

SYLLABUS
MASTER OF SCIENCE IN FRUIT SCIENCE
SEMESTER-I

COURSE CODE	COURSE TITLE	CREDITS
MAJOR		
FSC 501	Tropical fruit production	2+1
FSC 502	Sub-Tropical and Temperate Fruit Production	2+1
FSC 503	Propagation and Nursery Management for Fruit Crops	2+1
MINOR		
PHM 503	Packaging and Storage of fresh Horticultural Produce	1+1
PHM 505	Principles and Methods of Fruit and Vegetable Preservation	2+1
SUPPORTING		
STAT 502	Statistical Methods for Applied Sciences	3+1
NON-CREDIT		
PGS501	Library and Information Services	0+1
PGS502	Technical Writing and Communications Skills	0+1
PGS503	Intellectual Property and its Management in Agriculture	1+0



Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore
Shri Vaishnav Institute of Agriculture
M.Sc. (Ag.) Fruit Science

Course Code	Course Name	TEACHING & EVALUATION SCHEME							
		Theory			Practical		Credits		
		END SEM University Exam	Mid term exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*	L	P	Total
FSC 501	Tropical Fruit Production	50	30	00	15	05	2	1	3

1. Legends: L - Lecture; P – Practical

2. *Teacher Assessment shall be based on following components: Quiz / Assignment / Project /Participation in Class.

Aim of the course

To impart comprehensive knowledge to the students on cultural and management practices for growing tropical fruits.

The course is organised as follows:

No.	Blocks	Units
1	Introduction	I Importance and Background
2	Agro-Techniques	I Propagation, Planting and Orchard Floor Management
3	Crop Management	I Flowering, Fruit-Set and Harvesting

Theory

Unit I: Mango and Banana

Block 1: Introduction

Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.

Block 2: Agro-techniques

Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

Block 3: Crop Management

Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders – causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

Unit II: Guava and Pineapple

Block 1: Introduction

Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.

Block 2: Agro-techniques

Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

Block 3: Crop Management

Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders – causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

Unit III: Papaya and Avocado

Block 1: Introduction

Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.

Block 2: Agro-techniques

Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

Block 3: Crop Management

Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders – causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

Unit IV: Jackfruit and Annonas

Block 1: Introduction

Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.

Block 2: Agro-techniques

Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

Block 3: Crop Management

Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders – causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

Unit V: Aonla and Ber

Block 1: Introduction

Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.

Block 2: Agro-techniques

Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

Block 3: Crop Management

Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders – causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

Practicals

- Distinguished features of tropical fruit species, cultivars and rootstocks (2);
- Demonstration of planting systems, training and pruning (3);
- Hands on practices on pollination and crop regulation (2);
- Leaf sampling and nutrient analysis (3);
- Physiological disorders-malady diagnosis (1);
- Physico-chemical analysis of fruit quality attributes (3);
- Field/ Exposure visits to tropical orchards (1);
- Project preparation for establishing commercial orchards (1).

Teaching Methods/ Activities

- Class room Lectures
- Laboratory/ Field Practicals
- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

Learning outcome

The students are expected to equip themselves with know-how on agro-techniques for establishment and management of an orchard leading to optimum and quality fruit production of tropical fruits.

Suggested Reading

- Bartholomew DP, Paull RE and Rohrbach KG. 2002. The Pineapple: Botany, Production, and Uses. CAB International.
- Bose TK, Mitra SK and Sanyal D. 2002. Fruits of India – Tropical and Sub-Tropical. 3rd Edn. Naya Udyog, Kolkata.
- Dhillon WS. 2013. Fruit Production in India. Narendra Publ. House, New Delhi.
- Iyer CPA and Kurian RM. 2006. High Density Planting in Tropical Fruits: Principles and Practices. IBDC Publishers, New Delhi.
- Litz RE. 2009. The Mango: Botany, Production and Uses. CAB International.
- Madhawa Rao VN. 2013. Banana. ICAR, New Delhi.
- Midmore D. 2015. Principles of Tropical Horticulture. CAB International.
- Mitra SK and Sanyal D. 2013. Guava, ICAR, New Delhi.
- Morton JF. 2013. Fruits of Warm Climates. Echo Point Book Media, USA.
- Nakasome HY and Paull RE. 1998. Tropical Fruits. CAB International.
- Paull RE and Duarte O. 2011. Tropical Fruits (Vol. 1). CAB International.

