, cabbage, cauliflower, tapioca, onion, cucurbits.

UNIT I

In vitro culture methods and molecular approaches for crop improvement in vegetables, production of haploids, disease elimination in horticultural crops, micro grafting, somoclones and identification of somaclonal variants, *in vitro* techniques to overcome fertilization barriers, *in vitro* production of secondary metabolites.

UNIT II

Protoplast culture and fusion; construction, identification and characterization of somatic hybrids and cybrids, wide hybridization, embryo rescue of recalcitrant species, *in vitro* conservation.

UNIT III

In vitro mutation for biotic and abiotic stresses, recombinant DNA methodology, gene transfer methods, tools, methods, applications of rDNA technology.

UNIT IV

Quality improvement, improvement for biotic and abiotic stresses, transgenic plants.

UNIT V

Role of molecular markers in characterization of transgenic crops, fingerprinting of cultivars etc., achievements, problems and future thrusts in horticultural biotechnology.

Practical

Establishment of axenic explants, callus initiation and multiplication, production of suspension culture, cell and protoplast culture, fusion, regeneration and identification of somatic hybrids and cybrids; Identification of embryonic and non-embryonic calli, development of cell lines; *in vitro* mutant selection for biotic and abiotic stresses, *In vitro* production and characterization of secondary metabolites, isolated microspore culture, isolation and amplification of DNA, gene transfer methods, molecular characterization of transgenic plants.

Suggested Readings

Bajaj YPS. (Ed.). 1987. *Biotechnology in Agriculture and Forestry*. Vol.XIX. *Hitech and Micropropagation*. Springer.

Chadha KL, Ravindran PN & Sahijram L. (Eds.). 2000. *Biotechnology of Horticulture and Plantation Crops*. Malhotra Publ. House.

Debnath M. 2005. *Tools and Techniques of Biotechnology*. Pointer Publ.

Glover MD. 1984. *Gene Cloning: The Mechanics of DNA Manipulation*. Chapman & Hall.

Gorden H & Rubsell S. 1960. *Hormones and Cell Culture*. AB Book Publ.

Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Tissue Culture and Gene Transfer.* Orient & Longman (Universal Press).

Keshavachandran R et al. 2007. *Recent Trends in Biotechnology of Horticultural Crops*. New India Publ. Agency.

Panopoulas NJ. (Ed.). 1981. *Genetic Engineering in Plant Sciences*. Praeger Publ.

Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops*. Vols. I-III. Naya Prokash.

Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ.

Prasad S. 1999. *Impact of Plant Biotechnology on Horticulture*. 2nd Ed. Agro Botanica.

Sharma R. 2000. *Plant Tissue Culture*. Campus Books.

Singh BD.2001. *Biotechnology*. Kalyani.

Skoog Y & Miller CO. 1957. *Chemical Regulation of Growth and Formation in Plant Tissue Cultured in vitro.* Attidel. II Symp. on Biotechnology Action of Growth Substance.

Vasil TK, Vasi M, While DNR & Bery HR. 1979. *Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World*

Agriculture. Planum Press. Williamson R. 1981-86. *Genetic Engineering*. Vols. I-V.

ARTD-R-106 SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS 2+1

Objective

To educate principles and methods of quality seed and planting material production in vegetable crops.

Theory

UNIT I

Definition of seed and its quality, new seed policies; DUS test, scope of vegetable seed industry in India.

UNIT II

Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behaviour, seed development and maturation; methods of hybrid seed production.

UNIT III

Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control.

UNIT VI

Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology.

UNIT V

Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, leafy vegetables, okra, vegetatively propagated vegetables.

Practical

Seed sampling, seed testing (genetic purity, seed viability, seedling vigour, physical purity) and seed health testing; testing, releasing and notification procedures of varieties; floral biology; rouging of off-type; methods of hybrid seed production in important vegetable and spice crops; seed extraction techniques; handling of seed processing and seed testing equipments; seed sampling; testing of vegetable seeds for seed purity, germination, vigour and health; visit to seed processing units, seed testing laboratory and seed production farms.

Suggested Readings

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

Agrawal RL. (Ed.). 1997. *Seed Technology*. Oxford & IBH.

Bendell PE. (Ed.). 1998. *Seed Science and Technology: Indian Forestry Species*. Allied Publ.

