PROSPECTUS

Masters & Ph. D. Degree Programme

2025-26

Bihar Agricultural University

Sabour, Bhagalpur - 813 210

Website: https://bausabour.ac.in/

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ABOUT UNIVERSITY

Bihar Agricultural University, Sabour, established on 5th August, 2010 by an Act (No. 20 of 2010) State Legislature of Bihar as a State University specified by the UGC under section 22 of the UGC Act. 1956, is one of the premier Agricultural University of the country working for accelerating the growth of agriculture sector through technological interventions. The university within a short span of its establishment has achieved several milestones. The University established at Historical Bihar Agricultural College Campus located at Sabour, Bhagalpur, Bihar. Bihar Agricultural University is basic and strategic institution supporting more than 500 researchers and educationist towards imparting education at graduate and post graduate level, conducting basic, strategic, applied and adaptive research activities, ensuring effective transfer of technologies and capacity building of farmers and extension personnel. The degree programmes of the university and its colleges have been accredited by ICAR. The university is also an ISO 9001:2015 certified organisation with International standard operating protocols for maintaining highest standards in teaching, research, extension and training. The university has 10 colleges, 12 research stations spread in 3 agro-ecological zones of Bihar. The University also has 22 KVKs.

Bihar Agricultural University, Sabour is having following Colleges/ Unit :

1. *Bihar Agricultural College, Sabour, Bhagalpur.*
2. *Mandan Bharti Agricultural College, Agwanpur, Saharsa.*
3. *Veer Kunwar Singh College of Agriculture, Dumraon, Buxar.*
4. *Bhola Paswan Shastri Agricultural College, Purnea.*
5. *Dr. Kalam Agricultural College, Kishanganj.*
6. *Nalanda College of Horticulture, Noorsarai, Nalanda.*
7. *College of Agricultural Biotechnology, Sabour, Bhagalpur.*
8. *College of Agricultural Engineering, Ara, Buxar.*
9. *Bihar Forestry College and Research Institute, Munger.*
10. *College of Agri Business Management, Patna.*

The University offers courses for the award of Under Graduate, Post Graduate & Ph. D. Degree programme. This University is situated about 8 km east of Bhagalpur and the nearest railway station is Sabour. Sabour is directly connected by road, rail and air links. The National Highway No. 80 passes through Sabour which links Guwahati (Assam) and Patna (Bihar). The nearest Air Port (Patna) is located about 230 kms away from the University campus.

1.1 Photo Gallery

1. Bihar Agricultural College, Sabour, Bhagalpur

Bihar Agricultural College, Sabour, established in 1908, is one of the country's oldest agricultural colleges. At a height of 46 metres, it is located about 10 kilometres east of Bhagalpur (the nearest railway connection) at 86° 57' S longitude and 25° 15' N latitude. On 17thAugust, 1908, Sir Andrew Henderson Leith Frazer, Lt. Governor of Bengal, lay the foundation stone of an Agricultural College at Sabour. The college has a history of releasing the world's first mangohybrids, "Mahamood Bahar" and "PrabhaSanker." The Central Rice Research Institute, which was primarily built at Sabour with two sub-stations at Gaya and Cuttack, has a unique history with Bihar Agricultural College. *Hortus Malabaricus* (12 volumes), *Museum Restrcum* Et. Commercial (6 volumes), and Plants of the Commercial Coast (6 volumes) are among the rare books in the collection (3 volumes).

Sl. No.	Academic Units	Degree Programme	Total Seat
1	Bihar Agricultural College, Sabour, Bhagalpur	B.Sc. (Hons.) Agriculture	100
		M.Sc.(Agri.)	145
		Ph.D.	53
	Total		298

For more information about seat, Admission & Eligibility criteria, please refer page no. 13-16

2. Mandan Bharti Agricultural College, Agwanpur, Saharsa

The foundation of Mandan Bharti Agricultural College, Agwanpur, Saharsa, fulfilled a long-held dream of the Kosi people for agricultural growth of the region's frightened but troubled land. The college was founded in April of 2007, and it offers a dynamic and innovative educational programme to meet the present difficulties of scientific manpower, important research, extension services, and high-quality planting supplies. The 77.5-acre campus is equipped with modern amenities such as smart classrooms, well-equipped laboratories, and committed faculty. Besides education and technology transfer, the college is also involved in agricultural research. This college's research and extension area in the Koshi region (zoneII), which includes Saharsa, Supaul, Madhepura, and Khagaria.

Sl. No.	Academic Units	Degree Programme	Total Seat
1	Mandan Bharti Agricultural College, Agwanpur, Saharsa	B.Sc. (Hons.) Agriculture	100
		M.Sc.(Agri.)	4
		Ph.D.	0
	Total		104

For more information about seat, Admission & Eligibility criteria, please refer page no. 13-16

3. Veer Kunwar Singh College of Agriculture, Dumraon, Buxar

The Veer Kunwar Singh College of Agriculture, Dumraon (Buxar), is located18 kilometres east of Buxar, in the sub- division of Dumraon, which was traditionally known as Karm Bhumi of Lord Ram and Tapobhumi of Maharsi Vishwamitra. It was founded in 2010 and now provides a bachelor's degree in agriculture.It was founded in 2010 and now provides a bachelor's degree in agriculture. Smart class rooms, laboratories, dorms, and the Administrative Building are among the college's well-established teaching facilities. This is the sole Agricultural College in Bihar's Zone-IIIB, and it is always ready to assist farmers and concerned officers in areas such as Buxar, Bhojpur, Rohtas and Kaimur.

Sl. No.	Academic Units	Degree Programme	Total Seat
1	Veer Kunwar Singh College of Agriculture, Dumraon, Buxar	B.Sc. (Hons.) Agriculture	100
		M.Sc.(Agri.)	4
		Ph.D.	0
	Total		104

For more information about seat break-up, Admission & Eligibility criteria, please refer page no. 13-16

4. Bhola Paswan Shastri Agricultural College, Purnea

In the year 2011, this college was founded. It is 3 kilo metres from Purnea Junction and 4 kilo metres from the national highway. On the 16th of June2011, the Hon'ble Chief Minister of Bihar, Sri Nitish Kumar, lay the foundation stone. Sri Nitish Kumar, Hon'ble Chief Minister of Bihar, opened the College site, which included an administrative building, boys' and girls' hostels, staff quarters, a sports facility, and an Auditorium on 10th August, 2015. At this time, the college's infrastructure includes classrooms, labs, a training hall, student hostels, a library, and computers with internet access. The Department of Agriculture, Government of Bihar, created an 84-hectare Seed Multiplication Farm at Purnea in 1958, and the farm has been producing excellent seed of vital crops to meet. The needs of farmers in the state since then.

Sl. No.	Academic Units	Degree Programme	Total Seat
1	Bhola Paswan Shastri Agricultural College, Purnea	B.Sc. (Hons.) Agriculture	100
		M.Sc.(Agri.)	6
		Ph.D.	0
	Total		106

For more information about seat break-up, Admission & Eligibility criteria, please refer page no. 13-16

5. Dr. Kalam Agricultural College, Kishanganj

Dr. Kalam Agricultural College (DKAC), Kishanganj, was founded on the banks of the Mahanada on August 10, 2015near Arrabari on the Thakurganj- Kishanganj road. The College was named in the remembrance of the former President Late Dr. A.P.J Abdul Kalam. Kishanganj is also recognized For producing high-quality tea, in addition to pineapple and jute, and was the first district in Bihar to do so on a significant scale. D.K.A.C., Kishanganj is always ready to assist farmers and concerned officers in the State's Zone – II. In terms of classrooms, labs, libraries, hostels, and residence halls, the campus features a well-developed state-of-the-art infrastructure.

Sl. No.	Academic Units	Degree Programme	Total Seat
1	Dr. Kalam Agricultural College, Kishanganj	B.Sc. (Hons.) Agriculture	100
		M.Sc.(Agri.)	16
		Ph.D.	0
	Total		116

For more information about seat break-up, Admission & Eligibility criteria, please refer page no. 13-16

6. Nalanda College of Horticulture, Noorsarai, Nalanda

The college, known as the Nalanda College of Horticulture (NCOH), was founded on August 22, 2006. The ancient International Monastic University, which was founded in the 5th century BC and taught ideas, logic, grammar, medicine, meta physics, prose production, and rhetoric, is well-known across the world. The institution was founded with the goal of training high-quality human resources to help the state's horticulture sector grow faster. Smart classrooms, laboratories well-established protected agricultural structures, and a student and farmer's hostel area all part of the college's well-developed infrastructure.

Sl. No.	Academic Units	Degree Programme	Total Seat
1	Nalanda College of Horticulture, Noorsarai, Nalanda	B.Sc. (Hons.) Horticulture	50
		M.Sc.(Agri.)	10
		Ph.D.	3
	Total		63

For more information about seat break-up, Admission & Eligibility criteria, please refer page no. 13-16

7. College of Agricultural Biotechnology, Sabour

The College of agricultural biotechnology was established at the Sabour campus vide cabinet approval dated 17th August 2021. The college started its academic session since 2021-22 with a student intake capacity of 30.

Sl. No.	Academic Units	Degree Programme	Total Seat
1	College of Agricultural Biotechnology, Sabour	B.Tech.(Biotech.)	60
		M.Sc.(Agri.)	0
		Ph.D.	0
	Total		60

For more information about seat break-up, Admission & Eligibility criteria, please refer page no. 13-16

8. College of Agricultural Engineering, Ara, Buxar

The College of agricultural engineering was established in Ara vide cabinet approval dated 17th August 2021. Currently its functioning at the Dumraon campus. The college started its academic session since 2021-22 with a student intake capacity of 30. The needs of farmers in the state since then.