- Rani S, Sharma A and Wali VK. 2018. Guava (*Psidium guajava* L.). Astral, New Delhi.
- Robinson JC and Saúco VG. 2010. Bananas and Plantains. CAB International.
- Sandhu S and Gill BS. 2013. Physiological Disorders of Fruit Crops. NIPA, New Delhi.
- Schaffer B, Wolstenholme BN and Whiley AW. 2013. The Avocado: Botany, Production and Uses. CAB International.
- Sharma KK and Singh NP. 2011. Soil and Orchard Management. Daya Publishing House, New Delhi.
- Valavi SG, Peter KV and Thottappilly G. 2011. The Jackfruit. Stadium Press, USA.



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		Theory			Practical		Credits		
		END SEM University Exam	Mid term exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*	L	P	Total
FSC 502	Subtropical and Temperate Fruit Production	50	30	00	15	05	2	1	3

1. Legends: L - Lecture; P – Practical

2. *Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.

Aim of the course

To impart comprehensive knowledge to the students on cultural and management practices for growing subtropical and temperate fruits.

The course is organised as follows:

No.	Blocks	Units
1	Introduction	Importance and Background
2	Agro-Techniques	Propagation, Planting and Orchard Floor Management
3	Crop Management	Flowering, Fruit-Set and Harvesting

Theory

Unit I: Citrus, Grapes and Litchi

Block 1: Introduction

Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.

Block 2: Agro-techniques

Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

Block 3: Crop Management

Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders – causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

Unit II: Pomegranate, Apple and Pear

Block 1: Introduction

Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.

Block 2: Agro-techniques

Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

Block 3: Crop Management

Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders – causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

Unit III: Peach, Plum and Apricot

Block 1: Introduction

Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.

Block 2: Agro-techniques

Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

Block 3: Crop Management

Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders – causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

Unit IV: Apricot, Cherries, Berries, Persimmon and Kiwifruit

Block 1: Introduction

Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.

Block 2: Agro-techniques

Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

Block 3: Crop Management

Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders – causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

Unit V: Nuts- Walnut, Almond and Pecan

Block 1: Introduction

Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.

Block 2: Agro-techniques

Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

Block 3: Crop Management

Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders – causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

Practicals

- Distinguished features of fruit species, cultivars and rootstocks (2);
- Demonstration of planting systems, training and pruning (3);
- Hands on practices on pollination and crop regulation (2);
- Leaf sampling and nutrient analysis (3)
- Physiological disorders-malady diagnosis (1);
- Physico-chemical analysis of fruit quality attributes (3);
- Field/ Exposure visits to subtropical and temperate orchards (1);
- Project preparation for establishing commercial orchards (1).

Teaching Methods/ Activities

- Class room Lectures
- Laboratory/ Field Practicals
- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

Learning outcome

After successful completion of the course, the student are expected to equip themselves with principles and practices of producing subtropical (citrus, grapes, litchi, pomegranate, etc.) and temperate fruits (apple, pear, peach, plum, apricot, cherries, berries, kiwifruit, etc.) and nuts (almond, walnut, pecan, etc.)

Suggested Reading

- Chadha KL and Awasthi RP. 2005. The Apple. Malhotra Publishing House, New Delhi.
- Chadha TR. 2011. A Text Book of Temperate Fruits. ICAR, New Delhi
- Childers NF, Morris JR and Sibbett GS. 1995. Modern Fruit Science: Orchard and Small Fruit Culture. Horticultural Publications, USA.
- Creasy G and Creasy L. 2018. Grapes. CAB International.
- Davies FS and Albrigo LG. 1994. Citrus. CAB International.
- Dhillon WS. 2013. Fruit Production in India. Narendra Publishing House, New Delhi.
- Jackson D, Thiele G, Looney NE and Morley-Bunker M. 2011. Temperate and Subtropical Fruit Production. CAB International.
- Ladanyia M. 2010. Citrus Fruit: Biology, Technology and Evaluation. Academic Press.
- Layne DR and Bassi D. 2008. The Peach: Botany, Production and Uses. CABI.
- Menzel CM and Waite GK. 2005. Litchi and Longan: Botany, Production and Uses. CAB International.