Fageria MS, Arya PS & Choudhary AK. 2000. *Vegetable Crops: Breeding and Seed Production*. Vol. I. Kalyani.

George RAT. 1999. *Vegetable Seed Production*. 2nd Ed. CABI.

Kumar JC & Dhaliwal MS. 1990. *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ.

More TA, Kale PB & Khule BW. 1996. *Vegetable Seed production Technology*. Maharashtra State Seed Corp.

Rajan S & Baby L Markose. 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.

Singh NP, Singh DK, Singh YK & Kumar V. 2006. *Vegetable Seed Production Technology*. International Book Distributing Co.

Singh SP. 2001. *Seed Production of Commercial Vegetables*. Agrotech Publ. Academy.

ARTD-R-107 SEED CERTIFICATION, PROCESSING AND STORAGE OF VEGETABLE CROPS 1+1

Objective

To educate the recent trends in the certification, processing and storage of vegetable crops.

Theory

UNIT I

Seed certification, objectives, organization of seed certification, minimum seed certification standards of vegetable crops, field inspection, specification for certification.

UNIT II

Seed processing, study of seed processing equipments seed cleaning and upgrading, Seed packing and handling, equipment used for packaging of seeds, procedures for allocating lot number.

UNIT III

Pre-conditioning, seed treatment, benefits, types and products, general principles of seed storage, advances in methods of storage, quality control in storage, storage containers, seed longevity and deterioration, sanitation, temperature and relative humidity control.

UNIT IV

Seed testing; ISTA rules for testing, moisture, purity germination, vigor test, seed sampling, determination of genuineness of varieties, seed viability, seed health testing; seed dormancy and types of dormancy, factors responsible for dormancy.

UNIT V

Seed marketing, demand forecast, marketing organization, economics of seed production; farmers' rights, seed law enforcement, seed act and seed policy.

Practical

Seed sampling, purity, moisture testing, seed viability, seed vigor tests, seed health testing, seed cleaning, grading and packaging; handling of seed testing equipment and processing machines; seed treatment methods, seed priming and pelleting; field and seed inspection, practices in rouging, seed storage, isolation distances, biochemical tests, visit to seed testing laboratories and processing plants, mixing and dividing instruments, visit to seed processing unit and warehouse visit and know about sanitation standards.

Suggested Readings

Agrawal PK & Dadlani M. 1992. *Tecniques in Seed Science and Technology*. South Asian Publ.

Singh N, Singh DK, Singh YK & Kumar V. 2006. *Vegetable Seed Production Technology*. International Book Distr. Co.

Singh SP. 2001. *Seed Production of Commercial Vegetables*. Agrotech Publ. Academy.

Tanwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, GOI, New Delhi.

Rajan S & Baby L Markose 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.

ARTD-R-1117 PRODUCTION TECHNOLOGY OF UNDEREXPLOITED VEGETABLE CROPS 2+1

Objective

To educate production technology of underutilized vegetable crops.

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of:

UNIT I

Asparagus, artichoke and leek

UNIT II

Brussels's sprout, Chinese cabbage, broccoli, kale and artichoke.

UNIT III

Amaranth, celery, parsley, parsnip, lettuce, rhubarb, spinach, basella, bathu (chenopods) and chekurmanis.

UNIT IV

Elephant foot yam, lima bean, winged bean, vegetable pigeon pea, jack bean and sword bean.

UNIT V

Sweet gourd, spine gourd, pointed gourd, Oriental pickling melon and little gourd (kundru).

Practical

Identification of seeds; botanical description of plants; layout and planting; cultural practices; short-term experiments of underexploited vegetables.

Suggested Readings

Bhat KL. 2001. *Minor Vegetables - Untapped Potential*. Kalyani.

lndira P & Peter KV. 1984. *Unexploited Tropical Vegetables*. Kerala Agricultural University, Kerala.

Peter KV. (Ed.). 2007-08. *Underutilized and Underexploited Horticultural Crops*. Vols. I-IV. New India Publ. Agency.

Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall

Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS. 2001. *Minimal Descriptors of Agri-Horticultural Crops*. Part-II: *Vegetable Crops*. NBPGR, New Delhi.

