

# **SYLLABUS**

**(As per NEP 2020)**

**Master of Science in Rural Development and Agricultural  
Production**

**Department of  
RURAL DEVELOPMENT AND  
AGRICULTURAL PRODUCTION  
School of Human and Environmental Sciences,  
North-Eastern Hill University, Tura Campus,  
Chasingre, West Garo Hills,  
Meghalaya.  
2022**

**MEMBERS OF SYLLABUS COMMITTEE (2022)**

**DEPARTMENT OF RURAL DEVELOPMENT AND AGRICULTURAL PRODUCTION,  
North-Eastern Hill University, Tura Campus**

**Dr. Binu Mathew - Chairman**

**Prof. D.C. Kalita - Member**

**Prof. S.C. Srivastava - Member**

**Dr. B.K. Mishra - Member**

**Dr. Lolly S. Pereira - Member**

  
**Head**  
Head  
Dept. of RDAP  
NEHU, Tura Campus.

**Department of**  
**RURAL DEVELOPMENT AND AGRICULTURAL PRODUCTION**  
**North-Eastern Hill University, Tura Campus, Tura, Meghalaya.**

**GENESIS:**

The Department of Rural Development and Agricultural Production (RDAP) located at Tura Campus of North-Eastern Hill University was established in the year 2002 with 4 faculty members (2 Readers and 2 Lecturers) for rendering M.Sc. programme. Subsequently, more faculty members were inducted. The Ph.D. programme was started in the year 2008 and M.Phil. programme was started in the year 2014. Since its inception, it has been a sincere endeavor of the Department to keep abreast with the latest developments in the field of Agriculture, Horticulture, Animal Science, Food processing, Rural Development and allied sectors. The department has evolved over the years and apart from routine teaching and research activities, extension and outreach activities have also been initiated in the vicinity of the Campus.

**VISION:**

To contribute towards rural development by rendering knowledge, creating awareness and developing entrepreneurial skills through teaching, research, extension and training.

**MISSION:**

- To improve the scientific knowledge, skills and capabilities of the rural youth through teaching, research, extension, workshops and skill development programmes.
- To develop entrepreneurial skills among the rural people in agriculture and allied sectors.
- To collaborate with government/non-government organizations for the implementation of various agricultural and rural developmental activities.
- To offer consultancy services in relevant fields of agriculture, horticulture, rural development, animal husbandry and allied sectors.

**OBJECTIVES:**

- To deliver courses on different economic activities for the development of rural sector viz. agronomy, horticulture, organic farming, animal sciences, agro-processing, marketing etc.
- To carry out research on various aspects of rural development, agriculture and allied sectors.
- To study traditional agricultural practices, their strengths and weaknesses; validation and popularisation.
- To promote innovative agricultural planning and sustainable methods of ensuring fertility and productivity of land.
- To study human and social factors related to rural development and agricultural production with special emphasis on entrepreneurship.
- To carry out skill development programmes for the rural youth in agriculture and allied sectors like agronomy, horticulture, nursery management, processing of fruits and vegetables, animal rearing, processing of dairy products and other traditional food products.

## **REVISED SYLLABUS (2022)**

**(As per NEP 2020)**

### **BACKGROUND NOTE ON THE SYLLABUS**

The Department of Rural Development and Agricultural Production (RDAP) was established in the year 2002 with M.Sc. Programme and subsequently started M.Phil. and Ph. D. programmes. Since its inception, it has been a sincere endeavor of the department to revise its syllabus from time to time to keep abreast with the latest developments in the field of agriculture, rural development and allied sectors. The last revision of the syllabus was implemented in the year 2019. With the implementation of the National Education Policy 2020 it was felt necessary to revise the syllabus this year to keep pace with the changing scenario of education in the country. The salient features of the revised syllabus are as follows:

1. The Master's Degree Programme in RDAP shall strictly follow the guidelines of NEP 2020.
2. A total of 88 credit hours (2200 marks) should be completed by a student to complete the M.Sc.(RDAP) programme.
3. The entire credits to be earned have been spread over four semesters with 20, 24, 24 and 20 credits in the first, second, third and fourth semesters respectively.
4. All papers are of 4 credit hours (including theory, practical, study tour and field visits).
5. One credit hour is equivalent to 15 hours of teaching of theory papers and 30 hours of practical activities for practical papers.
6. Paper code bearing 'CC', 'GEC', 'SEC' and 'RM' are compulsory for all the students, while courses with 'DSEC' are optional papers.
7. Elective courses are to be opted from the first semester onwards and students may opt for one elective among the four different electives offered *viz.*, Rural Development (RD), Agronomy (AG), Horticulture (HO) and Animal Sciences (AS).
8. Students admitted to M.Sc. programme in RDAP, may opt for courses from outside the department in lieu of RDA-GEC-504 course offered in the first semester.
9. Wherever necessary, adequate revision of course contents have been made in other existing courses keeping in mind the latest developments in the relevant field.
10. Up to 40 % of the total credits of the programme can be achieved through MOOCs (SWAYAM).

**Syllabus of M.Sc. in Rural Development and Agricultural Production**  
(as per NEP 2020)

Course No.	Course Title	Theory (T)	Practical (P)	Total Credits (T+P)
<b>SEMESTER – I</b>				
RDA-CC-500	Introduction to Rural Development and Animal Husbandry	2	2	4
RDA-CC-501	Principles and Practices of Agronomy and Horticulture	2	2	4
RDA-DSEC-502(RD)	Rural Development Approaches, Programmes and Policies	3	1	4
RDA-DSEC-502(AG)	Production Technology of Field Crops- I	3	1	4
RDA-DSEC-502(HO)	Plant Propagation and Nursery Management	3	1	4
RDA-DSEC-502(AS)	Swine Production	3	1	4
RDA-DSEC-503(RD)	Rural Development Planning and Project Management	3	1	4
RDA-DSEC-503(AG)	Farming Systems and Sustainable Agriculture	3	1	4
RDA-DSEC-503(HO)	Commercial Floriculture and Landscaping	3	1	4
RDA-DSEC-503(AS)	Processing of Livestock Products	3	1	4
RDA-GEC-504	Statistical Techniques and Software Applications	3	1	4
<b>Total credits=</b>				<b>20</b>
<b>SEMESTER – II</b>				
RDA-CC-505	Basic Economic Theory and Policy	4	0	4
RDA-CC-506	Principles and Practices of Organic Agriculture	3	1	4
RDA-DSEC-507(RD)	Rural Development Organizations, Institutions and Administration	3	1	4
RDA-DSEC-507(AG)	Production Technology of Field Crops- II	3	1	4
RDA-DSEC-507(HO)	Post-Harvest Management of Horticultural Crops	3	1	4
RDA-DSEC-507(AS)	Commercial Poultry Production	3	1	4
RDA-DSEC-508(RD)	Rural Credit and Micro-Finance	4	0	4
RDA-DSEC-508(AG)	Pasture Management and Forage Crop Production	3	1	4
RDA-DSEC-508(HO)	Production Technology of Fruits and Plantation Crops	3	1	4
RDA-DSEC-508(AS)	Starter Culture and Fermented Milk Products	3	1	4
RDA-RM-509	Research Methodology & Proposal Writing	3	1	4
RDA-SEC-510	Processing of Food	2	2	4
<b>Total credits=</b>				<b>24</b>

	<b>SEMESTER – III</b>			
RDA-CC-600	Capacity Building	3	1	4
RDA-CC-601	Commercial Dairy Farming	3	1	4
RDA-CC-602	Agricultural Marketing & Entrepreneurship Development	3	1	4
RDA-DSEC-603(RD)	International Trade and Agriculture	4	0	4
RDA-DSEC-603 (AG)	Production Technology of Herbs, Medicinal and Aromatic Crops	3	1	4
RDA-DSEC-603(HO)	Production Technology of Vegetables and Spices	3	1	4
RDA-DSEC-603(AS)	Goat and Sheep Production	3	1	4
RDA-DSEC-604(RD)	Farm Management	3	1	4
RDA-DSEC-604(AG)	Weed Management	3	1	4
RDA-DSEC-604(HO)	Protected Cultivation of Horticultural Crops	3	1	4
RDA-DSEC-604(AS)	Market Milk	3	1	4
RDA-DSEC-605(RD)	Micro-Enterprise and Non-Farm Sector Development	3	1	4
RDA-DSEC-605(AG)	Social and Farm Forestry	4	0	4
RDA-DSEC-605(HO)	Integrated Pest Management of Horticultural Crops	3	1	4
RDA-DSEC-605(AS)	Traditional Indian Dairy Products	2	2	4
	<b>Total Credits =</b>	<b>17</b>	<b>7</b>	<b>24</b>
	<b>SEMESTER – IV</b>			
RDA 606	<b>Dissertation</b>			20
	Problem Identification and Review of Related Literature	0	4	4
	Proposal writing and presentation	0	2	2
	Data Collection and Tabulation	0	4	4
	Data Analysis, Interpretation and Discussion	0	4	4
	Report Writing	0	2	2
	Viva-Voce	0	4	4
	<b>Total Credits =</b>	<b>0</b>	<b>20</b>	<b>20</b>
	<b>Grand Total (I+II+III+IV Semesters)</b>			<b>88</b>

## **RDA-CC-500: Introduction to Rural Development and Animal Husbandry**

(Total Marks = 100; Theory= 50, Practical = 50) Credit: 2+2=4

### **Objective:**

To introduce the meaning, concept and dimensions of rural development and to study the structure of rural society and understand the rural and urban differences. The paper will also introduce the students to the importance and scope of Animal Husbandry.

### **Course Outcome:**

Understanding of the concept of rural development, rural socio economic structure, poverty and Census; principles and scope of livestock management.

### **Unit - I**

Concept, meaning and scope of rural development. Characteristics of underdevelopment- vicious circle of poverty and dualism: Meaning and dimensions of rural development; economic, social, and human development; determinants of rural development; Distinguishing features of rural society; rural and urban differences; Nature and extent of rural poverty, Types of rural settlements; demographic aspects of society; socio-cultural determinants of rural development; importance of cultural components in agricultural and rural development.

### **Unit-II**

Animal husbandry and poultry: definition, scope, branches; history and development. Resources and infrastructure of livestock in India with special reference to North-Eastern region; nutritional and economic importance of animal husbandry; role of livestock in socio-economic development of small farmers in India; population of livestock and poultry in India. General principles of livestock management. Indian and exotic breeds of cattle, buffalo, sheep, goat, pig: specific characteristics of breed and production. Importance of integrated farming system; farm wastes and manures, its economic disposal.

### **Unit - III (Practical)**

Study of rural settlement pattern

Component based study of poverty and base line survey to access BPL families.

Study of rural settlement pattern.

Study of rural social structure, customs and traditions

### **Unit-IV (Practical)**

Handling of livestock: cattle, pig, goat, for recording growth, production, treatment, and vaccination etc  
Important records to be maintained in livestock farms.

Livestock and their systems of marketing in and around Tura.

Visit to model livestock farms.

Identification of common feeds and fodder.

### **Suggested Readings:**

Banerjee GC 2014. A Text Book of Animal Husbandry, Oxford and IBH Publ. Co., New Delhi.

Chambers Robert 1984. Rural Development: Putting the Last First, Longman Publications, London

Desai AR 1984. Rural Sociology, Popular Prakashan, Bombay

Gary Paul Green 2013. Handbook of Rural Development, Edward Elgar Publishing Ltd

Mandal CG 1992. Rural Development: Retrospect Concept, New Delhi

Prasad J 2016. Principles of Dairy Farm Management, Kalyani Published, New Delhi.

## **RDA-CC-501: Principles and Practices of Agronomy and Horticulture**

(Total Marks = 100; Theory= 50, Practical = 50) Credit: 2+2=4

### **Objective:**

To introduce the students to various aspects of agronomy and horticulture, their importance, scope and limitations with special reference to the NE region and to provide the knowledge of different cultural practices associated with various crop production systems.

### **Course Outcome:**

Understanding of Indian agriculture, agronomy, horticulture, different branches of agriculture and horticulture, identification of various agronomical and horticultural crops, tools and implements used in agricultural operations.