- Pandey RM and Randey SN. 1996. The Grape in India. ICAR, New Delhi.
- Rajput CBS, and Haribabu RS. 2006. Citriculture, Kalyani Publishers, New Delhi.
- Sandhu S and Gill BS. 2013. Physiological Disorders of Fruit Crops. NIPA, New Delhi.
- Sharma RM, Pandey SN and Pandey V. 2015. The Pear – Production, Post-harvest Management and Protection. IBDC Publisher, New Delhi.
- Sharma RR and Krishna H. 2018. Textbook of Temperate Fruits. CBS Publishers and Distributors Pvt. Ltd., New Delhi.
- Singh S, Shivshankar VJ, Srivastava AK and Singh IP. 2004. Advances in Citriculture. NIPA, New Delhi.
- Tromp J, Webster AS and Wertheim SJ. 2005. Fundamentals of Temperate Zone Tree Fruit Production. Backhuys Publishers, Lieden, The Netherlands.
- Webster A and Looney N. Cherries: Crop Physiology, Production and Uses. CABI.



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		Theory			Practical		Credits		
		END SEM University Exam	Mid term exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*	L	P	Total
FSC 503	Propagation and Nursery Management for Fruit Crops	50	30	00	15	05	2	1	3

1. Legends: L - Lecture; P – Practical

2. *Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.

Aim of the course

To understand the principles and methods of propagation and nursery management in fruit crops.

The course is organised as follows:

No.	Blocks	Units
1	Introduction	I General Concepts and Phenomena
2	Propagation	I Conventional Asexual Propagation II Micropropagation
3	Nursery	I Management Practices and Regulation

Theory

Unit 1: Introduction

General Concepts and Phenomena: Introduction, understanding cellular basis for propagation, sexual and asexual propagation, apomixis, polyembryony, chimeras. Factors influencing seed germination of fruit crops, dormancy, hormonal regulation of seed germination and seedling growth. Seed quality, treatment, packing, storage, certification and testing.

Unit II: Propagation

Conventional Asexual Propagation: Cutting– methods, rooting of soft and hardwood cuttings under mist and hotbeds. Use of PGR in propagation, Physiological, anatomical and biochemical aspects of root induction in cuttings.

Unit III: Propagation

Layering – principle and methods. Budding and grafting – principles and methods, establishment and management of bud wood bank. Stock, scion and inter stock relationship– graft incompatibility, physiology of rootstock and top working.

Unit IV: Micropropagation: Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques – in-vitro clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture, genetic fidelity testing. Hardening, packaging and transport of micro-propagules.

Unit V: Nursery

Management Practices and Regulation: Nursery – types, structures, components, planning

and layout. Nursery management practices for healthy propagule production. Nursery Act, nursery accreditation, import and export of seeds and planting material and quarantine.

Practical

- Hands on practices on rooting of dormant and summer cuttings (3);
- Anatomical studies in rooting of cutting and graft union(1);
- Hands on practices on various methods of budding and grafting (4);
- Propagation by layering and stooling (2);
- Micropropagation- explant preparation, media preparation, culturing – meristem tip culture, axillary bud culture, micro-grafting, hardening (4);
- Visit to commercial tissue culture laboratories and accredited nurseries (2).

Teaching Methods/ Activities

- Class room Lectures
- Laboratory/ Field Practicals
- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

Learning outcome

The student would be expected to equip to acquire skills and knowledge on principles and practices of macro and micropropagation and the handling of propagated material in nursery.

Suggested Reading

- Bose TK, Mitra SK and Sadhu MK. 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash, Kolkatta.
- Davies FT, Geneve RL and Wilson SB. 2018. Hartmann and Kester's Plant Propagation: Principles and Practices. Pearson, USA/ Prentice Hall of India. New Delhi.
- Gill SS, Bal JS and Sandhu AS. 2016. Raising Fruit Nursery. Kalyani Publishers, New Delhi.
- Jain S and Ishil K. 2003. Micropropagation of Woody Trees and Fruits. Springer.
- Jain S and Hoggmann H. 2007. Protocols for Micropropagation of Woody Trees and Fruits. Springer.
- Joshi P. 2015. Nursery Management of Fruit Crops in India. NIPA, New Delhi.
- Peter KV, eds. 2008. Basics of Horticulture. New India Publishing Agency, New Delhi.
- Rajan S and Baby LM. 2007. Propagation of Horticultural Crops. NIPA, New Delhi.
- Sharma RR. 2014. Propagation of Horticultural Crops. Kalyani Publishers, New Delhi.
- Sharma RR and Srivastav M. 2004. Propagation and Nursery Management. Intl. Book Publishing Co., Lucknow.