ARTD-R-108 EMERGING SCENARIO IN RURAL SECTORS 3+1

Theory

- Flagship Agriculture/Rural development Programmes/ Health/ Education/ related to Government of India and their Impact
- Changing rural livelihoods in India/West Bengal and Livelihood Promotion: Emerging Scenario and role of Institutions
- Rural development administration – the past, present and future in India
- ICT application in Rural Development and their Impact in India
- Cooperatives and Rural Marketing: Emerging Models in India
- Social Entrepreneurship and Corporate Social Responsibility: The Indian Scenario
- Social Capital and Social Network Analysis: theory and measurements

- Trends in econometric modeling – scope of application in development research
- Trends in poverty and human development measurement/analysis
- Climate Change vis-à-vis Rural Development
- Rural Banking: Present Scenario and Emerging Trends
- Any other topic related to the research area of the student

[Students will take up selected topics from these lists in consultation with the respective guides]

Practical

- Discussion, term paper preparation on selected topic and presentation in the form of Seminar/ writing of Occasional Paper Series
- Development and presentation of at least one Case (Educational)

ARTD-R-109 EMERGING THOUGHTS AND TECHNIQUES IN EXTENSION 3+1

Theory

Approaches, Models and Methods of Extension – Dimensions of extension approach; General agricultural extension approach, Commodity specialized approach, T & V approach, Farming system development approach, Participatory approach, Project approach, Cost sharing approach etc.; Models of extension - Technology transfer model, Public extension model, Commodity extension model, T & V model, NGO model, Private sector model, Farmer Field School model, Innovative linkage model; Methods – Individual, Group and Mass methods

Emerging thoughts in extension – Farming System Perspective; Participatory Extension; Action Research; Agricultural Knowledge Information System; Innovation System Perspective; Sustainable Livelihoods; Agri-food chain/value chain; Positive Deviance

Tools and approaches for participatory extension – Gender analysis, Stakeholder analysis, Actor analysis, Participatory Assessment and Planning (PAP), Participatory Learning and Action (PLA), Participatory Farm Management methods (PFM), Participatory Rural Communication Appraisal (PRCA), Rapid Appraisal of Agricultural Knowledge Systems (RAAKS), Participatory Extension Approach (PEA) process and tools

Practical

Classroom presentations on Extension models

Preparation of monograph on Extension tools and techniques

Suggested Readings

Bagchi J. 2007. *Agriculture and WTO Opportunity for India*. Sanskruti.

Chambers R, Pacy A & Thrupp LA. 1989. *Farmers First*. Intermediate Technology Publ.

Crouch BR & Chamala S. 1981. *Extension Education and Rural Development*. Macmillan.

John KC, Sharma DK, Rajan CS & Singh C. 1997. *Farmers Participation in Agricultural Research and Extension Systems*. MANAGE, Concept Publ. Co.

Khan PM. 2002. *Text Book of Extension Education*. Himanshu Publ.

Narasaiah ML. 2005. *Agricultural Development and World Trade Organization*. Discovery Publ.

Talwar S. 2007. *WTO Intellectual Property Rights*. Serials Publ.

Van den Ban BW & Hawkins BS. 1998. *Agricultural Extension*. S.K. Jain Publ.

Venkaiah S. 2001. *New Dimensions of Extension Education*. Anmol Publ.

IRDM-R-110 INNOVATION IN RURAL DEVELOPMENT RESEARCH 0+2

Practical:

- Classroom based discussion on innovative research paradigms in the field of Rural Development

- Preparation, submission and presentation of a document on one innovative research paradigm related to rural development

ARTD-R-111 SUSTAINABLE RURAL LIVELIHOODS 2+2

Theory

Livelihoods Approach – Meaning and Principles: Origin, definition, characteristics; trends in rural livelihoods

Livelihoods framework – Elements of Livelihood Framework – asset pentagon, contexts, strategies and outcome; Different frameworks – DFID, CARE, UNDP, IFAD

Livelihood assessment and Value Chain Analysis – Livelihood assessment - Purpose and Principle; Tools of livelihood assessment; Value chain – concept, associated factors; methods of studying value-chain

Livelihood intervention – Meaning, design, approaches, appraisal; steps involved in livelihood intervention and its implementation

Practical:

Classroom based discussions on livelihood frameworks and preparation/presentation of a comparative document

Livelihood assessment and planning for a village - 4 days field work

ARTD-R-112 ADVANCES IN TRAINING TECHNOLOGY 2 + 1

Theory

UNIT I

Paradigm shift in training - learning scenario, Training Approaches – Experiential learning - laboratory - organization development (system) approaches; Training Design, Designing an effective training programme, Harmonizing training needs, Course Objective, content and methods.