Sl. No.	Academic Units	Degree Programme	Total Seat
1	College of Agricultural Engineering, Ara	B.Tech. (Ag. Engineering)	60
		M.Sc.(Agri.)	0
		Ph.D.	0
	Total		60

For more information about seat break-up, Admission & Eligibility criteria, please refer page no. 13-16

9. College of Agri Business Management, Patna

Note :- Currently running at BAU, Sabour Campus , Bhagalpur

Sl. No.	Academic Units	Degree Programme	Total Seat
1	College of Agri Business Management	MBA (Agri Business Management)	30
		Ph.D.	0
	Total		30

For more information about seat break-up, Admission & Eligibility criteria, please refer page no. 17

9. College of Forestry and Environmental Sciences, Munger

CM Nitish Kumar inaugurated the newly-constructed buildings of state's first forestry college at Munger Sadar block headquarters during his 'Samadhan Yatra' in Munger district. The college started its academic session since 2023-24 with a student intake capacity of 25.

Sl. No.	Academic Units	Degree Programme	Total Seat
1	Academic Units 9: Bihar Forestry College and Research Institute, Munger	B.Sc. (Forestry)	50
		M.Sc.(Agri.)	0
		Ph.D.	0
	Total		50

For more information about seat break-up, Admission & Eligibility criteria, please refer page no. 13-16

1.2 VISION

Bihar Agricultural University (BAU) was established with a vision of Improving quality of life of the people of the state specially the farming community which constitute more than two-third of the population. Having set of ultimate goal of benefiting society at large the university intends to achieve it by imparting world-class need based agricultural education, research, extension and training.

1.3 MANDATE

a) Education: Developing quality human ware and suitably trained human resources through professional programmes in agriculture and allied field.

b) Research: Undertaking mutually reinforced basic, applied and adaptive research and developing, acquiring and refining technologies along with the value chain to address the present and emerging problems and to capture new opportunities.

c) Extension: Ensuring effective transfer and adoption of appropriate technologies and knowledge through dynamic extension services consistent with socio-economic (income, inclusiveness and employment) and agro-ecological security.

d) Training: Establishing centre for excellence in training for capacity building of extension professional paraprofessionals as well as vocational training of adults, youth and women through conventional as well as open and distance learning.

1.4 MILESTONESE

a) Bihar Agricultural College, erstwhile Bengal Agricultural College established on 17th August 1908 is one of the five oldest agricultural colleges, started three years Diploma Course 'Licentiate in Agriculture' for making employment in Agriculture Department.

b) One of the India's first Fruit Research Station was established in 1934.

c) B. Sc. (Ag) degree course started at Bihar Agricultural College in 1945 and first batch of 28 students passed out under Patna University in 1948.

d) The world's first mango hybrids, Prabhashankar and Mahmud Bahar developed through planned hybridization programme was released in 1951.

e) The Extension Education in the college was introduced in the PG course curriculum for the first time in the country.

f) For the first time in the State, Post Graduate degree programme was introduced in the college in 1955 and first session started with five subject's *viz.*, Agronomy, Horticulture, Plant Pathology, Entomology and Extension Education. First batch of 23 students passed out in 1957.

g) In 2010, The Bihar Agricultural University, Sabour was established and Bihar Agricultural College became one of its constituent colleges.

1.5 EDUCATION

Bihar Agricultural University offers under graduate, Master and Ph.D Programmes. BAU is endeavouring to produce well trained and quality human resources in the form of Agricultural Graduates having knowledge, skills, proficiencies and also entrepreneurship abilities in vital areas of agriculture and allied discipline by imparting B.Sc.(Hons.) Ag. and B.Sc.(Hons.), Horticulture degrees at six different colleges. Postgraduate (Master) Programme are offered in fourteen

disciplines of agricultural science. The library at university and colleges are equipped with services like E-access, CDROM, book bank, references, circulation, resource sharing, reprography, clipping etc.

It is also hosting Centre of Excellence for Teaching and Learning (CETL) aiming towards Personal Branding and Soft Skills development among Agricultural Students. It is one of the first State Agricultural Universities to have started centre for Teaching Excellence in collaboration with University of Illinois USA to train faculty members in Teaching Technology and propagate good / teaching practices for quality leaning.

Besides advocating basic institutional knowledge students are also exposed to international organizations under sandwich programme to get an idea on research advances at global level and to prepare them for national and international competition. Entrepreneurship development through experiential learning in the disciplines of Horticulture (Commercial Horticulture, Protected Cultivation); Plant Pathology; Food Science and Post-harvest Technology, Animal Clinic and Communication Skills & Personality Development to provide holistic development of students is also provided regularly. Most recently BAU has started an electronic Media Production Centre under Rashtriya Krishi Vikas Yojana (RKVY) programme using Information & Communication Technologies, which is a modern Centre for open and distance learning with the use of e-learning, video conferencing and multimedia learningmaterials.

1.6 RESEARCH

The university research addresses almost every component of agriculture and is executed with six key programs including crop improvement, natural resource management, crop protection, product development and marketing, social sciences and animal science. The research activities in the university is typically targeted to cater the special needs, crops and ecologies of diverse farming communities at local, state and national level. As a symbol of growing confidence, several international partners like CIMMYT.

ICRISAT, IRRI, IPNI, ACIAR, ICARDA have expressed their interest and have joined inalliance with BAU to operate in collaborative mode.

1.7 CROP IMPROVEMENT

Crop improvement programme is taking account of major cereals, pulses, oilseeds, fibres and horticultural crops of the state including rice, wheat, maize, pulses, oilseeds, fiber crops, fruits and vegetables. Inter-disciplinary and multi location testing of elite breeding lines and improved management practices like aerobic rice, direct seeded rice for different rice ecosystems to enhance the rice productivity, terminal heat tolerance in wheat, heat and cold tolerance in maize going in together with production and livelihood security based on the demand of target group. Grain quality, bio-fortification and improvement for major biotic and abiotic stresses have been attempted to address the needs of ecology; conventional heterosis and molecular breeding the genetic potential. Addressing the nutritional security and self- sufficiency in pulse production in the state as well in country, the research activity in pulse crops like chick pea, pigeonpea, mungbean for improving production and productivity is being carried out. Pigeonpea genotype breeding for cold and submergence tolerance and approaches are intensively pursued to improve breeding for increasing the production and productivity of lentil and chickpea is also under process. Germplasm conservation of local illustrious cultivars like Katarni rice, Zardalu mango, Shahi litchi. Magadhi Pan etc. as well as their purification are also the paramount objective of the crop improvement

programme.

Bihar Agricultural University initiated some innovative work in rice improvement viz., development of transgenic rice resistant to glyphosate (N-phosphonomethyl glycine) herbicide, engineered resistance in rice against fungal pathogens, Brassinosteroid-mediated mutational analysis for abiotic stress alleviation in rice using modern cutting edge technology, molecular biology and biotechnology.

1.8 NATURAL RESOURCE MANAGEMENT

Natural resource management aims with the efficient utilization of natural resources for higher agricultural productivity, profitability and environmental sustainability. With the surging food security issues and associated production challenges in wide spread rice fallow area, vast area under Tal and Diara and arsenic and fluoride contaminated ground water in many districts are being administered by the university. Crop diversification, optimization of agro-techniques, moderations of management practices to mitigate greenhouse gas emission, improving productivity and nitrogen use efficiency through precision nutrient management, resource conservation technologies and remote sensing and GIS approach are being advocated at BAU for enhancing sustainability. Pressing on the climate change issue, special tasks have been taken up in form of research activities on carbon sequestration and greenhouse gas studies under various agro-ecological systems by exploiting opportunities for reducing or removing greenhouse gas emissions where feasible. As a long term sustainable strategy and environmental safety, conservation agriculture practices are being standardized for understanding and planning for adaptive transitions into new farming systems or livelihoods. Promotion of zero tillage and adoption of modern machineries are being advocated to reduce soil and labour drudgery. University has also been focusing on strengthening local institutionsto enable farmer for management of climate risks and adoption of context suitable agricultural practices technologies and systems.

Capturing new futuristic opportunities, a new dimension have also been included in the University research activities as Nanotechnology. Development of multi nutrient nano-clay polymer composite fertilizer for enhancing nutrient use efficiency, hydrogels for improving soil moisture retention capacity, use of partially acidulated nano-rock phosphate for enhancing phosphorus use efficiency, novel nano-polymer for increasing shelf life of fruits are the few initiatives under the agies of the

1.9 CROP PROTECTION

Crop Protection made significant contributions in survey and surveillance for key insect pests and diseases of major crops in Bihar and integrated management of important agricultural pests and pathogens. Integrated pest management modules in some cereals, pulses, vegetables and fruits developed are in vogue.

Crop Protection aims with basic and applied research leading to detection, identification, documentation of microbial bio-diversity. It also deals the virulence and genetic diversity of insect pests and pathogens, climate change inspect on disease and pest dynamics, biological control of plant diseases and insect pests introgression of disease & pests resistance genes and production of pathogens free plumbing material.

1.10 SOCIAL SCIENCES

Social Sciences provide a window for transferring technology from laboratory to farm. Bihar Agricultural University conceived new innovative approaches like leadership development among farmers and rural youth, promotion of agri-entrepreneurs for proper dissemination of agricultural

technology, provision of adequate capital for attracting youth towards agriculture. Mobilizing cutting edge sciences are being promoted at BAU to develop sustainable farming, reducing hunger and poverty and improving human nutrition, health and protecting the environment.

1.11 PRODUCT DEVELOPMENT AND MARKETING

Product development and marketing aims to enhance post-harvest quality preservation of vegetable crops, shelf life enhancement in fruit crops and development of value added products are being conducted to improve the marketability of the commodities. Mechanization plays a paramount role in uprising agricultural profitability. Designed and developed numbers of machines like Self-propelled secondary tillage machine, manual-cum-power operated maize-cum-paddy thresher are few achievements of Bihar Agricultural University.