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		Theory			Practical		Credits		
		END SEM University Exam	Mid term exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*	L	P	Total
PHM 503	Packaging and Storage of fresh Horticultural Produce	50	30	00	15	05	1	1	2

1. Legends: L - Lecture; P – Practical

2. *Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.

Aim of the course

To acquaint with the different storage systems and packaging systems for perishable horticultural produce.

The course is organized as follows:

No	Blocks	Units
1	Storage systems	I. Importance of storage II. Different methods of storage III. Modified methods of storage
2	Packaging	I. Importance of packaging and packaging methods II. New technologies in packaging

Theory

Unit I: Storage Systems

Importance of storage of horticultural produce, present status and future scope. Principles and methods of storage – field storage structures and designs for bulk storage of horticultural produce-onion and potato, etc. Evaporative cool chambers. Physiological changes during storage.

Unit II: Refrigerated storage – principles of refrigeration, types of refrigerants, refrigeration equipments. Cold storage rooms – Calculation of refrigeration load. Storage requirements of different fruits, vegetables, flowers. Storage disorder symptoms and control.

Unit III: Controlled or modified atmosphere (CA/MA) storage – principles, uses, structures and equipments, methods and requirements. Effect of CA storage on the physiology of stored produce. Hypobaric storage principle, uses, and requirements. Storage disorders.

Unit IV: Packaging

Importance of packaging of fresh and processed horticultural produce, present status and future scope. Gaps in packaging concepts. Packaging requirements of fresh horticultural produce. Packaging patterns and methods. Food packaging systems: Different forms of packaging such as rigid, semi-rigid, flexible forms. Traditional, improved and specialized packages. Paper based packages: corrugated fibre board boxes – raw material and types of boxes. Flexible packaging materials – types and their properties. Consumer and intermediate flexible bulk containers. Testing of flexible packaging material. Barrier properties of packaging materials.

Unit V: New technology in packaging – stretch wrapping system, vacuum packaging, gas packaging, controlled atmosphere (active and intelligent) packaging, vibra packaging, skin packaging, shrink packaging, formfill-seal packaging, Packaging machines. Quality control and

safety aspects of packaging materials.

Practical

- Study of special storage structures for bulk storage of onion/ potato, etc.;
- Study of storage behavior of different fruits and vegetables in zero energy cool chamber;
- Determination of refrigeration requirements (capacity) for given quantity of fruits and vegetables;
- Study of storage behaviour of different fruits and vegetables in cold room;
- Study of chilling injury and storage disorders;
- Study of shelf-life of fruits and vegetables in modified atmosphere packaging. Visit to special storage structures, cold storage units. Study of types of packaging materials, types of plastic films and their properties;
- Determination of water vapour transmission rate (WVTR) and gas transmission rate (GTR) of packaging material;
- Applications of packaging material for fresh fruits and vegetables, beverages, spice products;
- Determination of shelf-life of fresh products in different types of packages;
- Study of packaging machines – vacuum packaging machine, shrink wrapping machine, double seamer, etc. Visit to packaging unit.

Teaching Methods/ Activities

- Lectures
- Assignments (Reading/ Writing)
- Exposure visits
- Student presentations
- Group Work/ seminars

Learning outcome

After successful completion of this course, the students are expected to be able to understand:

- Importance of storage of horticultural produce
- Different methods of storage
- Importance of packaging for fresh horticultural produce
- Different methods of packaging

Suggested Reading

- Ahvenainen R. 2003. Novel Food Packaging Techniques, CRC Press, ISBN 0849317894.
- Ahvenainen R. 2001. Novel Food Packaging Techniques. CRC.
- Burg SP (Ed.). 2004. Postharvest physiology and hypobaric storage of fresh produce, CABI Publishing, ISBN 0851998011.
- Chattopadhyaya SK. 2007. Handling, transportation and storage of fruits and vegetables. GeneTech books, New Delhi.
- Chandra GopalaRao. 2015. Engineering for Storage of Fruits and Vegetables; Academic Press, 1st Edition.
- Coles R, McDowell D and Kirwan MJ. (Eds.). 2003. Food Packaging Technology, Blackwell Publishing, ISBN 1841272213.
- Mahadevaiah M and Gowramma RV. 1996. Food packaging materials. Tata McGraw Hill.
- Painy FA. 1992. A handbook of food packaging. Blackie Academic.
- Pantastico B. 1975. Postharvest Physiology, Handling and Utilization of Tropical and Subtropical Fruits and Vegetables. AVI Publ.