UNIT II

Designing an effective training session - the semantics involved, Designing experiential training sessions, simulation exercises, and openness in training transaction - managing dilemmas, ambivalence and conflicts and confusion (for both trainers and trainees).

UNIT III

Training Techniques for understanding and facilitation team building, group dynamics, motivation and empowerment, laboratory methods: micro-lab process work, and sensitivity training, Psychological instruments as training tools: , Inventories, Cases, etc.

UNIT IV

Participatory Training Techniques - Lecture, Brainstorming, Group discussion and Training Games. Role Play, Psycho-drama, Coaching, Counseling, etc., Trainer's and dilemmas, Factors Effecting Training Effectiveness and Training Evaluation.

Practical

Techniques of participatory training need assessment. Formulation of Course Objective, design of programmes. Simulation exercises. Participatory training methods - Role Play & Brainstorming, Group discussion and Counseling and Conducting experiential learning sessions. Training evaluation - Techniques of Knowledge, Skill & Attitude evaluation. Visit to training institutions and study of training technologies followed.

Suggested Readings

Agochiya D. 2002. *Every Trainer's Handbook*. Sage Publ.

Alan B & Calardy 2004. *Five Case Studies in Management Training*. Jaico Publ.

Kumar A. 2000. *Management Training Process.* Anmol Publ.

Leslie Rae. 1998. *Techniques of Training*. Jaico Publ.

Lynton RP & Pareek U. 1999. *Training for Development*. 2nd Ed. Vistar Publ.

Reid MA. 1997. *Training Interventions, Managing Employee Development*. Jaico. Publ.

Samanta RK. 1993. *Training Methods for Management and Development*. M.D. Publ.

Sethy ED. 2003. *A Practical Hand Book on Training*. Anmol Publ.

ARTD-R-113 TRANSFER OF TECHNOLOGY IN AGRICULTURE 2+1

Theory

UNIT I

Technology - Meaning and Concepts - Appropriate technology, transfer of technology - meaning and concepts. Systems of transfer of technology - Knowledge Generating System (KGS) - Knowledge Disseminating System (KDS) Knowledge Consuming System (KCS) - Input Supplying Agencies System (ISAS).

UNIT II

Appropriateness of communication media in the system of technology transfer.New communication for transfer and adoption of Agricultural technology.Extension training in transfer of technology.

UNIT III

Analysis. Constraints in Transfer of Technology, agencies or departments involved in TOT. Extension professional in TOT. Attributes of Technology and its Relation in TOT process. TOT to resource poor farmers. Role of Key communicators or local leaders in TOT. Private and Public partnership in TOT.

Practical

Analysis of Transferred technology. Analysis of knowledge generation and consuming systems. Formulation of communication strategies, Study of attributes of selected fast spreading technologies and slow technologies, study of constraints in TOT, visit to TOT centres of ICAR and SAU, Identification of key communicators, Case studies of Public-Private Partnerships, Visits to the print and electronic media centres to study their role in TOT.

Suggested Readings

Chaturvedi TN. 1982. *Transfer of Technology among Developing Countries; Need for Strengthening Cooperation*. Gitanjali Publ. House.

Dunn DD. 1978. *Appropriate Technology With a Human Face*. Macmillan Press.

Kapoor SK, Roy PB & Roy AK. 1980. *Role of Information Centres in Technology Transfer*. IASLIC, Kolakata.

Lekhi RK. 1984. *Technological Revolution in Agriculture*. Classical Publ. Co.

Singh SN. 1991. *Transfer of Technology to Small Farmers; An Analysis of Constraints and Experience*. Concept Publ. Co.

Wallender HW. 1980. *Technology Transfer of Management in the Developing Countries*. Ballinger Publ. Co., Cambridge.

ARTD-R-114 DIFFUSION AND ADOPTION OF INNOVATIONS 2 + 1

Theory

UNIT I

Diffusion – concept and meaning, elements; traditions of research on diffusion; the generation of innovations; innovation-development process; tracing the innovation-development process, converting research into practice.