1.12 EXTENSION AND OUTREACH

BAU Sabour has a statutory role to play with regards to extension. Extension service carried out by the KVKs, Colleges and research station of the BAU Sabour is the vehicle which carries scientific agricultural technology interventions developed by the university to the farm, for the overall benefit of the farming community. This major function of extension is accomplished through dissemination of farm information training of farmers and extension functionaries educating the farmers through field activities. In order to carry out these extensions, twenty KVKs twelve regional research stations and six colleges are working on and off the field. In order to enhance the farm profitability on sustainable basis, BAU delivers its extension services through innovative group approaches, modern ICT infrastructure and on field educational activities.

2. GENERAL INSTRUCTIONS

A). Admission to the University implies acceptance without any modification by the candidate and his/her parents/guardians of all provisions given in the prospectus or any change in the University rules, regulation, fees, etc. that are made from time to time.

B). The students who have been temporarily dismissed or permanently dropped from this/other University either on account of poor academic performance or on account or act(s) or indiscipline or those who have been debarred from seeking admission in this/other University shall not be eligible to apply for admission to any programme of this University.

C). If any document submitted by the candidate is found to be false at any stage during his/her stay in this University, his/her admission will be cancelled.

D). The information indicated in this prospectus is only for general guidance and could be modified/ changed from time to time by the University without giving any notice.

E). For correspondence regarding admission, contact:

REGISTRAR
Bihar Agricultural University, Sabour – 813 210,
Bhagalpur Phone: - 0641 –2452614, Fax:-0641 – 2452614
Website: www.bausabour.ac.in
Email: bauexam2025@gmail.com

2.1 IMPORTANT DATES (Tentative) to be informed

A.	Application form through University Website(www.bausabour.ac.in)	15 May- 10 June 2025
B.	Issue of Admit Card	To be Informed later
C.	Date of Examination	29.06.2025 (Tentative)

2.2 APPLICATION FEE & RESERVATION CATEGORY

Degree Programme	For UR & Others	For SC / ST
Master Degree	Rs. 1400/-	Rs. 500/-
Ph.D. Degree	Rs. 1600/-	Rs. 600/-

RESERVATION CATEGORY (ABBREVIATION)
UR – Unreserved
EWS – Economically Weaker Section
BC – Backward Class
EBC – Extremely Backward Class
SC – Scheduled Caste
ST – Scheduled Tribe
RCG/RCF – Backward Class Girl / Female

3. MASTER DEGREE PROGRAMME

3.1 ELIGIBILITY CRITERIA

a) A candidate should possess at least 60% marks in aggregate or 6.0/10.0 in Bachelor's Degree and in the case of SC/ST, 55% marks in aggregate or 5.5/10.0 OGPA & passed in credit based course system..

b) The candidate must possess the Bachelor Degree from ICAR's accredited College/recognized by ICAR or UGC affiliated Universities.

c) The Candidate appearing for the Bachelor Degree Examination is also eligible to apply provisionally for admission and appear in the Competitive Test. However, he/she must have final result with required CGPA (Provisional Degree Certificate and Transcript) on or before **the date of 1st counselling.**

d) Admission to Master Degree Programme is open for Domicile of Bihar only.

3.2 SUBJECT WISE SEATS AND ELIGIBILITY CRITERIA

S.N.	Degree Programme	BAU Seat	ICAR Seat	Eligibility Criteria
1	M.Sc.(Agri.) Agronomy	**12+6***	**5**	Bachelor's Degree in Agriculture/Bachelor's Degree in Horticulture
2	M.Sc.(Agri.) Agricultural Economics	**4**	**1**	
3	M.Sc(Agri.) Entomology	**6+6***	**2**	
4	M.Sc(Agri.) Postharvest Management	**5**	**1**	
5	M.Sc.(Hort.) Fruit Science	**9+10***	**4**	
6	M.Sc.(Hort.)Vegetable Science	**9+6***	**5**	
7	M.Sc(Agri.) Molecular Biology and Biotechnology	**6**	**2**	B.Sc.(Hons.) Agriculture/Hort./. Forestry/B.Tech(Biotech.)
8	M.Sc(Agri.) Genetics and Plant Breeding	**12**	**5**	Bachelor's Degree in Agriculture/Bachelor's Degree in Horticulture
9	M.Sc.(Agri.) Plant Pathology	**8+2***	**4**	
10	M.Sc(Agri.) Plant Physiology	**4**	**2**	
11	M.Sc(Agri.) Seed Science and Technology	**2**	**1**	
12	M.Sc(Agri.) Soil Science	**12+10***	**5**	
13	M.Sc.(Hort.) Floriculture and Landscaping	**4**	**1**	
14	M.Sc.(Agri.) Agricultural Extension Education	**4**	**2**	
15	M.Sc.(Agri.) Agricultural Statistics	**3**	**1**	
16	M.Sc.(Agri.) Nematology	**2**	**0**	
17	M.Sc.(Agri.) Agricultural Chemicals	**2**	**0**	
	Total	**144**	**41**	

Note :- * Marks Seats are Non-fellow and Non-residential.

3.3 CATEGORY WISE DISTRIBUTION OF SEATS

Master Degree Programme

S.N.	Degree Programme	BAU Seat	UR	EWS	BC	EBC	SC	ST	Roaster Point**
1	M.Sc. (Agri.) Agronomy	**18**	7	2	3	3	3		1-18
2	M.Sc. (Agri.) Agricultural Chemicals	**2**				1		1	19-20
3	M.Sc. (Agri.) Agricultural Economics	**4**	2		1		1		21-24
4	M.Sc. (Agri.) Agricultural Extension Education	**4**	1	1		1	1		25-28
5	M.Sc. (Agri.) Agricultural Statistics	**3**	2		1				29-31
6	M.Sc. (Agri.) Entomology	**12**	5	1	1	3	2		32-43
7	M.Sc. (Hort.) Fruit Science	**19**	8	2	3	3	3		44-62
8	M.Sc. (Hort.) Floriculture and Landscaping	**4**	2		1	1			63-66
9	M.Sc. (Hort.) Vegetable Science	**15**	6	2	2	2	3		67-81
10	M.Sc. (Hort.) Postharvest Management	**5**	2		1	1	1		82-86
11	M.Sc. (Agri.) Genetics and Plant Breeding	**12**	4	2	2	2	2		87-98
12	M.Sc. (Agri.) Molecular Biology and Biotechnology	**6**	3			2	1		99-04
13	M.Sc. (Agri.) Nematology	**2**	1		1				5-6
14	M.Sc. (Agri.) Plant Pathology	**10**	4	1	1	2	2		7-16
15	M.Sc. (Agri.) Plant Physiology	**4**		1	1	1		1	17-20
16	M.Sc. (Agri.) Seed Science and Technology	**2**	1		1				21-22
17	M.Sc. (Agri.) Soil Science	**22**	10	2	2	4	4		23-44
	Total	**144**	**58**	**14**	**21**	**26**	**23**	**2**	

Note: - The University reserves the right to make addition or deletion in number of seats without any notice.

** As per 100 points Model Roster of Government of Bihar

3.4 SELECTION CRITERIA

e) Selection will be made on the basis of competitive entrance examination.

f) Seat allotment will make on merit cum choice basis. Reservation policy of Government of Bihar will be applicable.

g) Merit list shall be prepared on the basis of marks obtained in competitive entrance examination.

h) Cut off marks for SC/ST candidate is 40% and 45% for all other categories in the merit list ofcompetitive entrance examination.

i) In case of same marks in the merit list of Competitive entrance examination, date of birth shallbe given priority.

j) Candidate may be sent off-campus for completing the research work.

4. Ph.D. DEGREE PROGRAMME

4.1 ELIGIBILITY REQUIREMENT

a) A candidate should possess at least 70% marks in aggregate or 7.0/10.0 in Master's Degree Programme and in case of SC/ST, 65% marks in aggregate or 6.5/10.00 OGPA. & passed in credit based course system.

b) The candidate must possess the Master Degree from ICAR's accredited College/ Institution / University/ Constituent College of UGC affiliated Universities.

c) The Candidate appearing in the Master Degree Examination is also eligible to apply provisionally for admission and appear in the Competitive Entrance Examination for admission in Ph. D. Degree Programme. However, he/she must have final result with required CGPA (Provisional Degree Certificate and Transcript) on or before the date of **1st counselling**.

d) Admission to Ph.D. is open for all eligible candidates.

e) A candidate can apply for admission to only one subject. No change would be allowed thereafter.

4.2 SUBJECT WISE NUMBER OF SEATS AND ELIGIBILITY CRITERIA

Sl. No.	Subject	BAU Seats	ICAR Seat	Eligibility Criteria
1	Agricultural Economics	2+1*	1	Master Degree in concern Subject
2	Agronomy	4	2	
3	Entomology	3	1	
4	Agricultural Extension	1+1*	1	
5	Horticulture (Fruit Science)	4	1	
6	Horticulture (Vegetable Science)	4+3**	1	
7	Postharvest Management	1	1	
8	Floriculture & Land Scaping	1+1*	0	
9	Genetics & Plant Breeding	4	1	
10	Molecular Biology and Biotechnology	1	1	
11	Plant Pathology	3+1*	1	
12	Plant Physiology	1	1	
13	Soil Science	4+1*	2	
14	Agricultural Statistics	1	0	
	Total	**34+8***	**14**	

Note :- *Seats are Non Fellowship & Non-residential

** 3 Seats for NCOH, Noorsarai

4.2 CATEGORY WISE DISTRIBUTION OF SEATS

Ph.D. Degree Programme

Sl. No.	Subject	BAU Seats	UR	EWS	BC	EBC	SC	ST	Roaster Point**
1	Ph.D Agronomy	4	2			1	1		1-4
2	Ph.D.Agricultural Economics	2+1	1	1	1				5-7
3	Ph.D. Agricultural Extension Education	1+1	1			1			8-9
4	Ph.D. Agricultural Statistics	1					1		10
5	Ph.D. Entomology	3	2		1				11-13
6	Ph.D. Fruit Science	4	1	1		1	1		14-17
7	Ph.D. Floriculture and Landscaping	1+1			1			1	18-19
8	Ph.D. Vegetable Science	4+3	3		1	2	1		20-26
9	Ph.D. Post Harvest Management	1		1					27
10	Ph.D. Genetics and Plant Breeding	4	2		1		1		28-31
11	Ph.D. Molecular Biology and Biotechnology	1				1			32
12	Ph.D. Plant Pathology	3+1	2			1	1		33-36
13	Ph.D. Plant Physiology	1		1					37
14	Ph.D. Soil Science	4+1	2		1	1	1		38-42
		34+8	**16**	**4**	**6**	**8**	**7**	**1**	

Note: - The University reserves the right to make addition or deletion in number of seats without any notice.