- Robertson GL. (Ed.). 2010. Food packaging and shelf life: a practical guide CRC Press, ISBN 9781420078442.
- Thompson AK. 2010. Controlled atmosphere storage of fruits and vegetables (2nd Edition), CABI International, ISBN 9781845936464.
- Wilson CL. (Ed.). 2007. Intelligent and active packaging for fruits and vegetables, CRC Press, ISBN 9780849391668.

Websites

- Storage practices and structures UCANR <http://ucanr.edu/datastoreFiles/234-1303.pdf>
- Low cost storage technologies for preservation-IARI http://www.iari.res.in/download/pdf/story4_eng.pdf
- https://energypedia.info/wiki/Cold_Storage_of_Agricultural_Products



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		END SEM University Exam	Mid term exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*	L	P	Total	
PHM 504	Packaging of Processed Horticultural Produce	50	30	00	15	05	2	1	3	

1. Legends: L - Lecture; P – Practical

2. *Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.

Aim of the course

To acquaint with the different and packaging systems for processed horticultural produce.

The course is organized as follows:

No	Blocks	Units
1	Packaging principles and functions	Functions of packaging Basic principles of packaging materials Manufacture of packaging materials Types of packaging materials Testing of packaging

Theory

Block 1: Packaging principles and functions

Unit I: Functions of packaging; Type of packaging materials; Selection of packaging material for different foods; Selective properties of packaging film; Methods of packaging and packaging equipment.

Unit II: Mechanical strength of different packaging materials; Printing of packages; Barcodes and other marking; Interactions between packaging material and foods; Environmental and cost consideration in selecting packaging materials.

Unit III: Manufacture of packaging materials; Potential of biocomposite materials for food packaging; Packaging regulations; Packaging and food preservation; Disposal of packaging materials.

Unit IV: Metal cans: types, fabrication, lacquering and tin quality. Double seaming technology – defects and causes. Glass containers – types; testing quality – thermal shock resistance, thermal shock breakage, impact breakage.

Unit V: Testing of packaging; Rigid and semi rigid containers; Flexible containers; Sealing Equipment. Labeling; Aseptic and shrink packaging; Secondary and transport packaging. Different packaging systems for dehydrated foods, frozen foods, dairy foods, fresh fruits and vegetables.

Practical

- Testing of packaging material: compression strength/drop test/thermal shock test/ seam evaluation/ seam defects;
- Determination of shelf-life of processed products in different types of packages;
- Study of packaging machines – vacuum packaging machine, shrink wrapping machine, double

seamer, etc.;

- Visit to packaging units.

Teaching Methods/ Activities

- Lectures
- Assignments (Reading/ Writing)
- Exposure visits
- Student presentations
- Group Discussions

Learning outcome

After successful completion of this course, the students are expected to be able to understand:

- Importance of packaging for processed horticultural produce
- Different methods of packaging, methods and their applications in food industry.

Suggested Reading

- Ahvenainen R. 2001. Novel Food Packaging Techniques. CRC
- Ahvenainen R. 2003. Novel Food Packaging Techniques, CRC Press, ISBN 0849317894.
- Coles R, McDowell D and Kirwan MJ. (Eds.) 2003. Food Packaging Technology, Blackwell Publishing, ISBN 1841272213.
- Joseph H Hotchkiss. 1987. Food and Packaging Interactions, (ACS symposium series - 365, April 5-10, 1987. American Chemical Society, Washington DC. 1988)
- Mahadevaiah M and Gowramma RV. 1996. Food packaging materials. Tata McGraw Hill.
- Painy FA. 1992. A handbook of food packaging. Blackie Academic.
- Robertson G. L. Ed. 2010. Food packaging and shelf life: a practical guide CRC Press, ISBN 9781420078442.
- Thompson AK. 2010. Controlled Atmosphere Storage of Fruits and Vegetables, CABI Publishing; 2nd revised edition.
- Wilson CL. (Ed.). 2007. Intelligent and active packaging for fruits and vegetables, CRC Press. ISBN 9780849391668.