UNIT II

The adoption process- concept and stages, dynamic nature of stages, covert and overt processes at stages, the innovation-decision process – a critical appraisal of the new formulation.

UNIT III

Adopter categories – Innovativeness and adopter categories, adopter categories as ideal types, characteristics of adopter categories; Perceived attributes of Innovation and their rate of adoption, factors influencing rate of adoption.

UNIT IV

Diffusion effect and concept of over adoption, opinion leadership- measurement and characteristics of opinion leaders, monomorphic and polymorphic opinion leadership, multi-step flow of innovation; concepts of homophily and heterophily and their influence on flow of innovations; Types of innovation-decisions – Optional, Collective and Authority and contingent innovation decisions; Consequences of Innovation-Decisions – Desirable or Undesirable, direct or indirect, anticipated or unanticipated consequences; Decision making – meaning, theories, process, steps, factors influencing decision – making.

Practical

Case studies in individual and community adoption process, content analysis of adoption studies, Identification of adopter categories on a selected technology, study of attributes of current farm technologies, Identification of opinion leaders, Sources of information at different stages of adoption on a selected technology, study of factors increasing or retarding the rate of adoption, presentation of reports on adoption and diffusion of innovations.

Suggested Readings

Dasgupta. 1989. *Diffusion Agricultural Innovations in Village India*. Wiley Eastern.

Jalihal KA & Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension.* Concept Publ. Co.

Ray GL. 2005. *Extension Communication and Management*. Kalyani Publ.

Reddy AA. 1987. *Extension Education*. Sree Lakshmi Press, Bapatla.

Rogers EM. 2003. Diffusion of Innovations. 5th Ed. The Free Press, New York.

ARTD-R-151 REVIEW OF LITERATURE 1 + 1

Theory

Introduction to systematic reviews of literature – what, why, how; Formulate key questions for a review, keywords/descriptors; Searching the literature – sources of literature, Bibliographical database, other web sources; Effective searching of literature – keywords and Boolean logic; Evaluation of scientific literature; Reading and note-taking – importance, strategies; Organising literature – strategies, use of software; Meta-analysis; Writing review – structuring the review, quoting/paraphrasing, the citation- referencing system, Style manual- (American Psychological Association etc.)**;** Publication protocol - Preparation and publication of review article and/ or original research work; Plagiarism – what is, avoiding plagiarism; Writing proposal for research grant

Practical

- Course readings, in class workshops, and discussion.
- Homework on protocol of systematic literature review.
- Final review paper with detailed outlines of the systematic review (written for a peer reviewed journal)
- Writing of a research paper for a peer reviewed journal
- Classroom presentation of the review.

Books

Hart, C. (1999). *Doing a literature review: Releasing the social science research imagination*. Sage Publications Limited.

Ridley, D. (2012). *The literature review: a step-by-step guide for students*. Sage Publications Limited.

Fink, A. (2009). *Conducting research literature reviews: from the Internet to paper*. Sage Publications.

ARTD-R-152 ADVANCED RESEARCH METHODOLOGY 2+ 2

Theory

- Importance of theory constructions in social science; Theory: Meaning, elements, Ideal Criteria, Functions, Types; Definitions: Meaning, types and Rules. Generalizations: Meaning, Classification. Relationship: Meaning Types.; Terminologies used in theory constructions: Axiom, Postulate, Proposition, Theorem, Fact, Concept, Construct, Probability and Measurement Basic Derived; Steps in theory building - Axiomatic Techniques, Historical approaches. Scientific application Theoretical concept in Social Sciences. Test of Theory: Applying appropriate statistical tests
- Research Designs: Quantitative Research Designs (Experimental, Correlational, Social Survey), Qualitative Research Designs (Grounded theory, Ethnography, Narrative), Combined Designs (Mixed methods, Action research);
- Scaling techniques in Social Sciences – meaning, types, principles, steps and quality, techniques of attitude scale construction - Paired comparison, Equal appearing intervals,, Successive Intervals, Summated ratings, Scalogram analysis, Scale discrimination technique, Q-sort techniques, Semantic different technique (at least three techniques); Reliability and Validity of Scales.
- Participatory research; Participatory tools and techniques in social research; Participatory action Research
- Quantitative data analysis: descriptive and inferential; application of multivariate statistics (Factor analysis, Cluster analysis, Parametric and Non-parametric regression models; complex data mining etc.), Time series analysis; Non-parametric statistics – univariate and multivariate
- Qualitative data analysis: preparation & organization, exploration & coding, building description & coding, representation, interpretation and validation;

Practical

- Practical on (construction of scale/test, if possible) - Likert type, Thurston etc.