### **Unit - I**

Agriculture: definition, history of Indian agriculture; branches of agriculture; Agronomy: definition, scope and branches. Cropping systems: different types of cropping systems; farming system, integrated farming system and precision farming. Climate: weather, elements of weather, climate, seasons; soil: definition, soil as a medium of plant growth, chemical composition, soil characteristics, soil structure, soil texture, acid soil, alkaline soil; crops: botanical classification, agronomical classification, *kharif* crops, *rabi* crops, *zaid* crops. Crop rotation: definition – types, principles and importance; manures and fertilizers: difference, types and methods of application like broadcasting, placement, foliar etc.; integrated nutrient management. Irrigation and drainage: methods of irrigation; seed: definition, quality and purity of seed, certified seed; Weeds: definition, harmful aspects of weeds; weed control methods.

### **Unit-II**

Horticulture: definition, branches, importance, scope and limitations in India with special reference to NE region; classification of horticultural crops; planning and layout of orchard; systems of planting, planting density; plant nutrients: essential elements, macro and microelements; phytohormones: types, role of plant growth regulators in horticulture crops. Pomology: Factors affecting fruit production; training and pruning- meaning, objectives and principles, methods, its effect on growth, flowering and yield. Olericulture: Classification of vegetable crops, types of vegetable garden; spices and plantation crops- importance, scope and limitations. Floriculture: landscaping: concept and principles, factors affecting landscaping; styles of gardening; prospects of dry flowers in NE region; Post-harvest management of horticultural crops: basic principles of food preservation.

### **Unit-III (Practical)**

Identification of various crops of kharif; rabi, and zaid season of NE India.

Identification of agronomical implements and equipments.

Identification, collection and preservation of important weeds.

Identification of various fertilizers and manures and herbicides.

Calculation of seed requirement of important field crops.

Familiarizing with various sprayers and spraying methods.

### **Unit- IV (Practical)**

Identification and uses of horticultural tools and implements.

Identification and familiarization of fruits and vegetable crops.

Identification of seeds of vegetables and spices.

Identification and familiarization of flowers and flower seeds.

Identification and familiarization of ornamental plants.

Calculation of planting density under different systems of planting.

### **Suggested Readings**

Balasubramanian P 2007 Principles and Practices of Agronomy, Agrobios, Jodhpur

Bose TK, Das P, and Maiti GG 1998. Trees of the world Vol- I. RPR Centre, Bhubaneswar.

Chadda KL 2012. Hand Book of Horticulture, ICAR, New Delhi.

Shanker G 1999. Practical Manual in Horticulture, Balyog Prakashan, Allahabad

Singh J 2004. Basic Horticulture, Kalyani Publishers, New Delhi.

Yellamanda Reddy T and Sankara Reddi GH 2005. Principles of Agronomy, Kalyani Publishers, New Delhi.



## **RDA-DSEC-502 (RD): Rural Development Approaches, Programmes and Policies**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To acquaint the students with theory, approaches and policies of rural development and poverty alleviation and to make them aware of various Rural development programmes, both historical and ongoing. The students will also be exposed to the ongoing programmes through field work.

### **Course Outcome:**

Knowledge of different theoretical approaches to rural development, rural development programmes -past and ongoing.

### **Unit - I**

Approaches to Rural Development- Western and Indian. Theoretical issues and approaches in rural development; western approaches to development: theories of development as applicable to rural situation: Indian approaches to rural development- Gandhi and Tagore; an account of rural development approaches in pre- and post-independence era; governmental approaches and policies; objectives and conceptualization: Community Development Programmes; technological approach- New Agricultural Technology; target group and target areas; Rural development and poverty alleviation programmes; measurement of poverty and BPL population; Wage and Self Employment Programmes Right to Information Act (RTI); social audit, Self Employment Programmes; National Livelihood Mission

### **Unit -II**

Area development Programmes; Drought Phone Area Programme (DPAP), Desert Development Programme (DDP), Integrated Waste Lands Development Programme (IWDP), Integrated Watershed Management Programme; Infrastructure building programmes: Pradhan Mantri Gram Sadak Yojna (PMGSY); Programme; Bharat Nirman Yojana: Central Rural Sanitation Programme, Rural Water Supply Programme, Rural Housing: PM Awas Yojna (PMAY).

### **Unit- III**

Social security system and family welfare programmes: National Social Assistance Scheme- National Old Age Pension Programme (NOAP), National Family Benefit Programme (NFBS). National Maternity Benefit Programme (NMBP), Kisan Samridhi Yojana. Food Security and Public Distribution programmes.

### **Unit- IV (Practical)**

Social Audit  
Study of PMGSY  
Study of social security programmes  
Study of PMAY

### **Suggested Readings**

Choudhury RC and Singh RP 2000. Rural Prosperity and Agricultural Policies and Strategies Vol. 1 to V, NIRD Publication, Hyderabad  
Dandakar VM.1996. Poverty and Rural Unemployment, Sage Pub., New Delhi  
Improved Quality of Life; Vol I & II, NIRD Publication, Hyderabad  
Ministry of Rural Development, Government of India, yearly reports  
Mishra SK and Vinai Puri 2009. Indian Economy, Himalaya Publishing House, Delhi  
Sreedhar G and D Rajshekhar 2014. Rural Development in India ( Strategies and Processes) Concept Publishing Company (P) LTD

## **RDA-DSEC-502(AG): Production Technology of Field Crops – I**

(Total Marks = 100; Theory = 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To acquaint students with theoretical and practical approaches of production of various field crops, pulses and oilseed crops.

### **Course outcome:**

Understanding of package of practices of various field crops and their protection measures.

### **Unit –I**

Package of practices and plant protection measures of field crops like paddy, maize, wheat, barley, oat and bajra with special reference to NE India.

### **Unit-II**

Package of practices and plant protection measures of pulses and legumes like pea, pigeon pea, horse gram, bengal gram, green gram, black gram, cowpea, lentil and soybean with special reference to NE India.

### **Unit – III**

Package of practices and plant protection measures like oil seed crops of mustard, groundnut, soybean, sesamum, rapeseed, sunflower, castor and safflower with special reference to NE Region.

### **Unit – IV (Practical)**

Identification of important kharif crops.

Sowing/transplanting methods of rice.

Maize sowing method for higher productivity.

Raising groundnut and sesamum.

Raising sunflower, mustard in the farm

Raising soybean.

Raising pigeon pea.

Determining requirements of seed, fertilizer and plant protection chemicals for major crops.

Acquaintance and precautions in use of pesticides, plant protection equipment- their handling and storage.

### **Suggested Readings:**

Ahlawat IPS, Omprakash and GS Saini 1998. Scientific Crop Production in India, Rama Publishing House, Meerut.

Das PC 1997. Oilseed Crops in India, Kalyani Publishers, New Delhi

Russell EJ 2007. Manuring for Higher Crop Production, Agrobios, Jodhpur

Singh C. 2004. Modern Techniques of Raising Field Crops, Oxford & IBH Publishing Co. New Delhi

TNAU 1999. Crop Production Guide, TNAU and Directorate of Agriculture, Chennai

Weiss EA 1983. Oil Seed Crops, Longman Group Ltd., London

Weiss EA 1997. Essential Oil Crops, Oxford Uni. Press, New York Singh, R.S. 2001, Plant Diseases, Oxford & IBH Pub Co., New Delhi.

## **RDA-DSEC-502 (HO): Plant Propagation and Nursery Management**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objective:**

To familiarize the students with different methods of plant propagation, tissue culture techniques and nursery management practices.

### **Course Outcome:**

Theoretical and practical understanding of various methods of plant propagation, plant tissue culture and cultural practices to be followed for effective management of a horticultural nursery.

### **Unit - I**

Propagation of horticultural crops: sexual and asexual propagation, its advantages and disadvantages; different methods of asexual propagation: cutting, layering, budding, grafting; factors influencing successful grafting/budding union, selection of buds; propagation of plants using specialized parts. Role of phytohormones in plant propagation.

### **Unit- II**

Plant tissue culture: principles, merits and demerits. Factors affecting plant tissue culture, Applications of PTC, types of PTC like meristem culture, root culture, seed culture, embryo culture, callus culture, protoplast culture, anther culture etc. Laboratory design: basic equipment required for establishment of PTC lab like growth room, culture environment. Role of different elements and plant growth regulators in PTC, methods of sterilization of apparatus, filters and explants. Common contaminants and their management. Basic steps of plant tissue culture.

### **Unit -III**

Prospects and limitations of horticultural nurseries in India with special reference to NE region; selection of site; components of nursery; layout of nursery; nursery practices: seedbed preparation, sowing/planting, transplanting, weeding, staking, hardening, pricking, pinching, disbudding, nipping, lifting etc.; irrigation systems for nurseries; plant protection of nursery plants. Nursery structures: types of nursery structure- greenhouse, poly house, lath house, tunnels, etc., their advantages and limitations; types of polyhouse and its components; Rooting media and their composition.

### **Unit- IV (Practical)**

Preparation of seed bed.

Sowing of seeds and transplanting of seedlings

Propagation by different methods of grafting

Propagation by different methods of budding

Propagation by different methods of layering

Propagation by different methods of cutting

Potting and repotting of ornamental plants

### **Suggested Readings:**

Guy W Adriance and Fred R Brison 2012. Propagation of Horticultural Plants, Biotech, Delhi

Hartmann HT, Kester DE, Davis FT Tr and Geneve RL 2015. Plant Propagation- Principles and practices. PHI Learning Pvt.Ltd., New Delhi.

MK Razdan 2019. Introduction to Plant Tissue Culture: Theory and Practices. Springer pub.

Maiti RG 2010. Plant Propagation at a Glance, Kalyani Publishers, New Delhi.

Saini RS 2006. Practical Nursery Production, Agrobios, Jodhpur

Sharaf and Sandhya 2012. Green House Management for Horticultural Crops, Oxford, New Delhi

V Sharma and Feroz Alam 2019. Plant Tissue Culture. Dream Tech Press, New Delhi.

## **RDA-DSEC-502 (AS): Swine Production**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objective:**

To familiarize the students with management practices of swine production, common diseases of swine, their prevention and control.

### **Course Outcome:**

Understanding of care and management practices for scientific swine production, systems of breeding, diseases of swine and their control and management.

### **Unit - I**

Introduction and scope of swine production in India with special reference to North- Eastern region. Swine population, Indian and exotic breeds of swine, distribution of swine. Advantage of swine production. Economic traits of swine. Care and management of breeding boars, gilt/ sows, care at mating. Care and management of pregnant sows/gilts, care at farrowing. Care and management of lactation sows and litters. Care and Management of piglets, colostrum feeding, creep feeding, weaning. Care of growing and finishing swine.

### **Unit-II**

Selection of breeding, breeding boars and gilts. System of breeding. Adverse effects of inbreeding. System of managements of swine. Feeding Pigs economically, creep feeding. Use of unconventional feed resources. System of housing and housing requirement of swine. Slaughter and preservation of pork. Marketing of different pig products in India and abroad.

### **Unit - III**

Maintenance of sanitation. Common diseases of swine and their control measures, cleaning and disinfection of sties and premises of pig farm. zoonotic diseases, diseases transmitted through pork and pork products. Schemes and plan of state and central Govt. under commercial swine production. Pig farm organization and management.

### **Unit-IV**

Identification of native and exotic breeds of pigs and their characteristics  
Formulation of rations and feeding schedule for various classes of swine.  
Routine and periodic jobs of a pig farm and maintenance of swine farm records.  
Preparation of feasibility report of a pig project.  
Care of pregnant sow, cutting of needle teeth, prevention of anaemia.  
Various records to be maintained in a pig farm.  
Visit to Model Pig farm

### **Suggested Readings:**

Anonymous (2018) Handbook on Pig Farming and Pork Processing 2nd Revised Edition. Pub: Director ICAR-Agricultural Technology Application Research Institute Zone-I, PAU Campus, Ludhiana.  
Banerjee GC 2014. A Text Book of Animal Husbandry, Oxford and IBH Publ. Co., Janapath, New Delhi.  
Aruna T Kumar 2008. Handbook of Animal Husbandry, Pub. Indian Council of Agricultural Research, New Delhi.

## **RDA-DSEC-503(RD): Rural Development Planning and Project Management**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To provide information on different tools and techniques of planning and various aspects of project management with special reference to micro-level planning.

### **Course Outcome:**

Understanding of various systems of planning in India, concept of project, stages of project development, and their economic evaluation and monitoring.