** As per 100 points Model Roster of Government of Bihar

4.2 SELECTION CRITERIA

a) Selection will be made on the basis of Competitive Entrance Exam. Candidates willing to secure admission will have to appear in Competitive Entrance Test. Counselling and Admission will be allowed in the subject applied for admission on the basis of seat availability and reservation policy of Government of Bihar.

b) Merit list shall be prepared on the basis of marks obtained in Competitive Entrance Exam.

c) The cut off marks for all other Categories except SC/ST Category is 45% and for SC/ST Category is 40% in the merit list of Competitive Entrance Examination.

d) In case of same marks in the merit list of competitive Entrance Examination, date of birth shallbe given priority.

e) Candidate may be sent off-campus for completing the research work.

6. IMPORTANT INSTRUCTION

6.1 REFUSAL OF ADMISSION

A). The Vice-Chancellor reserves the right to refuse the admission of any candidate despite his/her fulfillment of the academic requirements for admission on the basis of Competitive Examination-cum Academic performance, for reasons to be recorded in writing, whose admission in the opinion of the Vice-Chancellor shall not be in the best interest of the University. The decision of the Vice-Chancellor shall be final.

B). The students who have been permanently dropped or temporarily dismissed from BAU, Sabour University either on account of poor academic performance or on account of act of indiscipline or those who have been debarred from seeking admission in this University shall not be allowed to appear in the Competitive Entrance Examination or shall also not be allowed to seek admission as a sponsored candidate. Even if such candidate has appeared in the competitive Entrance Examination either by concealing the facts or due to oversight, shall not be eligible for admission.

C). Candidates found using unfair means in Competitive Entrance Examination of this University shall be permanently debarred from appearing in the Competitive Entrance Examination of the University in Future.

D). It is the responsibility of the candidate to furnish full and correct information on the application form. Any admission made on the basis of wrong or concealed information, provided by the candidates or due to any oversight or error in the Registrar office and detected subsequent to the admission or joining of the candidate would be cancelled at the cost and risk of the candidate.

7. RESERVATION OF SEATS

The Category (UR/EWS/BC/EBC/RCG/SC/ST) declared by the candidate in application form will be final. No subsequent change will be allowed. Reservation of seats shall be given as per the Policy of the Government of Bihar.

8. INSTRUCTIONS FOR FILLING THE APPLICATION FORM

Instructions to the candidates for filling the application form are given in **Appendix – I**. (Instructions for Submission of Application form).

9. SYLLABUS

Syllabus for competitive Entrance Examination for admission to Master's Degree Programme is appended in **Appendix – II**

Syllabus for competitive Entrance Examination for admission to Ph. D. DegreeProgramme is appended in **Appendix – III**

10. SCHEME OF EXAMINATION

Competitive Entrance Examination will carry 200 multiple choice questions each of 0.5marks. The duration of examination will be 2 hours. Candidates have to mark answer on the OMR Sheet with Blue/Black Ball Pen.

11. RESIDENTIAL REQUIREMENT AND UNIVERSITY FELLOWSHIP

1. Master's Degree Programme

- A minimum of four (4) semesters shall be the residential requirement for completing the coursework.
- The maximum duration within which a regular student must complete and obtain the degree shall be ten (10) semesters.

2. Ph.D. Degree Programme

- A minimum of six (6) semesters shall be the residential requirement for completing the coursework.
- The maximum duration within which a regular student must complete and obtain the degree shall be fourteen (14) semesters.

Note: The students admitted under supernumerary seats shall not be entitled to any scholarship or fellowship provided by the university. Additionally, such students will not be eligible for hostel accommodation entitlement.

12. COUNSELLING

Candidates called for counselling will be required to submit their relevant documents inoriginal as given below with one set of self-attested photocopies.:-

a) High School/equivalent examination mark sheet as well as certificate for proof of age.

b) 10+2/Intermediate Examination certificate and marks sheet.

c) Bachelor Degree Certificate/ Provisional Degree Certificate and Transcript.

d) Master Degree Certificate/ Provisional Degree Certificate and Transcript (For Ph.D. Programme)

e) Character Certificate from Head of the Institution last attended.

f) Domicile Certificate issued by the Competent Authority.

g) Caste certificate issued by the Competent Authority. (in case candidates claiming reservation).

h) AADHAR Card of Candidate.

Counselling does not guarantee admission. It depends on merit and availability of seats in a particular subject/ Faculty. In case, candidates fail to attend the counselling his/her candidature shall automatically stand rejected.

13. DIRECTIONS FOR CANDIDATE

a) Duplicate Admit card will be issued by the Registrar one day before the date of examination on payment of Rs. 50.00 for which two photographs and proof of application submission have to produce by the candidate himself/herself.

b) The candidate shall be present at the centre 30 minutes before the commencement of the Competitive Entrance Examination.

c) Candidate will not be admitted to the Examination Hall after 30 minutes from the commencement of the Examination.

d) Candidate who does not produce the Admit Card shall not be allowed to sit in the examination hall by the Centre Superintendent/Invigilator.

e) Candidate must preserve the Admit Card till his/her admission in the institution/Department.

f) Candidates are not allowed to leave the Examination Hall before Completion of the duration of Competitive Entrance Examination and handing over the OMR sheet and Question paper (Test Booklet) to the concerned Invigilator.

g) The candidate shall not remove any page(s) from the Test Booklet and if any page(s) is/are found missing from his/her booklet, he/she will be prosecuted against and shall be liable for cancellation of his/her candidature and legal action.

h) The candidate must fill in the Box with black ballpoint pen of good quality.

i) Candidates are not allowed to bring any books, notes or calculator, cell phone etc. in the Examination Hall.

j) Candidate must follow the instructions strictly as given by the invigilators in the examination hall.

k) No cutting or overwriting is allowed.

l) Impersonation in any form will lead to cancellation of candidature and legal action.

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14. APPENDIX - I

a) Keep a photo copy of your application form for your record.
b) Candidate will have to carry a copy of application print out along with necessary documentsat the time of counselling.

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15. APPENDIX - II

SYLLABUS FOR BAU ENTRANCE EXAMINATION FOR ADMISSION TO MASTER'S DEGREE PROGREMME

1. Agriculture Faculty

General Agriculture

Importance of Agriculture in national economy; basic principles of crop production; cultivation of rice, wheat, chickpea, pigeon-pea, sugarcane, groundnut, tomato, potato and mango. Major soils of India, role of NPK and their deficiency symptoms. General structure and function of cell organelles; mitosis and meiosis; Mendelian genetics. Elementary knowledge of growth, development, photosynthesis, respiration and transpiration; Elements of economic botany. General structure and function of carbohydrates, proteins, nucleic acids, enzymes and vitamins. Major pests and diseases of rice, wheat, cotton, chickpea, sugarcane and their management. Organic farming; bio-fertilizers; bio-pesticides. Recombinant DNA technology; transgenic crops. Food and industry; composting and biogas production. Important rural development programmes in India; organizational set up of agricultural research, education and extension in India. Elements of statistics. Measures of central tendency and dispersion, regression and correlation; concept of probability, sampling techniques and tests of significance.

Agronomy

Principles of Agronomy, Crop ecology and geography and Agricultural Meteorology: Agronomy – meaning and scope, National & International agricultural research institutes in India, Agro climatic zones of India, Tillage, crop stand establishment and planting geometry and their effect on crop, Physiological limits of crop yield and variability in relation to ecological optima, organic farming, Precision farming, Integrated farming systems, Principles of field experimentation. Principles of crop ecology and crop adaptation, climate shift and its ecological implications, Agro-ecological regions in India, Geographical distribution of crop plants, Greenhouse effect, Climatic factors and their effect on plant processes and crop productivity, Role of GIS and GPS in agriculture. Weather & climate, Earth's atmosphere, Solar radiation, Atmospheric temperature and global warming. Crops and atmospheric humidity, Weather forecasting.

Field crops: Origin, distribution, economic importance, soil and climatic requirement, varieties, cultural practices and yield of cereals (rice, wheat, maize, sorghum, pearl millet, minor millets, barley), pulses (chickpea, lentil, peas, Pigeon pea, mungbean, urdbean), oilseeds (groundnut, sesame, soybean, rapeseed & mustard, sunflower, safflower, linseed), fiber crops (cotton, jute, sun hemp), sugar crops(sugarcane), fodder & forage crops (sorghum, maize, napier, berseem, Lucerne, oats), medicinal & aromatic plants (menthe, lemon grass and isabgol) and commercial crops(potato, tobacco).