- Classroom based assignment/term paper on quantitative, qualitative and mixed methods – discussion and analysis of scientific literature

- Classroom practical on multivariate statistics

- Classroom practical on qualitative data analysis

Books

Babbie, E. R. (2012). *The practice of social research*. Wadsworth Publishing Company.

Blalock HM. (1969). *Theory Construction: Form verbal to Mathematical Formulations*. Prentice Hall.

Bryman, A. (2012). *Social research methods*. OUP Oxford.

Bryman, A., & Cramer, D. (2012). *Quantitative data analysis with IBM SPSS 17, 18 & 19: A guide for social scientists*. Routledge.

Burns RB. 2000. *Introduction to Research Methods*. Sage Publ.

Chandrakandan K & Karthikeyan C. 2004. *Behavioral Research Methodology*. Classical Publ.

Creswell, J. W. (2002). Educational research: Planning, conducting, and evaluating quantitative and Qualitative Research, Prentice Hall.

Daivadeenam P. 2002. *Research Methodology in Extension Education*. Agro-Tech Publ. Academy.

Denzin, N. K., & Lincoln, Y. S. (Eds.). (2005). *The Sage handbook of qualitative research*. Sage Publications, Incorporated.

Kerlinger N Fred. (2002). *Foundations of Behavioural Research.* Cengage Learning (Thompson)

Kerlinger N Fred. 2002. *Foundations of Behavioural Research*. Surjeet Publ.

Kothari CR. 2000. *Research Methodology Methods & Techniques*. 2nd Ed. Wishwa Prakasham.

Ray GL & Mondal S. 1999. *Research Methods in Social Science and Extension Education*. Naya Prokash.

Roger L & Domino WSK. 1980. *Research Methods*. Prentice Hall.

Sadhu AM & Singh A. 2003 *Research Methodology in Social Science*. Himalaya Publ. House.

Sarantakos S. 1998. *Social Research.* 2nd Ed. Macmillan.

Singh, K. (2007). *Quantitative social research methods*. Sage Publications Pvt. Limited.

Sinha SC & Dhiman AK. 2002. *Research Methodology*. ESS Publ.

Tashakkori, A., & Teddlie, C. (Eds.). (2002). *Handbook of mixed methods in social & behavioral research*. Sage Publications.

Verma RK & Verma G. 2002. *Research Methodology*. Commonwealth Publ.

Walizer MH & Panl L. 2002. *Research Methods & Analysis; Searching forRelationships.* Wiemil Harper & Row.

Wilkinson TS & Bhandarkar PL. 2002. *Methodology and Techniques of Social Research*. Himalaya Publ. House.

ARTD-R-153 APPLICATION OF COMPUTER IN RESEARCH 0+2

Practical

- Microsoft Excel and Grapher : Data entry, Data Presentation and Analysis
- Use of SPSS for data entry, Data Presentation and Analysis
- Data mining with STATISTICA and XLSTAT: Basic statistics and tables, ANOVA, Multivariate statistics (Multiple regression, Cluster Analysis, PLS, PCA, and Factor Analysis, General classification and regression tree, Boosted Regression Tree)

Books

- Landau, S., & Everitt, B. S. (2004). A Handbook of Statistical Analyses using SPSS.
- Marques De Sá, J. P. (2007). *Applied Statistics Using SPSS, Statistica, Matlab and R*. Springer-Verlag, Berlin Heidelberg.