### **Unit – I**

Meaning, need, objectives of planning in India; rural development planning in India: planning process, centralized planning; multilevel planning: decentralized planning, micro planning, participatory planning; BRGF planning; Micro-planning; agro--climatic planning and agricultural planning; Panchayat Raj and district planning, grass-root planning; planning for wage and self-employment; tribal development planning: tribal sub-plan and its performance.

### **Unit - II**

concept and definition of project; project cycle, components: time management, human resource management, financial management; stages of project development: project identification; project formulation; project planning and appraisal: technical, economic and social-cost benefit analysis of projects; financial aspects: NPV, IRR, PBP, BCR.

### **Unit -III:**

Project Implementation. Monitoring, evaluation and impact assessment; meaning and concepts; types and stages of monitoring, tools and techniques of monitoring; participatory monitoring; evaluation and impact assessment of projects; environmental impact assessment, Project Management Information System, Project Scheduling, Project Audits, Project Terminations.

### **Unit- IV(Practical):**

Study of Feasibility of investment in a project  
Project preparation for agricultural enterprise.  
Monitoring and evaluation of NREGS in village.  
Project reviews.

### **Suggested Readings:**

Alan Door 2004. Advanced Project Management, Kogan Page, New Delhi  
Chandra P 2006. Projects, TMH, New Delhi Dantwala, ML. 1997, Dilemma of Growth, Sage Pub., New Delhi  
Gopalakrishnan P 2007. Text Book of Project Management, Macmillan, New Delhi  
Jhingan ML 2007. Economics of Development & Planning, Vrinda Publication, Delhi  
Kerzner H 2005. Project Management, John Wiley & Sons, New Jersey  
Lock D 2007. Project Management, Gower Publication, England  
Nicholas JM 2005. Project Management for Business & Technology, PHI, Delhi Singh,

## **RDA-DSEC-503(AG): Farming Systems and Sustainable Agriculture**

(Total Marks = 100; Theory= 100, Practical= 0) Credit: 4+0=4

### **Objectives:**

To impart knowledge about farming systems and sustainability in agriculture.

### **Course Outcome:**

Learning of different farming systems, cropping systems, concepts of sustainable agriculture and integrated farming system.

### **Unit-I**

Farming System-scope, importance, and concept, Types and systems of farming and factors affecting types of farming, Farming system components and their maintenance. Contract farming.

### **Unit-II**

Cropping system and pattern, multiple cropping system, efficient cropping system and their evaluation, Allied enterprises and their importance, Tools for determining production and efficiencies in cropping and farming system.

### **Unit-III**

Sustainable agriculture-problems and its impact on agriculture, indicators of sustainability, adaptation and mitigation, conservation agriculture strategies in agriculture, High External Input Agriculture (HEIA), Low External Input Agriculture (LEIA) and Low External Input Sustainable Agriculture (LEISA) and techniques for sustainability.

### **Unit-IV:**

Integrated farming system-historical background, objectives and characteristics, components of IFS and its advantages, resource use efficiency and optimization techniques, resource cycling and flow of energy in different farming systems, farming system and environment.

### **Suggesting Readings:**

Alexander M John Wiley & Sons 2009. Introduction to Soil Microbiology, Inc., New York  
Chatterjee BN and Maiti S 2015. Cropping systems Theory and Practice  
Lekhi RK and Singh J 2005. Agricultural Economics Kalyani publishers, Ludhiana 91  
Palanniappan SP 2015. Cropping Systems in Tropics – Principles and practices.  
Sharma AK 2012. Bio fertilizers for Sustainable Agriculture. Agrobios (India), Jodhpur.  
Tandon PK and Dhanyal SP 2012. Principles and methods of farm management Kalyani publishers, Ludhiana.

## **RDA-DSEC-503(HO): Commercial Floriculture and Landscaping**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To impart technical knowledge on production of commercial flowers and orchids, post-harvest management of cut flowers, floral arrangements, bonsai making, dry flower making, growing house plants and landscaping.

### **Course outcome:**

Learning of production technology of commercial flowers and orchids, their harvesting techniques and post-harvest handling, different styles of bonsai making, different ways of growing house plants, Western and Japanese floral arrangements, making of different styles of bouquets, boutonhole, understanding of methods of dry flower making, styles and components of landscaping.

### **Unit- I**

Floriculture: present status, scope and limitations of floriculture industry; detailed study of soil and climatic requirement, varieties, planting, propagation, intercultural operations, nutrient management, harvesting, physiological disorders and cost of cultivation of the following flowering crops: rose, anthurium, carnation, gerbera, bird-of-paradise, gladiolus, heliconia, liliium.

### **Unit -II**

Orchid cultivation: types of orchids, orchid houses, receptacles for growing orchids, pots and potting materials, , nourishment of orchids, important factors for orchid cultivation, common diseases and pests of orchids; Bonsai culture: importance, selection of plants, stands and containers, potting mixture, wiring and shaping, dwarfing techniques; House plants: Factors influencing choice of house plants, locating house plants, container gardens, gardening in tubs or urns, hanging baskets, window box gardening, gardening in troughs, dishes, bowls and trays, jar, bottle and terrarium gardening.

### **Unit-III**

Post- harvest management of cut flowers; Flower arrangement: principles and practices, different styles of flower arrangement and bouquets. Dry flowers: importance and prospects in NE region, methods of dry flower making; Landscaping: basic principles, Garden components: trees, shrubs, herbs, climbers, bulbous plants, annuals, cacti and succulents, aquatic plants, topiary, hedge, edge, lawn: types of lawn grasses; methods of planting lawn, maintenance and renovation of lawn.

### **Unit IV (Practical):**

Preparation of different types of bouquets and bouton hole  
Different styles of Ikebana arrangement.  
Different styles of bonsai making  
Layout of different types of garden  
Planting of flowering and ornamental plants.  
Intercultural operations of flowering plants.  
Potting and re-potting of ornamental plants.  
Visit to commercial floriculture units and report writing.

### **Suggested Readings:**

Aswath C, Bose TK, L.P. Yadav. Pal P, Duta K and Rajiv Kumar 2021. Commercial Flowers, Astral International, New Delhi  
Bose TK and D Mukherjee 2002. Gardening in India, Oxford & IBH Publication, New Delhi  
Chadda KL and B Choudhry 2007. Ornamental Horticulture in India, ICAR, New Delhi  
Chattopadhyay 2012. Commercial Floriculture, GeneTech, New Delhi  
Desh Raj 2014. Floriculture at Glance, Kalyani Publishers, New Delhi  
Mukherjee SK 2002. Orchids, ICAR, New Delhi  
Prasad S 2005. Commercial Floriculture, Agro botanic, Bikaner  
Swarup V 2002. Indoor Gardening, ICAR, New Delhi  
Trivedi PP 2004. Home Gardening, ICAR, New Delhi

**RDA-DSEC-503 (AS): Processing of Livestock Products**  
(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

**Objective:**

To impart knowledge on processing techniques of milk and milk products, meat and meat products.

**Course outcome:**

Understanding of definition, properties of milk, common dairy operations and processing techniques of milk and meat products.

**Unit - I**

Milk and its properties; Importance of milk in human diet. Nature and functions of colostrum; quality control of milk. Sources of microbial contaminations of milk, hygienic handling of dairy animals, milk, and equipment's; bacteria commonly found in milk and its products; common dairy operations for milk and dairy products.

**Unit-II**

Processing technique of various classes of milk: standardized milk, toned milk, double toned milk, full cream milk, reconstituted milk, recombined milk, and humanized milk; methods of preparing cream, butter, and frozen milk products.

**Unit – III**

Meat industry its scope and potential; problems of production and marketing of meat. Ante- mortem and post-mortem inspection of food animals; methods of slaughter; meat borne diseases; nutritive value of meat, eating quality of meat and preservation. economic importance of slaughterhouse by-products; quality and grading of wool/fibre and their processing and marketing.

**Unit-IV (Practical):**

Sampling of milk for various tests.

Physio-chemical, microbial and organoleptic test of milk.

Preparation of cream, butter, and products Frozen Milk Products.

Visit to dairy plants and submission of report.

Familiarization of various meat products in market and their method of production.

Visit to slaughterhouse/ butchers' shop for inspection of carcass.

Standardization technique for adjustment of fat and solid non-fat in market milk processing.

**Suggested readings:**

AL Winton 2002. Milk and Milk Products, DVS Publishers, Guwahati

De Sukumar 1994. Outlines of Dairy Technology, Oxford Univ. Press, New Delhi

Harbert Roginski 2010. Encyclopaedia of Dairy Science, (4 Vols.), M.K. Book Distributor, 310, Shyamak, New Delhi

Handbook of meat and meat Processing, 2012. CRC Press Taylor & Francis Group 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742 © 2012 by Taylor & Francis.



## **RDA-GEC-504: Statistical Techniques and Software Application**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To equip the students with knowledge on various statistical tools and software useful for data analysis.

### **Course outcome:**

Understanding of statistics, various measures, basic principles of field experiments and their methods, various computer softwares.

### **Unit-I:**

Introduction to statistics, measures of central tendency, standard deviation and standard error and rank correlation, Coefficient of variation, Skewness, Kurtosis, Probability, statistical and classical definition of probability, Distribution – binomial, poisson and normal distribution and its characteristics. Simple, partial and multiple correlation and regression.

### **Unit-II:**

Analysis of Variance, Basic principles of Field experimentation, Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), Factorial Experiment and Split-plot Design. Missing values in RBD and LSD.

### **Unit -III:**

Tools and techniques of data analysis: Computer software and its classification: System and application software. Various statistical software packages- MS Excel and SPSS, R software etc.

### **Unit- IV(Practical):**

Calculation of Correlation and Regression.

Statistical analysis of CRD, RBD, LSD, factorial and Split-plot design.

Analysis of missing value in RBD and LSD with one value.

Use of statistical software in social and agricultural sciences.

### **Suggesting Readings:**

Agarwal SP 2015. Statistical methods: Concepts, Application and Computation. Delhi  
Chandel RS 1972. Handbook of Agricultural statistics, Achal Prakashan Mandir, Kanpur  
Arora Pawan 2000. Computers for beginners, New Light publishers, New Delhi  
Dixit 1999. Statistical and Intercede Design of experiment, Narosa, New Delhi  
Fielding J 2006. Understanding social Statistics, sage, London  
Frank H and Sline 2002. Statistics: Concepts and Application, Cup, New York

**RDA-CC-505: Basic Economic Theory and Policy**  
(Total Marks = 100; Theory= 100, Practical = 0) Credit: 4+0=4

**Objectives:**

To impart knowledge on concepts of basic micro economics and product pricing and to expose the students to macro-economics concepts and their uses, role of international environment on National Economy.

**Course Outcome:**

Knowledge of basic economic principles relating to cost and output determination and knowledge of Macro economics and parameters like national income, fiscal and monetary policy, foreign exchange and balance of payments.

**Unit I**

Meaning and concept of micro economics, Relevance of micro economics for production pricing; Classical and Neo Classical Approach, concepts of Demand, law of demand,, Consumers' theory: Definition and Basic Economic Problems – Choice and Scarcity; - Concept of Utility; consumers decision making- indifference curve and revealed preference theory.

**Unit II**

Production and pricing-Factors of production. Concept of firm, Revenue, cost and profit. Market Structures– Perfect Competition, Monopoly, Oligopoly, Law of supply, Concepts of different costs; relationship between average and, marginal cost in different market systems. Short run and long run costs, opportunity costs, breakeven analysis and product pricing. profit.

**Unit III**

Macro Economic Policy, GDP and the related concept, components and measurement of National Income. Circular flow of Income, Aggregate demand and Aggregate supply, Fiscal Policy and tools of fiscal policy, Monetary Policy and tools for controlling the inflationary or depressionary trends in economy.

**Unit IV**

Balance of payments. Trends in India's BoP, purchasing power parity and value of currency, devaluation, International Financial Institutions like IMF and World Bank, Global environment and National Economy.

**Suggested Readings:**

De S. 2017. India's Fiscal Policy: Prescriptions, Pragmatics and Policy, Cambridge University Press  
Dewett, KK. 2022. Modern Economic Theory, Business, English Books  
Jhingan, MJ 2017. Macro Economic Theory, Vrinda Publication  
Raj, D. 2004. Monetary Economics and Practice, Neha Publishers and Distributors  
Tandon, P. 2015. A Textbook of Microeconomic Theory, SAGE India, New Delhi.