Weed management: Principles of weed management, Classification, biology and ecology of weeds, crop weed competition and allelopathy, concepts and methods of weed control, Integrated weed management, Classification, formulations, selectivity and resistance of herbicides, Herbicide persistence in soil and plants, Application methods and equipments, Weed flora shifts in cropping

systems, Special and problematic weeds and their management in cropped and non-cropped situations, Weed management in field crops. Water management: Principles of irrigation, Water resources and irrigation development in India, Water and irrigation requirements, Concepts and approaches of irrigation scheduling, Methods of irrigation, Measurement of irrigation water, application, distribution and use efficiencies, Conjunctive use of water, Irrigation water quality and its management, water management in major field, crops (rice, wheat, maize, groundnut, sugarcane) Agricultural drainage. Dryland Agronomy: Characteristics of Dryland farming and delineation of Dryland tracts, constraints of Dryland farming in India, Types of drought and their management, contingency crop planning and mid- season corrections for aberrant weather and its recycling. Watershed management.

Sustainable land use systems: Sustainable agriculture: parameters and indicators, Conservation agriculture, safe disposal of agri-industrial waste for crop production, Agro-forestry systems, shifting cultivation, Alternate land use systems, Wastelands and their remediation for crop production.

Plant Breeding & Genetics/Plant Biotechnology/Plant Physiology & Biochemistry

Characteristics of prokaryotic and eukaryotic organisms; differences between fungi, bacteria, mycoplasms and viruses. Physical and chemical basis of heredity; chromosome structure. DNA replication, transcription and translation; genetic code; operon concept; protein biosynthesis. Genetic engineering; restriction enzymes; vectors; gene cloning; gene transfer. Plant cell and tissue culture; micro-propagation; somaclonal variation. Transformation; recombination; Heterosis. General application of biotechnology. Molecular and immunological techniques. Concept of bioinformatics, genomics and proteomics.

Elements of economic botany; integrated diseases management; sterilisation, disinfection and pasteurization; Koch's postulates; etiological agents of rusts, smuts, powdery/downy mildews, wilts, yellows, mosaic, necrosis, enations, blights and witches- broom; pH, buffer, vitamins, role of plant hormones in seed germination and dormancy; pollination/ fertilization in flowering plants; methods of seed testing; breeders, foundation and certified seeds; seed production in self and cross pollinated crops.

Importance of biochemistry in agriculture. Acid-base concept and buffers; pH. Classification, structure and metabolic functions of carbohydrates, lipids and proteins. Structure and function of nucleic acids. Enzymes: structure, nomenclature, mechanism of action; vitamins and minerals as coenzymes and cofactors. Metabolic pathways: glycolysis, TCA cycle, fatty acid oxidation, triglyceride biosynthesis. Electron transport chain; ATP formation. Photosynthesis: C-3, C-4 and CAM pathways. Nitrate assimilation; biological nitrogen fixation. Colorimetric and chromatographic techniques.

Plant Physiology

Importance in agriculture. Seed germination, viability and vigour. Photosynthesis- significance of C-3, C-4 and CAM pathway; photorespiration and its implications. Translocation of assimilates; dry matter partitioning; Harvest index of crops. Growth and development; growth analysis; crop-water relationship. Plant nutrients and their functions. Phytohormones and their physiological role. Photo-

periodism, vernalisation; pollination/ fertilization in flowering plants. Post-harvest physiology and its significance.

Soil Science

Volumetric and gravimetric analysis including complexmetric methods, periodic classification of element, Basic principle of instrumental analysis including spectro-photometry (Absorption and emission spectrography), Atomic structure –elementary concept of radioactivity, element and compound common ion effect, solubility product—hydrolysis of salts, buffer solution indicates equivalent weights and standard solution. Elementary concepts of organic compounds-nomenclature and classifications including hydrocarbons, alcohol, aldehydes, acids and esters, carbohydrates, fats and liquids, amino acids, nucleic acids. Pesticides, their classification and uses; biopesticides and botanical pesticides.

Soil as a medium for plant growth, composition of earth's crust, weathering of rocks and minerals, components of soil- their importance, soil profile, soil partials- physical mineralogical and chemical nature. Mechanical analysis, Stokes law, assumptions, limitations and applications. Soil, physical properties- density, porosity, texture, soil structure and their brief descriptions. Rheological properties in soils, calculations of porosity and bulk density. Soil air-Aeration, causes of poor aeration, factors affecting aeration, importance for plant growth. Soil temperature - sources and losses of soil heat. Factors affecting soil temperature, its importance in plant growth. Soil water-structure of water, soil-water- energy relationship, classifications, surface tension and movement in soil. Soil colloids- properties, structure of silicate clay minerals, sources of negative charges, properties, kaolinite, illite, montmorillonite and vermiculite clay minerals, milli-equivalent concept, cation exchange capacity, anion exchange capacity, buffering of soils. Problem soils and their distribution in India - acid, saline, sodic and acid sulphate soils – their characteristics, formation, problems and management. Irrigation, water quality and its evaluation. Waterlogged soils- basic features, distinction with upland soils.

Essential plant nutrients- criteria of essentiality, functions for plant growth, mechanisms for movement and uptake of ions in soils and plants, Forms of nutrients in soils, deficiency symptoms on plants, luxury consumption, nutrient interactions and chelated micronutrients. Soil fertility, evaluation and management for plant growth, soil testing and fertilizer recommendations. Soil classifications- diagnostic surface and sub- surface horizons, soil survey- types, objectives, uses, land capability classifications. Remote sensing and its application in agriculture, SIS, GIS and GPS-basic features and uses in agriculture, Elementary concepts of radio isotopes and uses in agriculture.

Soil micro-organisms, Classifications and their roles. Organic matter- decomposition, C:N ratios, mineralization and immobilization processes, humus, role of organic matter in soil quality. Soil erosion, types and control measures. Fertilizers and manures- classifications, NPK fertilizers, their reactions in soils, green manuring, recycling of organic wastes, composting. Soil and water pollution- sources, brief idea about different pollutants in soils and their managements Soil fertility and fertilizer use: Essential plant nutrients and their deficiency symptoms, concept of essentiality of plant nutrients, Indicators of soil fertility and productivity, Fertilizer materials and their availability to plants, slow release fertilizers, Nitrification inhibitors, Principles and methods of fertilizer application, Integrated nutrient management, site specific nutrient management.

Entomology

Classification of animal kingdom up to class; distinguishing characters up to orders in class Insecta; general organization of an insect external morphology with special reference to lepidopteran larvae, coleopteran adults; and honeybee; metamorphosis and moulting; different physiological systems; insect- plant relationship; insect pests of agricultural and horticultural crops, and their stored/processed products,insect vectors of plant diseases- identification, biology, nature of damage, and their management tactics; and pests of household, medical and veterinary importance and their control; useful and beneficial insectslike honeybee, lac insect, silkworm and pollinators; Nematode taxonomy, biology of important plant parasitic nematodes and their control; entomopathogenic nematodes, basic principles of insect and nematode pest management-cultural, biological, insecticidal, quarantine, and regulatory aspects; insecticide classification and insecticide resistance management; and insect protective transgenic crops.

Plant Pathology

Introduction of important plant pathogenic organisms - fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viroid, algae, Protozoa and phanerogamic parasites with examples of diseases caused by them; Prokaryotes: classification of prokaryotes according to Bergey's; General characters, Manual of reproduction and classification of fungi; Definition and objectives of Plant Pathology; Survival and Dispersal of Plant Pathogens; Plant disease epidemiology; General principles of plant diseases management; Integrated plant disease management (IPDM); Economic importance, symptoms, cause, epidemiology and disease cycle and important diseases of important field crops (rice, maize, sorghum, pearl millet, minor millets, wheat, barley; pigeon pea, green gram, black gram, chickpea, lentil, peas, bean, ground nut, sesame, soybean, rapeseed and mustard, sunflower, safflowerand linseed sugarcane); vegetables (tomato, brinjal, chillies, okra, cucurbitaceous vegetables, cole crops, bulb crops, tuber crops, root crops, beans), orchard and plantation crops (mango, banana, guava, citrus, litchi, papaya, palms) and their management.

Agricultural Economics

Theory of consumer behaviour, theory of demand, elasticity of demand, indifference curve analysis, theory of firm, cost curves, theory of supply, price determination, market classification, concept of macroeconomics, money and banking, national income. Agricultural marketing—role, practice, institutions, problems and reforms, role of capital and credit in agriculture, crop insurance, credit institutions, cooperatives, capital formation in agriculture, agrarian reforms, globalization, WTO & its impact on Indian agriculture.

Basic principles of farm management, concept of farming system and economics of farming systems, agricultural production economics-scope and analysis, factor-product relationship, marginal cost and marginal revenue, farm planning and budgeting, Agricultural finance: nature and scope. Time value of money, Compounding and discounting. Agricultural credit: meaning, definition, need, classification. Credit analysis: 4R's, 5C's and 7 P's of credit, repayment plans. History of financing agriculture in India. Commercial banks, nationalization of commercial banks.

Lead bank scheme, regional rural banks, scale of finance. Higher financing agencies, RBI, NABARD, AFC, Asian Development Bank, World Bank, role of capital and credit in agriculture; credit institutions, co-operatives and agrarian reforms in India.

Extension Education

Extension Education- concept, meaning, principles, philosophy, scope and importance; Extension programme planning and evaluation- steps and principles, models of organizing agricultural extension; historical development of extension in USA, Japan and India. Rural development, meaning, importance and problems; Rural development programmes in India- Pre-independence era to recent ones; Extension teaching methods, definition and concept of sociology, differences between rural & urban communities, social stratification., social groups, social organization and social change. Rural leadership, educational psychology- learning and teaching, role of personality in agricultural extension Indian rural system- its characteristics; value system, cost and class; structure and customs; rural group organization and adult education.

Communication, principles, concepts, process, elements and barriers in teaching methods. Different kinds of communication methods and media and AV aids/materials. Media mix, Campaign, Cyber extension- internet, cybercafé, Kisan Call Centers, teleconferencing, agriculture journalism, diffusion and adoption of innovations- adopter categories, capacity building of extension personnel and farmers- training to farmers, women and rural youth.