DETAILS OF Journal/e-Resources/ Suggested Research Areas in Horticulture (Vegetable Science) and Agricultural Extension

VEGETABLE SCIENCE

List of Journals

- American Journal of Horticultural Sciences
- American Potato Growers
- American Scientist
- Annals of Agricultural Research
- Annual Review of Plant Physiology
- California Agriculture
- Haryana Journal of Horticultural Sciences
- HAU Journal of Research
- Horticulture Research
- HortScience
- IIVR Bulletins
- Indian Horticulture

- Indian Journal of Agricultural Sciences
- Indian Journal of Horticulture
- Indian Journal of Plant Physiology
- Journal of American Society for Horticultural Sciences
- Journal of Arecanut and Spice Crop
- Journal of Food Science and Technology
- Journal of Plant Physiology
- Journal of Post-harvest Biology and Technology
- Post-harvest Biology and Technology
- Scientia Horticulturae
- Seed Research
- Seed Science
- South Indian Horticulture
- Vegetable Grower
- Vegetable Science

e- Resources

- www.iivr.org.in (Indian Institute of Vegetable Research)
- www.avrdc.org (AVRDC-The World Vegetable Centre)
- www.icar.org.in (Indian Council of Agricultural Research)
- www.krishiworld.com (Agriculture Portal)
- www.isvs.org.in (Indian Society of Vegetable Science)
- www.vegsci.isvs.org.in (Vegetable Science)
- www.tandfonline.com (Taylor & Francis Online :: International Journal of Vegetable Science)

Suggested Broad Topics for Master's and Doctoral Research

- Organic farming in vegetable crops
- Application of molecular markers in genetic improvement of vegetable crops
- Development of transgenic vegetables
- Growing vegetables under protected conditions
- Mulching in vegetable crops
- Micronutrients in vegetable crops
- Screening of vegetable s against abiotic stress
- Hi-tech methods for raising nursery of vegetable crops

- Dry land and coastal farming
- Drip/micro irrigation in vegetable crops
- Fertigation in vegetable crops
- Research on physiological disorders in vegetable crops
- Breeding for quality improvement
- Breeding for insect-pest and disease resistance
- Breeding for extending shelf life of vegetable crops
- Minimal processing of vegetables
- Concept of quality control in vegetable seed production
- Integrated nutrients management in vegetable crops
- Breeding for industrial and processing of vegetable crops
- Research on water management in vegetable crops
- Research on home storage of vegetable crops
- Hi-tech home gardening

EXTENSION EDUCATION

List of Journals

- Agricultural Extension Review
- European Journal of Agricultural Education and Extension
- Indian Journal of Social Work
- International Journal of Business and Globalization
- International Journal of Sustainable Development
- Journal of Extension
- Journal of Asia Entrepreneurship and Sustainability
- Journal of Environmental Extension
- Journal of Extension Education
- Journal of International Agriculture and Extension Education
- Journal of Rural Development
- British Journal of Educational Technology
- Economic and Political Weekly
- Indian Economic Panorama
- Indian Journal of Adult Education

- Indian Journal of Extension Education
- Indian Journal of Human Development
- Indian Journal of Open Learning
- Indian Journal of Social Development
- Indian Journal of Training and Development
- Indian Social Science Review
- Journal of Extension System
- Journal of Development Studies
- Journal of Educational Planning and Administration
- Journal of Educational Psychology
- Journal of Environmental Studies and Policy
- Journal of Sustainable Agriculture
- The Journal of Entrepreneurship

e- Resources

- www.pearsoned.com (Pearson Education Publication)
- www.mcgraw-hill.com (McGraw-Hill Publishing Company)
- www.oup.com (Oxford University Press)
- www.emeraldinsight.com (Emerald Group Publishing)
- www.sagepub.com (Sage publications)
- www.macmillanindia.com (Macmillan Publishing)
- www.krishiworld.com (Agriculture Portal)
- www.aiaee.org (The Association for International Agricultural and Extension Education)
- www.geogate.org (Agriculture Portal)
- www.icar.org.in (Indian Council of Agricultural Research)
- www.manage.gov.in (National Institute of Agricultural Extension Management)

Suggested Broad Topics for Master's and Doctoral Research

- Agricultural communication
- Agricultural Journalism
- Agriculture Education

- Agro Forestry Extension
- Banking & Credit
- Commercialization and Diversification in Agriculture
  - Vegetables
  - Horticulture
  - Agri. tourism
  - Floriculture
  - Mushroom cultivation
  - Bee Keeping
  - Organic Farming
- Cropping System/Farming System
- Diffusion and Adoption
- Dry Farming Technology
- Entrepreneurship Development
- Extension Administration and Management
- Extension Methods and techniques
- Extension Trainings
- Extension Management and Sustainable Agricultural Development
- Indigenous Practices
- Rural Organization and Institutions
- Scientific Productivity and Human Resource Development
- Youth/Women Development
- Social Marketing