## **RDA-CC-506: Principles and Practices of Organic Agriculture**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To impart knowledge on the concept and principles of organic agriculture, CGAP, bio-dynamic agriculture, methods of organic soil management, pest and disease management and organic certification procedures.

### **Course Outcome:**

Understanding of concept and principles of organic agriculture, CGAP, bio-dynamic agriculture, methods of organic management of soil, pests and diseases and certification procedures of organic produce.

### **Unit - I**

Organic Agriculture: concept, principles and objectives of organic agriculture; prospects and constraints of organic farming in India and NE region; International Federation of Organic Agriculture Movements (IFOAM) and global scenario of organic movement; Code of Good Agricultural Practices (CGAP): principles and management; bio-dynamic agriculture: concept, influence on plant growth and development.

### **Unit - II**

Organic management of soil: bio-fertilizers- different types of bio-fertilizers and their role in crop production; compost: different methods of composting; vermicomposting: establishment of small scale production unit; green manuring-types of green manures, methods of green manuring; indigenous formulations for nutrient management.

### **Unit - III**

Organic management of pests and diseases: biological control of pests; biopesticides; cultural methods- crop rotation, mixed farming, trap cropping, companion cropping, smothering crops, bait traps, light traps etc.; Trichoderma- mass multiplication; soil solarization- methods and advantages; indigenous formulations for disease and pest management; organic certification.

### **Unit – IV (Practical)**

Small-scale vermicomposting technique

Collection of local earthworms

Soil solarization for disinfection of soil

Preparation of plant-based decoctions for organic pest control.

Eco-friendly mulching methods.

### **Suggested Readings:**

Palaniappan SP and Annadurai K 2006. Organic Farming: Theory and Practices. Scientific Publishers, Jodhpur, India.

Panda SC 2011. Organic Farming for sustainable agriculture. Kalyani Publishers, Jalandhar,

Rangathan LS 2006. Vermitechnology. Agrobios, India.

Sharma AK 2005. A Handbook of Organic Farming. Agrobios, India.

Singh HP and George V Thomas 2014. Organic Horticulture; Principles, Practices and Technologies, Westville, New Delhi

Thapa U and Tripathy P 2010. Organic Farming in India- Problems and Prospects. Agro Publishing Academy, Udaipur

## **RDA-DSEC (RD) 507: Rural Development: Organizations, Institutions and Administration**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objectives**

To study the concepts of various organizations and institutions of Rural Development and the administrative and local institutions of governance, planning and implementation of Rural Development Programmes with an emphasis on decentralized planning, people's participation and role of non-governmental organizations in development of various aspects of rural society.

### **Course Outcome:**

Knowledge of implementing procedures and administration of rural development programmes and various Institutions and Organizations including NGOs involved in the process.

### **Unit – I**

Rural development organizations: organizational models and their limitations; characteristics of an ideal rural development organization; types of rural development organizations: governmental organizations; non-governmental organizations (NGOs) and community based organizations (CBOs); Rural Development

### **Unit- II**

Rural Development Administration: concept of development administration, distinction between public and private administration; bureaucracy and rural development; bureaucracy, democracy and rural development; rural development administrative structure at the state, district and block level; review of rural development administration- its strength and weakness; political leadership and rural development.

### **Unit III**

Peoples Participation and decentralized Planning, 73<sup>rd</sup> Constitutional Amendment, and the new Panchayat Raj System; constitutional provisions of PRIs; devolution of powers and functions to Panchayati Raj Institutions at the three- tier levels; composition of State Election Commission; composition of State Finance Commission; composition of District Planning Committee (DPC). Extension of PRIs to the Fifth Schedule areas; Local Governance system in North East; Village Development Board (VDB); Village Development Councils (VDCs); Sixth Schedule and .Autonomous District Councils (ADCs); local governance and empowerment of rural people, especially the weaker sections and the women,

### **Unit IV (Practical)**

Study of Block Office

Visit to SIRD/ Local Training Institute

Case study on role of NGO.

Study of functioning of ADC

Village council and their role in development.

### **Suggested Readings:**

Alwin Y 2000. Social Change and Development, New Delhi: sage Publications.

G Palanithurai 2004. Dynamics of New Panchayati Raj System in India (Multi volume Set), New Delhi: Concept Publishing Company,.

Girish Kumar 2006. Local Democracy in India, New Delhi: Sage Publications.

James Manor 1999. The Political Economy of Democratic Decentralisation, Washington DC: World Bank,.

Anonymous, 2000. National Institute of Rural Development, 2000, India Rural Development Report: Regional Disparities in Development and Poverty, NIRD Publication, Hyderabad

Jain GL 2000. Rural Economy and Society: Towards Development, Eastern Book House, Guwahati

Anonymous, 2001. Indian Panchayati Raj Report: Vol. I and II, NIRD Publication, Hyderabad.

## **RDA-DSEC-507(AG): Production Technology of Field Crops – II**

(Total Marks = 100; Theory = 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To familiarize students with production technology of millets, fiber crops, sugar crops and important cash crops.

### **Course Outcome:**

Learning of production technology of cereals, fiber crops, cash crops and their plant protection measures.

### **Unit – I**

Production technology of millets: sorghum, finger millet, barnyard millet, kodo millet, pearl millet, Italian millet, little millet and common millet.

### **Unit – II**

Production and processing technology of cotton, mesta, sunhemp, flax and jute including retting, extraction, grading and marketing with emphasis to varieties suitable to NE region.

### **Unit – III**

Production and plant protection measures of starch crops like potato, tapioca and sweet potato; sugar crops like sugarcane and sugar beet with special emphasis to NE region.

### **Unit – IV (Practical):**

Identification of important rabi crops.

Cultivation of tapioca and sweet potato in the farm.

Raising of millets in the farm.

Raising of sugarcane in the farm.

Determining the requirements of seed and fertilizers for major Rabi crops.

Calculation of cost of cultivation and production of different crops.

### **Suggested Readings:**

Das PC 1997. Oilseed Crops in India, Kalyani Publishers, New Delhi Singh, Dharampal, 1958, Rape and Mustard, Examiner Press, Fort, Bombay

Hillocks RJJM, Thresh and A Ballotter 2001. Cassava, Oxford Uni. Press, New York TNAU 1999, Crop Production Guide, TANU and Directorate of Agriculture, Chennai

Russell EJ 2007. Manuring for Higher Crop Production, Agrobios, Jodhpur

Singh Chidha 2004. Modern Techniques of Raising Field Crops, Oxford & IBH Publishing Co., New Delhi.

Weiss EA 1983. Oil Seed Crops, Longman Group Ltd., London

Weiss EA 1997. Essential Oil Crops, Oxford Uni. Press, New York.

## **RDA-DSEC-507(HO): Post-Harvest Management of Horticultural Crops**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To acquaint the students with principles and practices of post-harvest management of horticultural produce, methods of processing and preservation of fruits and vegetables.

### **Course Outcome:**

Learning of spoilage causing factors and their control, post-harvest management practices of horticultural produce, Understanding of principles and methods of preservation, learning of home scale processing techniques of various products of fruits and vegetables, packaging and quality control, low cost and high cost technology of storage.

### **Unit - I**

Food preservation: history, importance and objectives; prospects and constraints of processing industries in India and NE region of India; Importance of post-harvest management of horticultural crops; Pre-harvest and post-harvest factors influencing storage life of horticultural produce; Cold chain: its importance in post-harvest management; Spoilage: factors causing spoilage, classification of food according to ease of spoilage; Principles of food preservation.

### **Unit - II**

Methods of fruit and vegetable preservation: physical(low temperature, thermal processing, drying or dehydration, irradiation) chemical(addition of acid, brining, addition of sugar and heating, addition of chemical preservatives/antibiotics ) and fermentation methods(acetic acid, lactic acid, alcoholic); Selection of fruits and vegetables for processing; Common practices for reducing nutrient losses during processing; FPO specifications for fruit and vegetable products; Utilization of fruit and vegetable waste.

### **Unit – III**

Packaging: functions and requirements of packaging, materials used for packaging, their advantages and disadvantages. Requirements for setting up of small scale processing industry; Quality control: need in food industries, sequence of operations in quality control; Statutory provisions for quality control in India; Food standardization and regulatory agencies in India; Storage systems of fruits and vegetables: low cost and high cost technology.

### **Unit – IV (Practical)**

Preparation of different types of pickles.  
Determination of TSS by hand refractometer.  
Preparation of fruit jam.  
Preparation of fruit squash.  
Preparation of Ready to Serve (RTS).  
Preparation of tomato sauce.  
Visit to processing units followed by submission of report.

### **Suggested Readings:**

Chadda KL 2012. *Hand Book of Horticulture*, ICAR, New Delhi  
Laxminarayan Hegde 2014. *Quality Control in Fruits And Vegetables*, Discovery Publishing, New Delhi  
Ramesh Chand 2011. *Fruits and Vegetables Preservation*, Educational, Delhi  
Sidappa GS 2013. *Preservation of Fruits and Vegetables*, ICAR, New Delhi  
Srivastava RP and Sanjeev Kumar 2019. *Fruit and Vegetable Preservation; Principles and Practices*, CBS, New Delhi.  
Subbulakshmi and Shobha A. Udipi, 2010. *Food Processing and Preservation*, New Age International, New Delhi.

**RDA-DSEC-507 (AS) Commercial Poultry Production**  
(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

**Objective:**

To study about commercial production of Poultry, management of common diseases of poultry and preparation of feasible report on poultry farming.

**Course Outcome:** Learning of scientific production and management of commercial poultry farming.

**Unit-I**

Introduction and scope Poultry in India with special reference to North-East region. Breeds of Poultry. Housing, advantage, and disadvantages. Space requirement for different age groups under different rearing systems. Brooding: Types of brooders; preparation of shed to receive chicks; importance of environment, feeding and Vaccination. Care and management of growing, laying/broiler birds of both breeders and commercial categories of poultry.

**Unit-II**

Litter materials, litter-borne diseases, and control; potential for poultry litter used as fertilizers; dietary modification to minimize heat stress; special management during rainy and winter season; other stress management. Feeding management, Classification, selection of common feed ingredients and their nutrient composition. Nutrient requirement for different age groups. Feed formulations for poultry. Formation of egg in the hen body.

**Unit-III**

Common poultry diseases: bacterial, viral, fungal, parasitic, and nutritional deficiencies. Vaccination schedule for commercial layers and broilers: factors that govern vaccination schedule; vaccination principles type, methods, pre and post vaccination care. Economics of layer and broiler production; Projects reports layer in different systems of rearing. Projects reports for broilers. -Feasibility studies on poultry rearing- in context of small units and their profitability. Hatchery management- principles of incubation. Factors affecting fertility and hatchability. selection, care, and incubation of hatching eggs. Fumigation; sanitation and hatchery hygiene. Economics of hatchery business.

**Unit-IV(Practical):**

External and internal structure of egg, composition of egg.

Technique of selection and culling of poultry birds.

Preparation of model scheme for broiler farming.

Management of incubators, feeders, waterers, poultry farm and hatchery.

Health care and management of chicks, duckling, and turkey.

**Suggested Reading:**

Virender Singh 2021. The Complete Guide of Poultry Farming: Eggs Production, Raising Chickens  
Published by Independently Published, United States.

Banerjee GC 2012. A Text Book of Animal Husbandry, Oxford and IBH Publ. Co., Janapath, New  
Delhi

Gopal Krishnan CA and GB Mohanlal 2002. Livestock and Poultry Enterprises for Rural  
Development, Vikas Publishers House Pvt. Ltd., New Delhi.

Panda B 1990. Feeding of Poultry, ICAR, New Delhi.

Sastry NSR, CK Thomas and RA Singh 1986. Farm Animal Management and Poultry Production

**RDA-DSEC-508 (RD): Rural Credit and Micro Finance**  
(Total Marks = 100; Theory= 100, Practical= 0) Credit: 4+0=4

**Objectives:**

To acquaint the students with various financial organizations for rural credit and micro-finance sector development.

**Course Outcome:**

Understanding of rural credit, types, role of financial institutions, concept of micro-finance, principles of micro-finance, sources, MFIs, Delivery models in various countries.