Agricultural Statistics

Statistics – definition, use and limitations; Frequency Distribution and Curves; Measures of Central Tendency: Arithmetic mean; Geometric mean, Harmonic mean, Median, Mode; Measures of Dispersion: Range, Mean deviation, Quartile deviation, Variance and Coefficient of Variation; Probability: Definition and concepts, law of addition and multiplication, conditional probability, Bayes' theorem; Binomial, multinomial, Poisson and normal distribution; Introduction to Sampling: Random Sampling; Standard Error; Tests of Significance - Types of Errors, Null Hypothesis, Level of Significance, Testing of hypothesis; Large Sample Test- SND test for Means, Single Sample and Two Samples; Student's t-test for Single Sample, Two Samples and Paired t test. F test; Chi-Square Test for goodness of fit and independence of attributes; Correlation and Regression and associated tests of significance. Experimental Designs: basic principles, Analysis of variance, Completely Randomized Design (CRD), Randomized Block Design (RBD).

Introduction to Computers, Operating Systems, definition and types, Applications of MS-Office for document creation & Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions, Database, concepts and types, uses of DBMS in Agriculture, World Wide Web (WWW): Concepts and components. Introduction to computer programming languages, concepts and standard input/ output operations, e-Agriculture, concepts and applications, Use of ICT in Agriculture. Computer models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone Apps in Agriculture for farm advises, market price, postharvest management etc; Geospatial technology for generating valuable agri-information. Decision support systems(DSS); concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems for supporting Farm decisions. Preparation of contingent crop-planning using IT tools.

Horticulture

Layout and establishment of orchards; pruning and training; propagation, climatic requirement and cultivation of fruits like mango, banana, citrus, guava, grape, pineapple, papaya, apple, pear, peach and plum; cultivation of plantation crops like coconut and cashew nut and spices like black pepper, coriander,turmeric, important physiological disorders; major vegetable crops of tropical, subtropical and temperate regions 'like cole crops (cauliflower, cabbage and knol khol), cucurbits (pumpkin, bottlegourd, bittergourd, luffa, muskmelon and watermelon, cucumber), root crops (radish, tapioca sweet potato and potato), leafy vegetables (fenugreek and spinach); solanaceous crops (tomato, chillies and brinjal); techniques for raising the nursery; nutritive value of fruits and vegetables and their role in human nutrition; basic physiology of ripening in fruits and vegetables and their products; type of fruits and vegetable products and control of fungal and bacterial diseases; major floricultural crops grown in India for commercial purposes like rose, carnation, chrysanthemum, marigold, tuberose, gladiolus, orchids; establishment and maintenance of lawns, trees, shrubs, creepers, hedges and annuals; type of gardens, methods of crop improvement; male sterility and incompatibility; pure line and pedigree selection; backcross, mass selection; heterosis; plant nutrients, deficiency symptoms of nutrients, manures and fertilisers, systems of irrigation, management of important pests and diseases of fruits and vegetables.

General chemistry of food constituents, physical properties of foods, properties of cottoldal systems, gels and emulsions. Minerals in foods, physicochemical changes in foods during processing and storage, functions of food nutrients, dietary allowances and nutritional requirements. Metabolism of carbohydrates, lipids and protein. Biological value and PER. Food additives, contaminants and anti- nutritional factors. Food flavors and puff- flavors.

National and international food standards, modern analytical techniques in food analysis. Preparation andmanufacturing technology of cereals and bakery products, beef, pork, poultry, fish & sea foods and egg, sausages and table ready meats, dairy products, fresh fruits, fresh vegetables, processed fruits, processed vegetables, Post Harvest Handling and storage of Fruits and Vegetables. Sugars, sweets, fats and oils, fermented foods, alcoholic and non-alcoholic beverages, indigenous foods, fast, readymade and fashion foods. Dehydration and concentration methods, irradiation, microwave and solar processing of foods, food by-products & downstream processing, flavoring and pigment technology. Judging of food products, food plant management and legal aspects, food plant safety, risk and hazards. Effluent treatment and environment pollution, waste solids upgrading and treatment, food storage, functions of packaging, packaging operations, types of containers, FFS, hermetics closures, canning packaging materials and package testing, transportation and marketing food products.

Role of intrinsic and extrinsic properties of food in relation to microbial growth. Microbiology of fruits, fruit products, vegetables, soft drinks, bakery products, milk and milk products, milk, fish, egg and marine produces. Spoilage of foods, food pathogens and their toxins in relation to human health. Food preservation by sugar, salt, chemicals, heat, cold, irradiation, dehydration and packaging. Microbiology of fermented foods and beverages and factors affecting their quality. Methods for microbiological examination of foods, food hygiene and safety regulations. Water quality and waste disposal in food industry.

Agricultural Engineering

Basic concepts of various forms of energy; unit and dimensions of force, energy and power; IC Energies: Basic principles of operation of compression, ignition and spark ignition engines, two strokes and four stroke energies; cooling and lubrication system, power transmission system, broad understanding of performance and efficiency of tractors, power tillers and their types and uses; Tillage: objectives, methods of ploughing; Primary tillage implements: construction and function of mould board ploughs, disc and rotary ploughs; Secondary tillage implements: constructions and function of tillers, harrows, levellers, ridges and bund formers; Sowing and transplanting equipment: seed drills, potato planters, seedling transplanter; Grafting, pruning and training tools and equipments; Inter-cultural equipments: sweep, Junior hoe, weeders, long handle weeders etc.

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16. APPENDIX - III

SYLLABUS FOR BAU ENTRANCE EXAMINATION FOR ADMISSION TO Ph. D. DEGREE PROGRAMME

GENETICS & PLANT BREEDING

Unit 1: General Genetics and Plant Breeding

Mendelian inheritance. Cell structure and division, Linkage, its detection and estimation. Epistasis. Gene concept, allelism and fine structure of gene. Extra chromosomal inheritance. DNA – structure, function, replication and repair. Genetic code. Gene-enzyme relationship. Replication, Transcription and Translation. Gene regulation in prokaryotes and eukaryotes. Nuclear and cytoplasmic genome organization. Spontaneous and induced mutations and their molecular mechanisms. Crop domestication, evolution of crops and centres of diversity. Emergence of scientific plant breeding. Objectives and accomplishments in plant breeding and the role of National and International institutes. Gametogenesis and fertilization. Modes of sexual and asexual reproduction and its relation to plant breeding methodology. Apomixes, incompatibility and male sterility systems and their use in plant breeding.

Unit 2: Economics Botany and Plant Breeding Methods

Origin, distribution, classification, description and botany of cereals (wheat, rice, maize, sorghum, pearl millet, minor millets); pulses (pigeonpea, chickpea, black gram, green gram, cowpea, soyabean, pea, lentil, horse gram, lab-lab, rice bean, winged bean, lathyrus, Lima bean; oilseeds (groundnuts, sesamum, castor, rapeseed mustard, sunflower, Niger, linseed); fibers and sugar crops, fodder and green manures; Breeding methods for self-pollinated, cross-pollinated and clonally propagated crops. Component, recombinational and transgressive breeding. Single seed descent. Populations, their improvement methods and maintenance, Hybrid breeding and genetic basis of heterosis. Ideotype breeding. Mutation breeding, Concept of tree breeding.

Unit 3: Genome Organization and Cytogenetics of Crop Plants

Chromosome structure, function and replication. Recombination and crossing over. Karyotype analysis. Banding techniques. *In situ* hybridization. Special types of chromosomes. Chromosomal interchanges, inversions, duplications and deletions. Polyploids, haploids, aneuploids and their utility. Wide hybridization and chromosomal manipulations for alien gene transfer. Pre-and post-fertilization barriers in wide hybridization. Genome organization and cytogenetics of important crop species- wheat, maize, rice, sorghum, Brassica, cotton, Vigna, potato and sugarcane. Principles and procedures of genome analysis. Cytogenetic techniques foe gene location and gene transfer, Construction and use of molecular marker based chromosome maps. Comparative mapping and genome analysis.

Unit 4: Quantitative and Biometrical Genetics

Quantitative characters. Multiple factors inheritance. Genetic control of polygenic characters. Genetic advance and types of selection and correlated response. Hardy Weinberg law. Linkage

disequilibrium. Genetic load. Polymorphism. Breeding value, heritability. Response to selection, correlated response. Estimates of variance components and covariance among relatives. Mating designs with random and inbred parents. Estimation of gene effects and combing ability. Effects of linkage and epistasis on estimation of genetic parameters. Maternal effects. Genotype-environment interactions and stability of performance. Heterosis and its basis. Mating system and mating design-diallel, line X tester, NC-1, NC- II and NC-III designs, approaches to estimate and exploit component of self and cross pollinated crops. Genotype X environment interaction and stability analysis.

Unit 5: Genetic Engineering and Biotechnological Tools in Plant Breeding

Somatic hybridization, micropropagation, somaclonal variation in vitro mutagenesis. Artificial synthesis of gene. Genetic and molecular markers, generations of molecular markers and their application in genetic analyses and breeding. Molecular markers in genetic diversity analysis and breeding for complex characters. Gene tagging, QTL mapping and marker aided selection. Genome projects and utilization of sequence formation. Vectors. DNA libraries, DNA fingerprinting, DNA sequencing. Nuclei acid hybridization and immunochemical detection. Chromosome walking, Recombinant DNA technology, Gene cloning strategies. Genetic transformation and transgenics. Antisense RNA, RNAi and micro RNA techniques in crop improvement.

Unit 6: Plant Breeding for Stress Resistance and Nutritional Quality

Genetic basis and breeding for resistance to diseases and insect-pests. Breeding for vertical and horizontal resistance to diseases. Genetic and physiological basis of abiotic stress tolerance. Breeding for resistance to heat, frost, flood, drought and soil stresses. Important quality parameters in various crops, their genetic basis and breeding for these traits. Role of molecular markers in stress resistance breeding: MAS, MARS and MABB.