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		Theory			Practical		Credits		
		END SEM University Exam	Mid term exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*	L	P	Total
PHM 505	Principles and Methods of Fruit and Vegetable Preservation	50	30	00	15	05	2	1	3

1. Legends: L - Lecture; P – Practical

2. *Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.

Aim of the course

Understanding spoilage, underlying principles and methods of processing of fruits and vegetables.

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand Principles and different methods of preservation
- Principal spoilage organisms, food poisoning and their control measures
- Canning of fruits and vegetables
- Processing equipments and layout of processing industry

Theory

Block 1: Principles and Methods of Fruit and Vegetable Processing

Unit I: Introduction, Historical development in food processing, type of food and causes for food spoilage. Basic principles of fruits and vegetables processing;

Unit II: Thermal processing, pH classification of foods, heat resistance of microorganism; Heat resistance of enzymes in foods, Spoilage of thermal processed food; Containers – canning, rigid tin plates and cans, aluminium cans, glass containers – types; flexible packaging materials, Composite can, specification, corrosion of cans, heat penetration into containers and methods for determination of process time.

Unit III: Effects of low temperature on fresh commodities and prepared product. Freezing preservation, freezing points of foods, slow and quick freezing, Cryogenic freezing and frozen food storage. Drying and dehydration, sun drying solar dehydration, mechanical drying types of driers, osmotic dehydration.

Unit IV: Food fermentation – alcoholic, acetic and lactic fermentation. Pickling and curing; Effect of salt on food preservation, types of salt cured products. Traditional and new products; chemical preservation, SO₂, benzoic acid, sorbic acid, antioxidants and antibiotics, newer preservatives. Preservation by controlling water activity – high sugar products, intermediate moisture food, food concentration.

Unit V: Food irradiation, principles, types and sources of radiation, mode of action of ionizing radiation; radiation effect on food constituents and regulation.

Practical

- List and cost of equipment, utensils, and additives required for small scale processing industry;
- Chemical analysis for nutritive value of fresh and processed fruits and vegetables;
- Preparation and preservation of fruit based beverages and blended products from fruits and vegetables;
- Evaluation of pectin grade; preparation and quality evaluation of fruit jam;

- Preparation of papain;
- Blanching and its effects on enzyme;
- Preparation of dehydrated vegetables;
- Study of different types of spoilages in fresh as well as processed horticultural produce;
- Study of biochemical changes and enzymes associated with spoilage;
- Sensory evaluation of fresh and processed fruits and vegetables;
- Visit to processing units.

Teaching Methods/ Activities

- Lecture
- Assignment (Reading/ Writing)
- Exposure visits
- Student presentation
- Group Work

Suggested Reading

- Barret DM, Somogyi LP and Ramaswamy H. Eds. 2005. Processing Fruits: Science and Technology (2nd Edition), CRC Press, ISBN 9780849314780.
- FAO. 2007. Handling and Preservation of Fruits and Vegetables by Combined Methods for Rural Areas- Technical Manual. FAO Agricultural Services Bulletin 149.
- Fellows PJ. 2009. Food Processing Technology: Principles and Practice (3rd Edition), Woodhead Publishing, ISBN 9781845692162.
- Lal G, Siddappa GS and Tandon GL. 1998. Preservation of Fruits and Vegetables. ICAR, ISBN 9788171640904.
- Ramaswamy H and Marcotte M. 2006. Food Processing: Principles and Applications. Taylor & Francis.
- Salunkhe DK and Kadam SS. 1995. Handbook of Fruit Science and Technology: Production, Composition and Processing. Marcel Dekker.
- Srivastava RP and Kumar S. 2014. Fruit and Vegetable Preservation: Principles and Practices (3rd Edition), CBS Publishing, ISBN 9788123924373.
- Verma LR and Joshi VK. 2000. Postharvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation and Waste Management. Indus Publishing Company, New Delhi, India. ISBN 8173871086.