**Unit - I**

Rural credit: context, concept, importance and need; classifications of credit; financial institutions: Reserve Bank of India, NABARD, commercial banks, regional rural banks (RRBs), co-operative banks and other rural financial institutions; flow and delivery mechanism of credit to rural sector: priority sector lending. Micro finance: concept, need, evolution, features, components; micro credit; micro-savings; micro insurance, Indian and global perspectives; emergence and growth of micro finance sector in India; regulatory and legal framework for microfinance institutions in India.

**Unit- II**

Models and experiences in micro-finance in India and abroad (Bangladesh, Pakistan, Philippines, Nepal, Malaysia, Sri Lanka, Thailand); Role of international organizations in micro-finance developments; individual and group based lending; group formation, development and management of savings and credit in SHGs; capacity building: group dynamics and team building, leadership and communication skills.

**Unit-III:**

Micro-finance institutions: formal financial institutions, micro-finance and women empowerment, micro-finance and health, , micro-finance and enterprise development, , micro-finance and education, , micro-finance and poverty.

**Unit-IV:**

Sources of micro-finance; process of micro-finance, challenges and difficulties in micro-finance process, subsidy schemes and plans; transaction cost for micro-entrepreneurs. Operational Aspects of micro-finance; Financial products and services, financial accounting and reporting - Revenue models of Microfinance - Risk management - Basics of banking - Compliance to various regulations

**Suggested Readings:**

Ahmed Syed Masud 2001. Microcredit and Emotional Well Being: Experience of Poor Rural Women from Matlab, Bangladesh, World Development, 29 (11)

Chavan Pallavi and R Ramakumar 2002. Microcredit and Rural Poverty, Economic and Political Weekly, 37 (10): 955-65

David and Paul Mosely 1996. Finance Against Poverty, Routledge Publishers

Hashemi Syed M 1996. Rural Credit Programmes and Women's Empowerment in Bangladesh, World Development, 24 (4) Hulme.

Karmakar KG 1999. Rural Credit and Self-Help Groups: Micro-Finance Needs and Concepts in India, Sage Publication, New Delhi

Khandker S 1998. Fighting Poverty With Micro Credit: Experience In Bangladesh, New York, OUP, World Bank



## **RDA-DSEC-508 (AG): Pasture Management and Forage Crop Production**

(Total Marks = 100; Theory = 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To acquaint students with the concept and approaches of pasture management and also impart scientific knowledge on forage crop production.

### **Course Outcome:**

Understanding of grassland and pasture and their maintenance, types, production technology of fodder crops and conservation technology of forages.

### **Unit – I**

Grassland and pasture: management and maintenance; native and sown pastures; grass-legume mixtures; autecology and growth behaviour in different range grasses; management of native grasslands; ley farming and grazing management.

### **Unit – II**

Establishment and cultivation of important fodder and legume crops: para grass, guinea grass; napier grass, setaria grass, signal grass, stylo, berseem, lucerne, maize, sorghum and cowpea.

### **Unit – III**

Significance of conservation and conservation technology of forages: hay, silage, urea-treated straw, urea- molasses liquid / block.

### **Unit – IV (Practical)**

Identification of seeds and fodder crops of NE Region.

Production of berseem.

Production of sorghum, maize & cowpea.

Production of setaria grass

Cultivation of napier grass.

Cultivation of para grass and stylo.

Hay and silage making.

### **Suggested Readings:**

Chatterjee BN 1998. Principles and Practices of Forage Crop Production, Oxford and IBH Publishing Co. Pvt. Ltd New Delhi

Das Vivendra LD 1998. Forage Crops, International Book Distribution, Dehra Dun

Rios Sotomayor Antonio and WD Pitman 2000. Tropical Forage Plants: Development and Use, CRC Press LLC, U.S.A

Russell EJ 2007. Manuring For Higher Crop Production, Agrobios, Jodhpur

Singh Chidha 2004. Modern Techniques of Raising Field Crops, Oxford & IBH Publishing Co., New Delhi

Singh LNA and J Singh 1994. Forage, Grasses and Legumes, Scientific Publishers, Jodhpur.

## **RDA-DSEC-508 (HO): Production Technology of Fruits and Plantation Crops**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To acquaint students with theoretical and practical aspects of the production technology of important fruits and plantation crops of NE region of India.

### **Course Outcome:**

Understanding of production technology and harvesting techniques of fruits and plantation crops, learning of curing and processing techniques of produce from plantation crops.

### **Unit - I**

Detailed study on the area, distribution, soil and climatic requirement, varieties, planting, propagation, intercultural operations, nutrient management, harvesting, yield and cost of cultivation of tropical and sub-tropical fruit crops like mango, banana, mandarin orange, lemon, pineapple.

### **Unit - II**

Detailed study on the area, distribution, soil and climatic requirement, varieties, planting, propagation, intercultural operations, nutrient management, harvesting, yield and cost of cultivation of temperate fruit crops like apple, pear, peach, plum and strawberry.

### **Unit – III**

Detailed study on the area, distribution, soil and climatic requirement, varieties, planting, propagation, intercultural operations, nutrient management, harvesting, yield, curing and primary processing and the cost of cultivation of plantation crops like tea, rubber, cashew, arecanut, coconut.

### **Unit- IV (Practical)**

Identification and description of fruits and plantation crops.

Contour layout using A-frame

Planting of fruits crops using planting board.

Calculation of requirements of simple and complex fertilizers.

Calculation of cost of fertilizers.

Calculation of requirement of planting material.

Calculation of the cost of cultivation of different fruits and plantation crops.

Visit to commercial plantation areas /processing units and report writing

### **Suggested Readings:**

Bal JS 2014. Fruit Growing, Kalyani Publishers, New Delhi

Bose TK, Mitra SK and Sanyal D 2002. Fruits of India: Tropical and Sub -Tropical, Naya Udyog, Calcutta

Chadda KL 2012. Hand Book of Horticulture, ICAR, New Delhi

Henry Y Nakasone and Robert E Paul 2004. Tropical Fruits, University Press, New York

Shanmugavelu, KGN Kumar and KV Peter 2005. Production Technology of Spices and Plantation Crops, Agrobios, Jodhpur

Thapa U, Sharangi AB and AK Pal 2009. Varieties of Horticultural Crops. Agrotech Publishing Academy, Udaipur- 313002.

## **RDA-DSEC-508 (AS): Starter Culture and Fermented Milk Products**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objective:**

To study about importance of starters in fermented milk Industry and to know about various fermented milk products in detail.

### **Course Outcome:**

Understanding the basic concept of starter culture, classification, propagation and genetic improvement of starter culture and learning the production technology of various fermented milk products.

### **Unit-I**

Introduction to starter cultures. Starter cultures and their classification. Propagation of starter cultures. Purpose of propagation, traditional methods-advantages and limitations. Metabolism in starter cultures Vitamin metabolism in starter cultures Quality and activity of starters. Antimicrobial compounds produced by starters and interactions among starter cultures. Activity & purity test and standards for starter cultures Causes of slowness of starters. Problems associated with starter itself, with control of starters, with milk and with production method. Bacteriophage action ultra-structures, classification, detection and control . Preservation and forms of starters. Criteria for selection of method, preservation techniques. Forms of starters- Liquid, frozen, dried, concentrated and DVS cultures.

### **Unit-II**

Genetic improvement of starters. Scope and need, characteristics which can be manipulated, genetic tools –mutation, conjugation, transformation, transduction, protoplast fusion and genetic engineering Plasmids, value of improved strain. Starter distillates. Composition of synthetic and bacterial distillates, production, and application. Introduction – fermented milk products. History, definitions/ types, classification of fermented milk products.

### **Unit-III**

Yoghurt- Definition, types and microflora, enumeration of yoghurt starters. Types of yoghurts, yoghurt production-significance of each processing steps. Post production processing of yoghurt into various types, nutritive value, therapeutic value, spoilage, defects and quality assurance. Dahi- Definition and standards, methods of production, types of starters. Desirable properties of dahi, composition of dahi Modified dahi- bhapa dahi and misti dahi, defects. Cultured butter milk. Flavour in cultured butter milk, advances in CBM production. Probiotics, acidophilus and bifidus milk products. Probiotics: Importance, definition, types and selection criteria for cultures. Acidophilus and bifidus products- Nutritional, therapeutic, safety and quality aspects of probiotic products. Kefir- Kefir-manufacture, composition, nutritional and therapeutic properties. Koumiss- manufacturing, nutritive and therapeutic values. Other fermented milks- Kishk, yakult, villi.

### **Unit-IV (Practical)**

Propagation of Starter Cultures.

Activity and Purity test of starter cultures.

Preparation of various fermented milk products such as Yoghurt, Dahi, misti dahi, cultured butter milk, acidophilus milk, kefir, koumiss.

Shelf-life study of fermented milk.

Preparation of commercial projects for fermented milk.

### **Suggested Reading:**

Hutkins RW 2006. Microbiology and Technology of Fermented Foods. Blackwell Publ. Professional, Iowa, USA.

Law BA 1997. Microbiology and Biochemistry of Cheese and Fermented Milks. 2<sup>nd</sup> ed. Blackie, New York.

Prajapati JB 1995. Fundamental Dairy Microbiology, Ekta Prakashan, Nadiad, India.

Robinson RK 2002. Dairy Microbiology Handbook. John Wiley and Sons, Inc., New York.

## **RDA-RM-509: Research Methodology and Proposal Writing**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To impart knowledge on scientific research, methods of data collection and analysis.

### **Course outcome:**

Understanding of concept, types of research, data collection and their methods, data analysis, interpretation, various sampling methods, writing of synopsis and dissertation, test of significance.

### **Unit –I:**

Scientific research: meaning, objectives and characteristics; basic elements of scientific methods; fact, concept, hypothesis, theory and research, types of research design: exploratory, descriptive, diagnostic and experimental research designs and their limitations; action research; preparation of resource inventory; participatory research tools: origin, major methods of PRA. Focus Group Discussion.

### **Unit -II:**

Methods of data collection; observation, questionnaire, interview, schedule; case study method, content analysis; survey methods and sampling techniques: definition of sampling, aims of sampling, types of population, choice of sampling method, random sampling, stratified sampling, systemic sampling, multi-stage sampling.

### **Unit -III:**

Methods of data analysis: tabulation, preparation of graphs/charts; data processing, analysis and interpretation and report writing, Synopsis writing, Dissertation writing; hypothesis, test of significance; Student's Z test, Student's t-test, F-test and  $X^2$  (chi square) test. Proposal writing-meaning, concept, and importance.

### **Unit- IV (Practical):**

Preparation of resource inventory.

Practical uses of test of significance

Techniques of preparation of questionnaires and schedule.

Collection of data, data analysis and report writing.

Proposal writing, Writing of model synopsis, report writing

### **Suggested Readings:**

Ahuja Ram 2001. Research Methods, Jaipur, Rawat Publications

Bhandarkar PL and TS Wilkinson 1999. Methodology and Techniques of Social Research, Bombay, Himalaya Publishing House

Goode and Hatt 1964. Methods in Social Research, Oxford, New York

Krishnaswami OR 1998. Methodology of Research in Social Sciences, Himalaya Publishing House, Mumbai

Murkherjee Neela 1996. Participatory Rural Appraisal: Methodology and Application, Concept Pub., New Delhi

Ray GL and Sagar Mondal 1999. Research Methods in Social Sciences and Extension Education, Naya Prokash, Calcutta

## **RDA-SEC-510: Processing of Food**

(Total Marks = 100; Theory= 50, Practical = 50) Credit: 2+2=4

### **Objective:**

To acquaint the students with various methods of processing of fruits and vegetables and preparation of soya milk and soya milk based products.

### **Course outcome:**

Learning various methods of preparation of processed products from fruits and vegetables, preparation of soya milk and various products from soya milk.

### **Unit- I**

Food preservation: history, importance and objectives. Pickles: process behind pickle formation, types of pickle, problems in pickle making; Jam, Jelly, Marmalade: process of preparation and problems in jam production; Fruit beverages: process of preparation of juices, Ready to serve(RTS), nectar, cordial, squash, crush, syrup, concentrate; Tomato processing: process of preparation of tomato juice, puree and paste, chutney, soup, sauce, general considerations and problems in preparation; Chutneys: process of preparation; fruit toffee: process of preparation; Common practices for reducing nutrient losses during processing; FPO specifications for fruit and vegetable products; Utilization of fruit and vegetable waste.