Unit 7: Plant Genetic Resources and their Regulatory System; Varietal Release and Seed Production

Plant exploration, germplasm introduction, exchange, conservation, evaluation and utilization of plant genetic resources. Convention on Biological Diversity and International Treaty on Plant Genetic Resources for Food and Agriculture. Intellectual Property Rights. Biodiversity Act. Plant Variety Protection and Farmers' Rights Act. System of variety release and notification. Types of seeds and seed chain. Seed production and certification.

Unit 8: Statistical Methods and Field Plot Techniques

Frequency distribution. Measures of central tendency, probability theory and its applications in genetics. Probability distribution and tests of significance. Correlation, linear, partial and multiple regression. Genetic divergence. Multivariate analysis. Design of experiments- basic principles, completely randomized design, randomized block design and split plot design. Complete and incomplete block designs. Augmented design, Grid and honeycomb design. Hill plots, unreplicated evaluation. Data collection and interpretation.

PLANT PATHOLOGY

Unit 1: History and Principles of Plant Pathology

Milestones in phytopathology with particular reference to India. Major epidemics and their social impacts. Historical developments of chemicals, legislative, cultural and biological protection measures including classification of plant diseases. Physiologic specialization, Koch's postulates. Growth, reproduction, survival and dispersal of plant pathogens. Factors influencing infection, colonization and development of symptoms.

Unit 2: Laboratory and Analytical Techniques

Preparation and sterilization of common media. Methods of isolation of pathogens and their identification. Preservation of microorganisms in pure culture. Methods of inoculation. Measurement of plant disease. Molecular detection of pathogens in seeds and other planting materials: Nucleic acid probes, Southern, Northern and Western hybridization, ELISA, ISEM and PCR. Laboratory equipment and their use: autoclave, hot air oven, laminar flow, spectrophotometer, electrophoresis, light and electronmicroscopy, incubator, ultracentrifuge, ELISA Reader.

Unit 3: Physiological and Molecular Plant Pathology

Altered metabolism of plants under biotic and abiotic stresses. Molecular mechanisms of pathogenesis: elicitors, recognition phenomenon, penetration, invasion, primary disease determinant. Enzymes and toxins in relation to plant disease. Mechanisms of resistance, Structural and Biochemical defense mechanisms. R-Genes, Phytoanticipins. Phytoalexins. PR proteins, Hydroxyproline rich glycoproteins (HRGP). Antiviral proteins. SAR and ISR. HR and active oxygen radicals. Tissue culture. Somaclonal variation and somatic hybridization. Elementary genetic engineering. Management of pathogens through satellite, antisense - RNA. Ribozymes, coat protein, RNA interference, plantibodies, hypovirulence, cross protection. Useful genes and promoters, plant transformation techniques, biosafety and bioethics.

Unit 4: Mycology

Classification of fungi. Life cycles of important phytopathogenic fungi. Economic mycology, edible fungi and entomogenous fungi. Mycorrhizal associations. Cell organelles, their morphology, functions and chemical composition.

Unit 5: Plant Bacteriology

Identification and classification of bacteria. morphology, ultrastructure and chemical composition of prokaryotic cell in relation to function. Growth curve, nutrition and auxotrophic mutants. Resting cells in prokaryotic, elementary bacterial genetics and variability: transformation, conjugation, transduction. Biology of extra chromosomal elements: plasmid borne genes and their expression: avr, her, vie and pat genes. Bacteriophages: lytic and lysogenic cycles. Prokaryotic inhibitors and their mode of action. Economic uses of prokaryotes. Morphology, biochemical characteristics, reproduction and life cycle of phytoplasma and other fastidious prokaryotes.

Unit 6: Plant Virology

Nature, composition and architecture of viruses and viroids. Properties of viruses. Variability in viruses. Satellite viruses and satellite RNA. Assay of plant viruses including biological, physical, chemical, serological and molecular methods. Conventional and biotechnological techniques used in detection and diagnosis. Behaviour of viruses in plants including infection, replication and movement. Histopathological changes induced by viruses in plants, inclusion bodies. Transmission of viruses: virus -vector relationships. Nomenclature and classification of viruses.

Unit 7: Plant Disease Epidemiology

Concepts in epidemiology. Development of disease in plant population. Monocyclic and polycyclic pathogens. Role of environment and meteorological factors in the development of plant disease epidemics. Survey, surveillance (including through remote sensing), and prediction and forecasting of diseases. Epidemic analysis and prediction models. Crop loss assessment: critical and multiple point models.

Unit 8: Phanerogamic Parasites and Non-parasitic Diseases

Diseases caused by Phanerogamic parasites and their management. Diseases due to unfavourable soil environment, drought and flooding stress etc. Nutritional deficiencies. Primary /secondary air pollutants and acid rain.

Unit 9: Fungal Diseases of Crop Plants

Fungal diseases of cereals, millets, oilseeds, pulses, fruits, vegetables, plantation, fiber, spices and ornamental crops with special reference to etiology, disease cycle, perpetuation, epidemiology and management. Post-harvest diseases in transit and storage; aflatoxins and other mycotoxins and their integrated management.

Unit 10: Bacterial and Viral Diseases of Crop Plants

Crop diseases of cereals, pulses, oilseeds, vegetables, fruits, plantation and fiber crops caused by bacteria, viruses, viroids, phytoplasmas and other fastidious prokaryotes. Mode of transmission and pathogen vector relationships. Epidemiology and management.

Unit 11: Management of Plant diseases

General principles of plant quarantine. Exotic pathogens and pathogens introduced into India. Sanitary and phytosanitary issues under WTO, TRIPS and PRA. Genetic basis of disease resistance and pathogenicity: gene for gene hyphothesis; parasite mediated frequency -dependent selection concept of QTL mapping; breeding for disease resistance. Production of disease free seeds and planting materials. Seed certification. Chemical nature and classification of fungicides and antibiotics: their bioassay and compatibility with other agricultural chemicals; resistance to fungicides/ antibiotics; effect on environment. Spraying and dusting equipments, their care and maintenances. Important cultural practices and their role in disease management, solarization, integrated disease management. Microorganisms antagonistic to plant pathogens in soil, rhizosphere and phyllosphere and their use in the control of plant diseases; soil fungistasis. Plant growth promoting Rhizobacteria. Biotechnology for crop disease management.

AGRICULTURAL ENTOMOLOGY/ENTOMOLOGY

Unit 1: Systematic

History and development of Entomology, Evolution of insects, position of insects in the animal world, characteristics of phylum Arthropoda, structural features of important arthropod groups such as Trilobita, Chelicerata and Mandibulata, structural features of important classes of phylum Arthropoda viz. Arachnida, Crustacea, Chilopoda, Diplopoda and Hexapoda. Classification of insects up to order level, habits, habitats and distinguishing features of different Order and important Families.

Unit 2: Morphology

Body wall, its structure, outgrowths, endoskeleton, Body regions, segmentation, sclerites and sutures, Insect Colors. Head and head appendages, types of mouth parts, antennae, their structure and types. Thorax structure, thoracic appendages and their modification. Wings, their modification and venation, Abdomen; structure, abdominal appendages both in Pterygota and Apterygota. External genitalia, generalstructure and modification in important insect orders.

Unit 3: Embryology, Internal Anatomy and Physiology

Embryonic and post embryonic development, types of metamorphosis, physiology of ecdysis. General features and types of larvae and pupae. Structure, function and physiology of Digestive, Circulatory, Respiratory, Reproductive, Nervous and Excretory systems, Sense Organs; structure and types. Insect food and nutrition; minerals, carbohydrates, proteins and amino acids, lipids, vitamins and their role in growth and development, artificial diets.

Unit 4: Ecology

Concept of ecology, Environment and its components-biotic and abiotic factors and their effects on growth, development, population dynamics, distribution and dispersal. Principle of biogeography and insects biodiversity. Assessment of diversity indices. Biotic potential and environmental resistance. Ecosystems, agroecosystems analysis, their characteristics and functioning. Intra and inter specific relationship; competition, predator-prey and host-parasite interactions, ecological niche. Life table studies, population models. Food chain and food web. Arthropod population monitoring, pest forecasting.Diapause and causes of pest out breaks.

Unit 5: Biological Control

Importance and scope of biological control, history of biological control: Biocontrol agents-parasites, predators and insect pathogens. Important entomophagous insect Orders and Families. Ecological, biological, taxonomic, legal and economic aspects of biological control, phenomena of multiple parasitism, hyperparasitism, superparasitism and their applied importance. Principles and

procedures of using exotic biocontrol agents. Utilization of natural biocontrol agents: conservation, habitat management and augmentation. Mass multiplication techniques and economics. Effective evaluation techniques, Biocontrol organizations in world and India. Successful cases of biological control of pests. Use of biotechnological tools in enhancing the potentials of Bio-Control Agents.

Unit 6: Chemical Control and Toxicology

History, scope and principles of chemical control. Insecticides and their classification. Formulations of insecticides. Susceptibility of insects to the entry of insecticides. Physical, chemical and toxicological properties of different groups of insecticides: chlorinated hydrocarbons, organophosphates, carbamates, synthetic pyrethroids, chlordimeform, chitin synthesis inhibitors, avermectins, nitroguanidines, phenylpyrrozzoles, botanicals (natural pyrethroids, rotenone, neem products, nicotine, pongamia spp.etc). Chloronicotinyl, pyrozole, phenylpyrrozzoles, oxadiazines, benzamidazole, neristoxin, rodenticides, insect hormones, Insecticide induced resurgence. Combination insecticides. Problems of pesticide hazards and environmental pollution. Safe use of pesticides, precautions and first aid treatments. Insecticides Act 1968, registration and quality control of insecticides. Evaluation of toxicity, methods of toxicity testing, determination of LD 50, LT 50, RL 50 etc. Pesticides residues in the environment and their dynamics of movements, methods of residue. Pharmacology of insect poisons. Mode of action of different groups of insecticides; neuroactive (axonal and synaptic) poisons, respiratory poisons, chitin synthesis inhibitors. Metabolism of insecticides; activative and degradative metabolism, detoxification enzymes and their role in metabolism. Selectivity of insecticidal actions; insecticide resistance; mechanism, genetics and management of insecticide resistance.