Websites

- <http://agriinfo.in/default.aspx?page=topic&superid=2&topicid=2065>
- <http://www.fao.org/docrep/x0209e/x0209e02.htm>
- http://www.cstaricalcutta.gov.in/images/CTS%20Fruits_and_Vegetables%20NSQF.pdf



Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore
Shri Vaishnav Institute of Agriculture
M.Sc. Ag. Horticulture (Fruit Science)

Course Code	Course Name	TEACHING & EVALUATION SCHEME								
		Theory			Practical		Credits			
		END SEM University Exam	Mid term exam	Teachers Assessment *	END SEM University Exam	Teachers Assessment *	L	P	Total	
STAT 502	Statistical Methods for Applied Sciences	50	30	00	15	05	3	1	4	

1. Legends: L - Lecture; P – Practical

2. *Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

1. Anderson TW. 1958. *An Introduction to Multivariate Statistical Analysis*. John Wiley.
2. Dillon WR & Goldstein M. 1984. *Multivariate Analysis - Methods and Applications*. John Wiley.
3. Goon AM, Gupta MK & Dasgupta B. 1977. *An Outline of Statistical Theory*. Vol. I. The World Press.
4. Goon AM, Gupta MK & Dasgupta B. 1983. *Fundamentals of Statistics*. Vol. I. The World Press.
5. Hoel PG. 1971. *Introduction to Mathematical Statistics*. John Wiley.
6. Hogg RV & Craig TT. 1978. *Introduction to Mathematical Statistics*. Macmillan.
7. Morrison DF. 1976. *Multivariate Statistical Methods*. McGraw Hill.
8. Siegel S, Johan N & Casellan Jr. 1956. *Non-parametric Tests for Behavior Sciences*. John Wiley.
9. Learning Statistics: <http://freestatistics.altervista.org/en/learning.php>. Electronic Statistics Text Book: <http://www.statsoft.com/textbook/stathome.html>.



Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore
Shri Vaishnav Institute of Agriculture
M.Sc. (Ag.) Fruit Science

Course Code	Course Name	TEACHING & EVALUATION SCHEME							
		Theory			Practical		Credits		
		END SEM University Exam	Mid term exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*	L	P	Total
PGS 501	Library and Information Services	00	00	00	60	40	0	1	1

1. Legends: L - Lecture; P – Practical

2. *Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.

Objective

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

Practical

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



Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore
Shri Vaishnav Institute of Agriculture
M.Sc. (Ag.) Fruit Science

Course Code	Course Name	TEACHING & EVALUATION SCHEME							
		Theory			Practical		Credits		
		END SEM University Exam	Mid term exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*	L	P	Total
PGS 502	Technical Writing and Communications Skills	00	00	00	60	40	0	1	1

1. Legends: L - Lecture; P – Practical

2. *Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.

Objective

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

Practical (Technical Writing)

- Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.;
- Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion);
- Writing of abstracts, summaries, précis, citations, etc.;
- Commonly used abbreviations in the theses and research communications;
- Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations;
- Writing of numbers and dates in scientific write-ups;
- Editing and proof-reading;
- Writing of a review article;
- Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks);
- Error analysis (Common errors), Concord, Collocation, Phonetic symbols and transcription;
- Accentual pattern: Weak forms in connected speech;
- Participation in group discussion;
- Facing an interview;
- Presentation of scientific papers.

Suggested Readings

1. Barnes and Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.
2. Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
3. Collins' Cobuild English Dictionary. 1995.
4. Harper Collins. Gordon HM and Walter JA. 1970. Technical Writing. 3rd Ed.
5. Holt, Rinehart and Winston. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
6. James HS. 1994. Handbook for Technical Writing. NTC Business Books.



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Course Code	Course Name	TEACHING & EVALUATION SCHEME							
		Theory			Practical		Credits		
		END SEM University Exam	Mid term exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*	L	P	Total
PGS 503	Intellectual Property and Its Management in Agriculture	00	00	00	60	40	1	0	1

1. Legends: L - Lecture; P – Practical

2. *Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.

Objective

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

Theory

Unit I:

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

Unit II:

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

Unit III:

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

Unit IV:

Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity

Unit V:

International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

1. Erbis FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
2. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.

3. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.
 4. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
 5. Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
 6. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
- The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; The Biological Diversity Act, 2002.