### **Unit - II**

Soya milk: introduction and history, nutritional and health aspects of soya-bean and its blend with dairy products; need for soya food fortification in milk based products; soya bean products analogous to dairy; soya dairy blend. By-products of soya milk and its utilization. Cost benefit analysis of soya milk production; concept in quality management of soya based dairy products.

### **Unit – III (Practical)**

Preparation of different types of pickles.  
Determination of TSS by using hand refractometer.  
Preparation of fruit jam/jelly.  
Preparation of fruit squash.  
Preparation of Ready to Serve (RTS).  
Preparation of tomato sauce.  
Preparation of fruit chutney.  
Preparation of fruit toffee.  
Visit to processing units followed by submission of report.

### **Unit-IV (Practical)**

Preparation of soya milk and its various products such as –plain soya milk, flavoured soya milk, Tofu, Ice-cream etc.  
Study about packaging and shelf-life of various soya-based milk products.  
Preparation of project report on soya milk.

### **Suggested Reading:**

Encyclopaedia of Food Sciences and Nutrition (Second Edition), 2003.  
H Panda 2014. Technology of Soya Milk, Tofu, Hydrolyzate and Allied Soyabean Products with Project Profiles, Publisher: Engineers India Research Institute; First edition (1 January 2014).  
Sidappa GS 2013. Preservation of Fruits and Vegetables, ICAR, New Delhi  
Srivastava RP and Sanjeev Kumar 2019. Fruit and Vegetable Preservation; Principles and Practices, CBS, New Delhi.  
Subbulakshmi and Shobha A Udipi 2010. Food Processing and Preservation, New Age International, New Delhi.

## **RDA-CC-600: Capacity Building:**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To understand the concepts of training, capacity building, capacity development and human resource, discuss capacity development- approaches, strategies, needs assessment and methods and tools.

### **Course outcome:**

Learning of concept of capacity building, types and levels, their approaches and strategies, planning and organization, assessment exercises.

### **Unit -I:**

Capacity Development: Meaning, Need and principles; Types and levels of capacities - Institutional capacities, Organizational capacities (how various actors come together to perform given tasks), Individual capacities. Types of capacity building - Based on structure, Based on context. and other categories (online, Webinar, distance etc.). Components of capacity development; Capacity development cycle.

### **Unit-II:**

Capacity Development- Approaches and Strategies, Capacity Development Dilemma- Theory versus Practice, Trainee versus Task, Structured versus Unstructured, Generic and Specific; Approaches in Capacity Development -Informative approach, Participatory approach, Experimental approach/ Experiential, Performance-based approach; Capacity Development Strategies - Academic strategy, Laboratory strategy, Activity strategy, Action strategy, Personal development strategy, Organizational development strategy.

### **Unit -III:**

Planning and Organization of Capacity Development Programmes, Steps in Designing and Planning of Capacity Development: Organising capacity development programme; Operational arrangements at different stages- Before the programme, During the programme, Middle of the programme, At the end of the programme, After the programme, Follow up; Stakeholders' responsibilities.

### **Unit-IV(Practical):**

Capacity development needs assessment exercise, Capacity development project formulation exercise, Planning organizing and conducting an extension capacity development programme. Designing a programme, writing learning objectives, Developing objectives into curriculum Training plan. Organizing capacity development workshop

### **Suggested Readings:**

- Bolger J 2000. Capacity development: why, what and how. CIDA Capacity Development Occasional  
Chrysostome E 2019. Capacity Building in Developing and Emerging Countries. Plattsburg:  
Gerardus Blokdyk 2018. Capacity building A Clear and Concise Reference.  
Milana M, Webb S, Holford J, Waller R and Jarvis P 2018. The palgrave international handbook on adult and lifelong education and learning. London: Palgrave Macmillan. McGill Ebook: <https://mcgill.on.worldcat.org/oclc/1006472012>  
Ross BH 2015. The psychology of learning and motivation. First edn. Amsterdam Netherlands: Academic Press (Psychology of Learning and Motivation, Volume 63). McGill  
Tennant M 2002. Psychology and adult learning. 3rd edn. London: Routledge. McGill Ebook: <https://mcgill.on.worldcat.org/oclc/58789987>

**RDA-CC-601: Commercial Dairy Farming**  
(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

**Objective:**

To study the basic management practices for commercial dairy farming and formulation of dairy projects for dairy entrepreneurs.

**Course outcome:**

Understanding the various aspects of commercial dairy farming.

**Unit - I**

Importance and scope of dairy animals in rural development; comparison of dairy farming in India with advance countries; opportunities in dairy farming; dairying under mixed and specialized farming; starting a dairy farm; procurement of goods; housing and layout of dairy farm; breed selection and breeding; development of green fodder suiting to local conditions and environment.

**Unit - II**

Feeds and feeding management of dairy animals; budgeting and herd recording; personnel management; management of lactating cows, dry cows, pregnant cows, and heifers; care and management of cow at and after calving; raising young dairy calves; pricing policy and cost of milk production; storage of milk; distribution of milk; sanitation and disease control on dairy farm; organic milk production.

**Unit - III**

Dairy Entrepreneurship Development Scheme, objectives, eligible beneficiaries, financial institutions eligible for re-finance under the scheme. Dairy farm wastes and its economic disposal; bio-gas technology in Indian economy and KVIC Model; preparation of model dairy project for small, marginal, and landless farmers suiting to local condition and availability of market.

**Unit-IV (Practical):**

General introduction, care and handling of dairy animals.

Marking and dehorning of animals.

Sanitary production of milk and method of milking.

Important dairy farm records.

Determination of body weight, temperature, pulse rate and respiration rate of dairy animals.

Identification of common feeds.

Formulation of concentrate mixture for dairy cows and determining cost of milk production.

Identification of common tools used on dairy farm.

Computation of feed and ration for dairy animals.

**Suggested Readings:**

Banerjee GC 2000. A Textbook of Animal Husbandry, Oxford and IBH Publ. Co., New Delhi.

Sunil Kumar and BK Mishra 2013. Livestock Production & Management: Recent Trends & Future Prospects, New India Publishing Agency, New Delhi.

Prasad J 2008. Principles of Dairy Farm Management, Kalyani Publishers, Kolkata.

Sunil Kumar and Birendra Kumar Mishra 2014. Advances in Livestock Production and Management, Jaya Publishing House, Delhi-110095

## **RDA-CC 602: Agricultural Marketing and Entrepreneurship Development**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To impart knowledge on marketing and entrepreneurship development and the role of different organizations in entrepreneurship development.

### **Course outcome:**

Understanding of concept of markets and marketing process, types, functions, role of institutions in marketing, concept of entrepreneurship, types, theories, role of various organizations in entrepreneurship development.

### **Unit – 1:**

Concept and definition of market and its component. Classification of markets, market structure, market forces, role of marketing in rural and agriculture development, Marketing functions, marketing channels, marketing margin and price spread, minimum support price, role of financial institutions including NABARD and APEDA in marketing of rural products, Cooperative marketing, Market integration, Marketing efficiency.

### **Unit - II**

Concept and definition of entrepreneur and entrepreneurship. Factors responsible for entrepreneurship. Characteristics of rural entrepreneur. Functions of Entrepreneur, Types of Entrepreneurs. Theories of entrepreneurship development. Entrepreneurial Process: Managing Enterprise. Phases of Entrepreneurial Venture, preparation of project report and business plan.

### **Unit – III**

Concept of micro, small and medium enterprise, sickness and symptoms of micro enterprises. Role of DIC, SISI, IIE, NEDFi, NERAMAC and SIRD in rural entrepreneurship development; role of financial institutions in promoting entrepreneurship; problems and prospects of promoting entrepreneurship for rural and agricultural development; need, importance and status of entrepreneurship development in NE.

### **Unit -IV (Practical):**

Study of marketing channels of major crops and livestock products.

Estimation of marketing costs, marketing margin and price spread

Visit to agricultural co –operative marketing societies' regulated markets.

Visit to a local enterprise and prepare report on the activities of the unit.

Visit to SISI or DIC or IIE or any other support organization and prepare a report.

Selection of a project, market survey and preparation of project report (business plan).

### **Suggested Readings:**

Acharya SS and N L Aggarwal 2015. Agricultural Marketing in India (3rd ed.), Oxford and IBH, Delhi

Cynth L 2000. Entrepreneurship: Ideas in Action, South Western Educational Publishing.

F Kuratko, L Riochar and M Hodgetts 1988. Entrepreneurship: A Contemporary Approach, The Dryden Press Green

Gupta CP and NP Srinivasan 1992. Entrepreneurship Development, Sultan, Guwahati Hirsch

Mali DD 2001. Micro Entrepreneurship Development: Policies and Programmes, IIE Publication, Guwahati

Mali DD 2002. Entrepreneurship Development in North East, IIE Publication, Guwahati

Robert D and AP Peter Michael 1998. Entrepreneurship, Irwin McGraw Hill, New Delhi



**RDA- DSEC 603(RD): International Trade and Agriculture**  
(Total Marks = 100; Theory= 100, Practical = 0) Credit: 4+0=4

**Objectives**

To make the students aware of various theories of trade and related concepts like Balance of Payments, the emerging institutions regulating trade in agriculture and to understand the impact of trade regulations on environment and food security.

**Course Outcome:**

Knowledge of selected theories of International, and national organizations Like World Trade Organization, Food and Agricultural Organization, International Food Policy Research Institute and their policies impacting trade in agriculture and their implications for food security in country.

**Unit - I**

Relevance of and logic of International trade. Some theories of international trade like vent for surplus theory, comparative cost advantage theory and modern theory. History of trade and Indian Agriculture.

**Unit II**

Concept and need for economic reforms; history of economic reforms in India; meaning and concept of liberalization and globalization; liberalization policies in India: objectives, approaches and chronology; liberalization and globalization since 1990s; extent and importance of external sector in Indian rural economy and extent of globalization; current trends.

**Unit - III**

Global Cooperation; WTO and Indian agriculture; Growth trends in Indian agriculture since globalization; contract farming in India: types of contract farming, advantages and disadvantages, growth of contract farming in India: Policy developments in agriculture since independence and agriculture sector reforms; emergence of subsidy and agricultural pricing policy; environmental issues in Agriculture sector; role of agriculture in foreign trade; AoA and its implications;

**Unit IV**

Environment: commercialization of agriculture and environmental degradation; types and extent of land degradation; environmental sustainability: role of trade on development and environment; Trends in food grain production in post-liberalization period; food crisis and food insecurity; measures of food security: production and social security approach; social security and social safety nets; poverty and unemployment in globalization period.

**Suggested Reading**

- Dominick Salntare 2010. International Economics, Print India Press, India
- Lodha S, B P Bhatnagr and Navneet Sharma (Edt) 2007. Delhi Global Competitive advantage, Volume I and Volume II, Abhijeet Publication
- Ahluwalia MS 2002. Economic Performance of the States in the Post-Reforms Period, NCAER
- Kumar Pushpam and B Sudhakar Reddy (eds), 2007. Ecology and Human Well-being, Sage Publications, New Delhi
- Reddy AVS and B K Thapliyal (eds) 2003. Impact of Liberalization and Globalization on Rural Livelihoods, National Institute of Rural Development, Hyderabad
- Saxena KG, Louhui Liang and Kanok Rerkasem 2007. Shifting Agriculture in Asia: Implications for Environmental Conservation and Sustainable Livelihood ,Bishen Singh, Mahendra Pal Singh. 23-A, New Connaught Place, Dehradun
- Yadav SB (ed) 2006. A Decade of WTO and Indian Economy, Sumit Enterprises, New Delhi

## **RDA-DSEC-603(AG): Production Technology of Herbs, Medicinal and Aromatic Crops**

(Total Marks = 100; Theory = 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To acquaint students with the cultivation, plant protection and marketing of important herbs, medicinal and aromatic plants with special reference to NE Region.

### **Course Outcome:**

Learning of production technology and plant protection measures of important herbs, medicinal and aromatic crops.

### **Unit – I**

Introduction, importance and uses of herbs, medicinal and aromatic plants; major medicinal and aromatic plants in N.E. Region; problems, prospects and marketing of herbal, medicinal and aromatic plants. Package of practices of rosemary, thyme, marjoram, oregano, sage and parsley.

### **Unit – II**

Production technology and plant protection measures of medicinal plants: brahmi, gingseng, aloe vera, cinchona, belladonna, poppy and rauwolfia.

### **Unit- III**

Production technology and plant protection measures of aromatic crops: mentha, palmarosa, citronella, lemon grass, basil and patchouli.

### **Unit – IV (Practical)**

Identification of medicinal plants

Identification of aromatic plants.

Identification of herbal spices.

Raising mentha.

Raising cinchona.

Raising palmarosa.

Raising citronella.

Raising lemon grass.

Raising basil.

Raising dioscorea.

### **Suggested Readings:**

Bentley R 2002. Medicinal Plants, (4 Vols.), Atlas Books & Periodicals, Delhi

Bhattacharjee SK 2002. Hand Book of Medicinal Plants, Atlas Books & Periodicals, Delhi

GuhaBakshi DN, P Sensarma and DC Pal 2001. Lexicon of Medicinal Plants in India, (Vol I, II & III), NayaProkash, Calcutta.

Gupta R 1980. Medicinal and Aromatic Plants: Hand Book of Agriculture, ICAR, New Delhi.

## **RDA-DSEC-603 (HO): Production Technology of Vegetables and Spices**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To equip the students with theoretical and practical knowledge on the scientific production of important vegetables and spices with special reference to NE Region.

### **Course Outcome:**

Understanding of production technology and harvesting techniques of important vegetables and spices; curing and processing procedures of important spices.

### **Unit - I**

Detailed study on the area, distribution, soil and climatic requirement, varieties, planting, propagation, intercultural operations, nutrient management, harvesting, grading, packing, storage and cost of cultivation of important summer vegetables like brinjal, tomato, chilli, cucumber, pumpkin, bottle gourd, okra and cowpea.

### **Unit – II**

Detailed study on the area, distribution, soil and climatic requirement, varieties, planting, propagation, intercultural operations, nutrient management, harvesting, grading, packing, storage and cost of cultivation of important winter vegetables like pea, cabbage, cauliflower, radish, carrot and onion.

### **Unit – III**

Detailed study on the area, distribution, soil and climatic requirement, varieties, planting, propagation, intercultural operations, nutrient management, harvesting, curing, processing, storage and cost of cultivation of important spice crops like large cardamom, black pepper, ginger, turmeric and vanilla.

### **Unit- IV (Practical)**

Identification and description of important vegetable crops.

Planning and layout of a kitchen garden.

Identification of seeds of vegetables and spices crops.

Calculation of seed rate for different vegetables.

Calculation of cost of cultivation of different vegetables and spices crops.

### **Suggested Readings:**

Chadda KL 2012. Hand Book of Horticulture, ICAR, New Delhi

Dhaliwal MS 2014. Handbook of Vegetable Crops, Kalyani Publishers, New Delhi

Prem Singh Arya 2014. Spice Crops of India, Kalyani Publishers, New Delhi

Pruthi JS 2001. Minor Spices and Condiments: Crop Management and Post-Harvest Technology, ICAR, New Delhi.

Shanmugavelu KG, N Kumar and KV Peter, 2005. Production Technology of Spices and Plantation Crops, Agrobios, Jodhpur

Thapa U and Tripathy P 2017. Production Technology of Temperate Vegetable Crops, AgroTech, Udaipur

**RDA-DSEC-603(AS): Goat and Sheep Production**  
(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

**Objective:**

To understand the importance, scope and management practices of Goat and Sheep production.

**Course outcome:**

Learning of management practices of Goat and Sheep production, vaccination, breeding and economics of production.

**Unit - I**

Introduction and scope of production; Goat production at national and state level, Goat production for profit. Exotic and indigenous breeds of goat. Selection of Goat for chevon and milk. Package of practices for goat farming, feeding and management; breeding of goat, heat detection does, housing and sanitation and general care and management.

**Unit-II**

Economics of goat production; quality of goat milk and its nutritional importance for baby feeding. Goat housing, routine health care, deworming, vaccination, breeding schedule; general care and management; Culling and selection of goat, economics of Goat production.

**Unit-III**

Introduction and scope of sheep production; exotic and indigenous breeds of sheep; package of practices for sheep farming, feeding and management; breeding of sheep, heat detection, housing and sanitation and general care and management; economics of sheep production; Sheep feeding and housing, routine health care, deworming, vaccination, breeding schedule; general care and management; economics of sheep production.

**Unit-III (Practical):**

Handling, identification, and selection of goats for meat and milk production.

Detection of parasitic infection in goats and their prevention; goat farm records.

Calculation of profit and loss in goat farming.

Dipping, spraying, and spotting sick sheep, examination of parasitic infection, vaccination.

Judging sheep for wool and mutton production.

Working out economics of sheep production.

**Suggested Readings:**

Jindal SK 2013. Goat Production and health management, New India Publication, New Delhi,

Taneja GC 2009. Sheep Husbandry in India, Published by Orient Longman, New Delhi.

Aruna T Kumar 2008. (Revised and expanded version) Handbook of Animal Husbandry, Published by, ICAR, New Delhi.

Banerjee GC 2014. A Text Book of Animal Husbandry, Oxford and IBH Publ. Co., Janapath, New Delhi.

**RDA-DSEC-604 (RD): Farm management**  
(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

**Objectives:**

To acquaint the students with basic principles of farm management.

**Course outcome:**

Understanding the concept and importance of farm management, learning of principles and tools of farm management, analysis and preparation of farm budgets.

**Unit-I:**

Farm management – meaning, definition, scope, subject matter and its importance. Nature and Characteristics of a farm management science, Relationship of Farm Management with other sciences, Characteristics of farming as a business. Farm management decisions; Principles involved in farm management decisions.

**Unit-II:**

Production economics- meaning, nature and scope, its objectives, languages of production economics, Cost concepts. Stages of production functions, types of production functions. Production relationships: Factor –product, Factor-factor and product-product relationships.

**Unit III:**

Tools of farm management analysis: farm planning and farm budgeting. Farm business analysis: farm accountancy, farm records and accounts and its advantages. Financial Records: Farm Inventory, methods of valuation and Depreciation, Net worth statements, income statement, farm inventory. Farm financial management.

**Unit-IV (Practical):**

Preparation of farm plan and budget  
Estimation of optimum input combination  
Estimation of optimum output combination  
Estimation of depreciation  
3R's of credit in farm management

**Suggested Readings:**

David FH 1971. Production Function, Macmillan, London  
Heady and Dillon 1995. Agricultural Production Function  
Heady EO 1964. Economics of Agricultural production and Resource Use, Prentice Hall, India  
Kahlon AS and Karamsingh 1980. Economics of Farm Management in India, Allied, Delhi  
Lawrence and Johnson: Farm Management Analysis  
Lekhi and Singh 2012. Agricultural Economics, Kalyani Publication, New Delhi  
SS Johl and TR Kapur 2005. Fundamentals of Farm business management.2018. Kalyani Publication, New Delhi

**RDA-DSEC-604 (AG): Weed Management**  
(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

**Objectives:**

To acquaint the students with basic knowledge of weeds in the field crops and their management.

**Course outcome:**

Understanding of characteristics and types of weeds, learning the methods of weed control, concept of Integrated weed management, application of herbicides, and weed management in major field crops.

**Unit-I**

Introduction to weeds, characteristics of weeds, their harmful and beneficial effects on ecosystem. Classification of weeds, reproduction and dissemination of weeds. Weed biology and ecology, Crop-weed association, crop-weed competition, allopathy and its application for weed management.

**Unit-II**

Methods of weed control-physical and biological methods, Integrated weed management, Herbicide classification, concept of adjuvant, surfactant, herbicide formulation and their use. Advantages and limitations of herbicides use, Introduction to the mode of action of herbicides and selectivity. Bio-herbicides and their application in agriculture. Concept of herbicide mixture and utility in agriculture. Herbicide compatibility with agrochemicals and their application. Integration of herbicides with non-chemical methods of weed management. Herbicide Resistance and its management.

**Unit-III**

Weed management in major field crops viz., Rice, Wheat, Maize, Rapeseed and Mustard, Millets, Oats, shift of weed flora in cropping systems.

**Unit-IV (Practical)**

Techniques of weed preservation.

Weed identification and their losses study.

Study of herbicide formulations and mixture of herbicide.

Herbicide and agro-chemicals study.

Study of methods of herbicide application, spraying equipment.

Calculation of herbicide doses and weed control efficiency and weed index.

**Suggested Readings:**

Aldrich RJ and Kramer RJ 1997. Principles in Weed Management.

Gupta OP 2007. Weed management Principles and Practices.

Gupta OP 1984. Scientific Weed Management Today and Tomorrows.

Gupta OP 2008. Modern Weed Management

Jayakumar R and Jagannathan R 2007. Weed Science Principles.

Mandal RC 1999. Weed, Weedicides and Weed Control Principles and Practices.

Rao VS 2006. Principles of Weed Science.

## **RDA-DSEC-604 (HO): Protected Cultivation of Horticultural Crops**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To familiarize the students with the concept of protected structures for horticultural crop production and provide knowledge on the production technology of some horticultural crops under protected structures.

### **Course Outcome:**

Understanding of the importance, prospects and constraints of protected structures for horticultural crop production, learning of production technology of some horticultural crops under protected structures.

### **Unit - I**

Protected cultivation: present status in India and NE region, importance, prospects and constraints; different protected structures used in horticulture crop production; greenhouse- principles, advantages and disadvantages, classification, components of a greenhouse. Greenhouse production systems: geponics, soil-less culture, hydroponics, aeroponics; soil-less media- properties and types.

### **Unit - II**

Systems of irrigation in the protected structures; drip irrigation- advantages and limitations, components of drip irrigation system, operation and maintenance. Fertigation- advantages and limitations, methods of fertigation, factors affecting fertigation. Management of pests and diseases.

### **Unit - III**

Protected nursery raising technology: types of multi-celled plastic plug-trays, their advantages and limitations, seed sowing, temperature control, height control, pillowing and its control, transplanting, intercultural operations, hardening of seedlings and plant protection measures. Application of protected cultivation in crop production.

### **Unit- IV (Practical)**

Identification and familiarization of different components of a greenhouse.

Different types of protected structures.

Micro irrigation systems used in the greenhouse.

Important cultural requirements for horticulture crop production in a protected structure.

Identification and study of characteristic features of different growing media.

Characteristic features of fertilizers suitable for fertigation.

### **Suggested Readings:**

Prasad S and Kumar U 2007. Green House Management for Horticultural Crops, Agrobios, Jodhpur.

Balraj 2012. Protected Cultivation of Vegetable Crops, Kalyani Publishers, New Delhi

Preethi TL 2012. Protected Horticulture, Narendra Pub., Delhi

Singh Brahma, Singh Balraj and Naved Sabir 2014. Advances in Protected Cultivation, NIPA, New Delhi

Singh DK and Peter KV 2014. Protected Cultivation of Horticultural Crops, NIPA, New Delhi

Singh Dharm 2013. Hydroponics: Soilless Culture of Plants, Agrobios (India), Jodhpur.

## **RDA-DSEC-604(AS): Market Milk**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

**Objective:** To Know about Market milk and its various classes. To study the manufacturing process, quality and legal standards of market milk.

### **Course Outcome;**

Learning of manufacturing process, quality and legal standards of market milk.

### **Unit-I**

Introduction and history of dairy development in India. Dairying in India - Distinctive features. Dairy development in India - Before and after Operation Flood. Milk production and consumption. Clean milk production. Practices related to animal and milking personnel environment. Procurement of milk. Milk collecting systems and pricing policies. Preservation of raw milk-Lactoperoxidase - Thiocyanates (LP) system Transportation of raw milk.

### **Unit-II**

Physico-chemical, microbiological and nutritional properties of milk Physical properties and composition of milk Macro components of milk - Fat and lactose Macro components of milk - Protein Micro components of milk. Microbiology of raw milk. Nutritional properties of milk Common dairy operations- Reception of milk. Chilling and storage of milk. Filtration and clarification. Separation of milk - Cream separators. Bactofugation, Standardization of milk, Homogenization - Definition and theories. Homogenization - Types and operation of homogenizers, Homogenization - Effect on milk properties.

### **Unit-III**

Principles of heat treatment. Principle and methods of pasteurization, Heat exchangers - Plate and tubular type, Working of HTST pasteurizer, Sterilization-Definition, purpose and methods, Ultra-high temperature process, UHT milk -Homogenization, packaging and defects, Processed milk varieties, Legal standards and variants of market milk, Special milks. Cleaning and sanitization. Common dairy detergents and their properties. Dairy sanitizers and their properties. Cleaning and sanitization protocols - CIP and SIP, Tests for detergents and sanitizers. Packaging of milk- Packaging-materials and process. Quality assurance in milk processing. Detection of preservatives, neutralizers, and adulterants. Chemical quality of milk-Fat, SNF, TS and acidity, Microbiological quality of milk, Indian food regulation in global scenario, Quality and safety regulations.

### **Unit-IV**

Familiarization with equipment's for reception of milk in plant.

Pre-treatments: Chilling, clarification, filtration, Standardization and numericals relating to it. Cream separation: parts of separator and the process.

Operation of LTLT, HTST pasteurizer.

Sampling and chemical examination of pasteurized, sterilized and UHT processed milk.

Preparation of special milks; toned, double toned, standardised, flavoured, sterilised.

Strength of common detergents and sanitizers used in market milk plant.

### **Suggested Readings**

Aneja RP 1994. Dairying in India – A Success Story. Publication No. 1994/4. Asia Pacific Association of Agricultural Research Institutions (APAARI), Bangkok.

Singh RRB, Sabikhi L, Patil GR and Sharma N 2003. Clean Milk Production – Strategies and Interventions. NDRI Publication No. 10/2003

Thompkinson DK and Sabikhi L 2012. Quality Milk Production & Processing Technology. Xxvii+ 274 pp. New India Publishing Agency, New Delhi

[www.agricultureinformation.com](http://www.agricultureinformation.com)

[www.fao.org/docrep/T3080T/t3080T07.htm](http://www.fao.org/docrep/T3080T/t3080T07.htm)

[www.nddb.org/aboutnddb/operationflood.html](http://www.nddb.org/aboutnddb/operationflood.html)

[www.dahd.nic.in/dahd](http://www.dahd.nic.in/dahd)



## **RDA-DSEC-605 (RD): Micro-Enterprise and Non-Farm Sector Development**

(Total Marks = 100 Theory= 75, Practical = 25) Credit: 3+1=4

### **Objective:**

To study the role of micro industries and various financial and other supportive institutions in the removal of unemployment and poverty; to study the managerial and behavioral dimensions of entrepreneurship.

### **Course outcome:**

Understanding of concept of micro-enterprise, their role, industrial policy, rural industries.

### **Unit - I**

Micro-enterprise: meaning and concept; growth of micro-enterprise in India; role of micro-enterprise in rural economy: rural industrialization, employment and poverty alleviation; micro-enterprise in SHG framework; basic economic concepts: cost and pricing structure; marketing: types of markets; marketing constraints and imperfections; pre-requisites of micro-entrepreneurs.

Industrial Policy and Micro, Small and Medium Enterprises, Rural non-farm sector: meaning, concept and importance; employment in non-farm sector: extent and scope; role of micro-enterprises in development of non-farm sector;

### **Unit II**

Rural industries: concept, definitions and types; government policy towards non-farm sector and rural industrialization; role of specific institutions in developing rural industries; promoters of micro-enterprises: governmental and non-governmental organizations and their role in micro-enterprise development and rural industrialization. Start Up Projects in rural sector.

### **Unit III**

Managerial and behavioral dimensions of entrepreneurs; entrepreneurial motivation: different theories; behavioral factors determining entrepreneurial growth; sustainability of enterprises; entrepreneurial skill development; role of family and culture in the development of entrepreneurship.

### **Unit IV (Practical):**

Study of a successful enterprise

Role of NGO in rural entrepreneurship training

Study of processing and marketing arrangements of a local enterprise

Industrial States and Rural Industrialization

### **Suggested Readings**

Ghosh A 2005. Capital Formation and Entrepreneurship in Indian Agriculture, Concept Pub, Delhi

Mali DD 2005. Promoting Entrepreneurship Lessons from India's North-East, Speed Pub Guwahati

Patro S 2002. Financing Small Scale Industries, Mohit Pub., Delhi

Rao HK 2001. Changes in Structure of Employment in Rural Area, NIRD Publication, Hyderabad

Saini JS 2003. Entrepreneurship Development Programme and Practices, Deep and Deep, New Delhi

**RDA-DSEC-605 (AG): Social and Farm Forestry**  
(Total Marks = 100; Theory= 100) Credit: 4+0=4

**Objectives:**

To acquaint the students with basic knowledge of social forestry, their need, importance and management.

**Course Outcome:**

Understanding of forest types, components, agroforestry, community forestry, social forestry.

**Unit-I:**

Forest- importance, types, classification, ecosystem, biotic and abiotic components, Concept, definition of Social and farm forestry and their importance and objectives. Role of forests – productive role – food, fuel, clothing, shelter, timber and non-timber forest produce and protective role – climate amelioration, habitat for wildlife, purification of atmosphere. Status of Indian forests – Comparison with other countries, National Forest Policy.

**Unit-II:**

Agroforestry – definition – different terminologies – components – distinction between agroforestry and social forestry. Benefits and constraints of agro forestry. Classification of agro forestry systems on structural, functional, socio- economic and ecological basis. Agri-silvicultural systems – improved fallow species in shifting cultivation, taungya system, multi species tree garden, alley cropping, multipurpose trees and shrubs on farmlands, crop combinations with plantation crops, fuel wood plantations. Shelter belts, wind breaks, Silvipastoral system – protein bank, live fence of fodder and hedges and trees and shrubs on pasture. ‘

**Unit-III:**

Agri-silvipastoral systems – homestead, woody hedgerows for browse, mulch, green manure, soil conservation – other systems, Planning in agroforestry – Diagnosis and Design, Agroforestry systems for Meghalaya. Role of trees in soil fertility - Economics of agroforestry.

**Unit-IV:**

Community forestry – evolution of social forestry concepts – Social forestry in Meghalaya, Interface forestry – JFM (Joint Forest Management), TAP (Tamil Nadu Afforestation Project). Wasteland development – definition – extent and classification. Suitable trees for problem soils –planting technique for wastelands. Trees in soil and water conservation. Afforestation for sand dune stabilization, mine burden, coastal

**Suggested Readings:**

K T Parthiban L and M P Divya 2014. Social Forestry & Agroforestry. Satish Serial Publication House, Delhi.

Lutfun Nahar Lata and AZM Manzoor Rashid 2020. Social Forestry: Principles, Evolution, and Implications for Sustainable Development

Singh R and SK Ghosh 2003. Social Forestry and Forest Management. Global Vision Publishing House

SK Ghosh and Rita Singh 2005. Social Forestry and Forest Management. GVPH-Publishers and Exporters, New Delhi.

## **RDA-DSEC-605 (HO): Integrated Pest Management of Horticultural Crops**

(Total Marks = 100; Theory= 75, Practical = 25) Credit: 3+1=4

### **Objectives:**

To familiarize the students with the concepts, principles and methods of Integrated Pest Management (IPM) of horticultural crops.

### **Course Outcome:**

Understanding of concept, principles and components of IPM, learning of techniques of IPM of important tropical and subtropical fruits, important summer and winter vegetables, important spices and plantation crops of NE India.

### **Unit - I**

Integrated Pest Management (IPM): definition, concept, principles and components. Agents of crop damage: insects, diseases, nematodes, vertebrates, weeds etc. Methods of pest management: biological, mechanical, physical, cultural, chemical and legal methods. Classification of pesticides: insecticides, fungicides, nematocides, rodenticides, molluscicides, miticides, aviacides and herbicides. Classification of insecticides based on killing action: contact action, stomach action, systemic action, fumigation etc. Formulations of pesticides: dry formulation, liquid formulation. Equipments used for pest management.

### **Unit - II**

IPM of important tropical and subtropical fruit crops of NE India like mango, banana, pineapple, citrus etc., IPM of important temperate fruit crops of NE India like apple, pear, peach, and strawberry., IPM of important plantation crops of NE India like tea, cashew, arecanut, and coconut.

### **Unit – III**

IPM of important summer vegetables of NE India like cucurbitaceous crops, solanaceous crops and okra. IPM of important winter vegetables of NE India like cruciferous crops, pea and onion. IPM of important spices of NE India like large cardamom, black pepper, ginger etc.

### **Unit- IV (Practical)**

Identification and familiarization of equipments used for pest management.

Soil solarization methods for pest control.

Seed treatments and rhizome treatment.

Pesticide application methods.

Preparation and application of Bordeaux mixture.

Field visit to identify pests.

Collection and identification of weeds.

### ***Suggested Readings:***

Dhaliwal GS, Ram Singh and Vikas Jindal 2013. A textbook of integrated pest management , Kalyani Publishers, New Delhi

Robert F Norris, Edward P Caswell-Chen and Marcos Cogan 2003. Concepts in Integrated Pest Management Prentice Hall of India , New Delhi

Sethunath PK and Nitish KT 2014. Integrated Plant Production and Protection, Crescent Publishing, New Delhi

Singh Gorakh 2012. Insect pests and disease management of important horticultural crops, Westville, New Delhi

Venugopal Rao N 2003. Concepts in Integrated Insect Pest Management. Agrobios(India), Jodhpur  
Rajinder Peshin and Rajinder Kalra 2000. Integrated Pest Management: adaption and its impact on agriculture, Classical, New Delhi .

**RDA-DSEC-605 (AS): Traditional Indian Dairy Products**  
(Total Marks = 100; Theory= 50, Practical = 50) Credit: 2+2=4

**Objective:**

To project the present status, modernization, and globalization of traditional Indian dairy products with a focus on process innovation, shelf life, quality, and functionality enhancement.

**Course Outcome:**

Learning the production methods of traditional Indian dairy products, quality, shelf life, and functionality enhancement.

**Unit-I**

Importance and scope of Traditional milk products. History and developments in traditional dairy products. Classification of traditional dairy products. Indian dairy products and their western counterparts. Khoa – Definition, varieties and standards, Methods of preparation, Chemical composition; quality and yield, packaging and shelf-life; defects in khoa and uses of khoa. Khoa based sweets: Peda, Burfi, Kalakand, Milk cake, Gulabjamun -Product description, method of preparation, composition, quality, packaging, and shelf life.

**Unit-II**

Basundi- Product description, method of preparation, yield, packaging, and shelf life. Payasam/Kheer Varieties, method of preparation, yield, packaging, and shelf life. Paneer- Definition and product description, methods of preparation. Rabri, kulfi/malai- ka- baraf- Product description, method of preparation, yield, packaging, and shelf life. Channa – Definition and product description, methods of preparation. Preparation of chhana from buffalo milk. Yield, packaging, and preservation of chhana. shelf life and defects. Chhana based sweets. Rasogolla, Sandesh, Rasmalai, Rajbhog, Pantoora, Chhana Podo – Product description, preparation, quality, packaging, and shelf life.

**Unit-III**

Paneer- Product description, standards, methods of manufacture. Recent developments in paneer manufacture, yield, composition, factors affecting quality, packaging, and shelf-life. Chakka – Product description, method of preparation. Shrikhand – Methods of production, packaging, and shelf life. Lassi and Chhachh/Mattha (Country Buttermilk) – Methods of manufacture, packaging and shelf life, defects. Miscellaneous traditional dairy foods. Raita, Kadhi, Dahiwada and Raabadi. Microbiology of traditional dairy products. Microbiological quality and safety aspects of traditional dairy products.

**Unit –IV (Practical)**

Preparation of indigenous dairy products and testing of quality and shelf-life of -kheer, chhana, panir, rabri, lassi, makhhan, kulfi, softy ice-cream, dahi, misti dahi, ghee, and srikhand, Khoa and chhana based sweets.

**Suggested Reading**

Aneja RP, Mathur BN, Chandan RC and Banerjee AK 2002. Technology of Indian dairy products. A Dairy India Publication.

Goyal MR, Kumar A and Gupta AK 2018. Novel Dairy Processing Technologies: Techniques, Management, and Energy Conservation. CRC Press.

Websites

Indian Dairy Product Market–Indian Council of Food and Agriculture–  
[https://icfa.org.in/assets/doc/reports/Indian\\_Dairy\\_Product\\_Market.pdf](https://icfa.org.in/assets/doc/reports/Indian_Dairy_Product_Market.pdf)  
<https://www.tib.eu/en/search/id/.Present-Status-of-Traditional-Dairy-Products/>