Unit 7: Host Plant Resistance

Chemical ecology: mechano- and chemoreceptors. Host plant selection by phytophagous insects. Secondary plant substances and their defenses against phytophagous insect. Basis of resistance (Antixenosis, Antobiosis, Tolerance). Biotypes development and its remedial measures. Tritrophic interactions, induced resistance. Breeding for insect resistant plant varieties. Resistance development and evaluation techniques. Genetics of Resistance: vertical resistance, horizontal resistance, oligogenic resistance, polygenic resistance. Biotechnological approaches and development of transgenic insect resistant plants, its advantages and limitations. Case histories. Insect resistance to transgenic plants and its management.

Unit 8: Innovative Approaches in Pest Control

Behavioral control: pheromones-types and uses, advantages and limitations. Hormonal control: types and function of insect hormones, insect hormone mimics, advantages and limitations. chemosterilants, antifeedants, attractants, repellents; their types, method of applications, advantages and limitations. Genetic control: concepts and methods, case histories, advantages and limitations. Potentialities of IPM.

Unit 9: Integrated Pest Management

History, concept and principles of IPM. Components of IPM: Host plant resistance, agronomic manipulations, mechanical and physical methods, chemical methods, biocontrol agents utilization, genetic and behavioral control strategy etc. IPM strategies for field and horticultural crops. IPM case histories. Concept of damage levels- Economic threshold levels (ETL), Economic injury levels (EIL) and their determination. System approach, Agro ecosystem and cropping system vs. IPM. Constraints and Strategies of IPM implementation. Plant quarantine laws and regulations.

Unit 10: Pesticide Application Equipments

Types of appliances: sprayers, dusters, fog generators, smoke generators, soil injecting guns, seed treating drums, flame throwers, etc. Power operated sprayers and dusters. Types of nozzles and their uses. Maintenance of appliances. Aerial application of pesticides, principles of aerial application, factors affecting the effectiveness of aerial application. Equipments for aerial applications. Advantages and disadvantages of aerial application.

Unit 11: Pests of Field Crops and their Management

Distribution, host range, biology and bionomics, nature of damage and management of arthropod pests ofcereals, Oilseed, pulses and fibre crops, sugarcane and tobacco. Polyphagous pests: locusts, termites, hairy catepillars, cut worms and white grubs.

Unit 12: Pests of Horticultural Crops and their Management

Distribution, host range, biology and bionomics, nature of damage and management of arthropod pests of vegetables, fruits and plantation crops, spices, condiments and ornamentals, Vertebrate Pests.

Unit 13: Pests of Stored Products and their Management

Fundamentals of storage of grains and grain products. Storage losses, sources of infestation/infection, factors influencing losses, insect and non-insect pests, their nature of damage and control. Microflora in storage environment and their control. Storage structures, bulk storage and bag storage, their relative efficacy and demerits. Grain drying methods and aeration. Non-insect pests (rodents, birds, mites) of stored products and their control. Regulated and quarantine pests. Integrated management of storage pests.

Unit 14: Arthropod Vectors of Plant Diseases

Common arthropod vectors viz., aphids, leaf hoppers, plant hoppers, whiteflies, thrips, psylids, beetles, weevils, flies, bees and mites and their relationship with the plant pathogenic fungi, bacteria, viruses, mycoplasma. Mechanism of pathogen transmission : Active mechanical

transmission, biological transmission. Toxicogenic insects, mites and phytotoxemia. Some important arthropod vector transmitted diseases and their epidemiology in India. Management of vector and its effect on control of diseases.

Unit 15: Honey Bees and Bee-keeping

Honey bees and their economic importance. Bee species, their behaviour, habit and habitats. Bee Keeping: bee pasturage, hives and equipments, seasonal management. Bee enemies including diseasesand their control.

Unit 16: Silkworms and Sericulture

Silkworm species, their systematic position and salient features. Rearing techniques of mulberry - muga, eri and tassar silkworms. Nutritional requirements of silkworms. Sericulture: rearing house and appliances, silkworm breeds, principles of voltism and nioultism, seed production and its economics. Different molecular approaches in developing silkworm breeds. Silkworm genomics- a model genetic system- transgenic silkworm- production of foreign proteins. Mulberry pests, diseases and their management. By products of sericulture and its value addition, uses in pharmaceutical industry. Enemies and diseases of silkworms and their management. Sericulture organization in India.

Unit 17: Lac Insect

Lac insect, its biology, habit and habitats. Host Trees: pruning, inoculation, lac cropping techniques, and harvesting. Enemies of lac insect and their control.

Unit 18: Other Useful Insects

Pollinators, biocontrol agents of weeds, soil fertility improving agents, scavengers. Use of insects and insect products in medicines. Usefulness of insects in scientific investigations, insects as food.

Unit 19: Statistics and Computer Application

Frequency distribution, mean, mode and median. Standard, normal, bionomial and Poisson's distribution,Sampling methods and standard errors. Correlation and regression: Partial and multiple, tests of significance; t, F, chi- square, Duncan's multiple range tests. Design of experiments: Principles of Randomized block design, Completely randomized block design, Latin square design, Split-plot designs. Probit analysis. Use of software packages like SPSS, SAS, etc. for the above tests and designs of experiments for analysis.

VEGETABLE SCIENCE

Unit 1. Production Technology of Cool Season Vegetable Crops

Introduction, climatic and soil requirement, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of: potato, cole crops: cabbage, cauliflower, knol khol, sprouting broccoli, Brussels sprout, root crops: carrot, radish, turnip, and beetroot, bulb crops: onion and garlic, Peas and beans, leafy vegetables: palak, methi and coriander cool season vegetables.

Unit 2. Production Technology of Warm Season Vegetable Crops

Introduction, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures, economics of crop production and seed production of: Tomato, eggplant, hot and sweet pepper, Okra, cowpea and cluster bean, Cucurbitaceous crops, and sweet potato, amaranths.

Unit 3. Breeding of Vegetable Crops

Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, biotechnology and their use in breeding in vegetable crops - molecular marker, genomics, marker assisted selection and QTLs. Potato and tomato, Eggplant, hot pepper, sweet pepper and okra, Peas and beans, lettuce, gourds, melons, pumpkins and squashes, cabbage, cauliflower, carrot and radish.

Unit 4. Growth and Development

Cellular structures and their functions; definition of growth and development, growth analysis and its importance in vegetable production; Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellilns, cyktokinins and abscisic acid; Application of synthetic hormones, plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production; Role of light, temperature and photoperiod on growth, development of underground parts, flowering and sex expression in vegetable crops; apical dominance; Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening; Plant growth regulators in relation to vegetable production; morphogenesis and tissue culture techniques in vegetable crops. sex expression in cucurbits and checking flower and fruit drops and improving fruit set in Solanaceous vegetables.

Unit 5. Seed Production

Introduction; modes of propagation in vegetables; Seed morphology and development in vegetable seeds; Floral biology of these plant species; classification of vegetable crops based on pollination and reproduction behavior; steps in quality seed production; identification of suitable areas/locations for seed production of these crops; Classification based on growth cycle and pollination behavior; methods of seed production; comparison between different methods e.g. pollination mechanisms; sex types, ratiosand expression and modification of flowering pattern in cucurbits; nursery raising and transplanting stage; Seed production technology of vegetables viz. solanaceous, cucurbitaceous, leguminous, malvaceae, cole crops, leafy vegetables, root, tuber and bulb crops; harvesting/picking stage and seed extraction in fruit vegetables; clonal propagation and multiplication in tuber crops e.g. Potato and sweet potato, seed-plot technique in potato; hybrid seed production technology of vegetable crops, TPS (true potato seed) and its production technique; hybrids in vegetables; maintenance of parental lines; use of male sterility and self-incompatibility in hybrid seed production, importance and present status of vegetable industry.

Unit 6. Systematics of Vegetable Crops

Principles of classification; different methods of classification; salient features of international code of nomenclature of vegetable crops; Origin, history, evolution and distribution of vegetable crops, botanical description of families, genera and species covering various tropical, subtropical and temperate vegetables; Cytological level of various vegetable crops; descriptive keys for important vegetables; Importance of molecular markers in evolution of vegetable crops; molecular markers as an aid incharacterization and taxonomy of vegetable crops.

Unit 7. Production Technology of Underexploited Vegetable Crops

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, planting time and method, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of: Asparagus and leek; Brussels sprout, Chinese cabbage, broccoli and kale; Amaranth, celery, parsley, parsnip, lettuce, rhubarb, spinach, basella and bathu (chenopods); lima bean, winged bean, vegetable pigeon pea and sword bean; Sweet gourd, spine gourd, pointed gourd, little gourd (kundru).

Unit 8. Post-Harvest Technology of Vegetable Crops

Importance and scope of post-harvest management of vegetables; Maturity indices and standards for different vegetables; methods of maturity determinations; biochemistry of maturity and ripening, enzymatic and textural changes, ethylene evolution and ethylene management, respiration, transpiration, regulation methods; Harvesting tools, harvesting practices for specific market requirements; post-harvest physiological and biochemical changes, disorders-chilling injury in vegetables, influence of pre-harvest practices and other factors affecting post-harvest losses, packaging house operations, commodity pretreatments- chemicals, wax coating, prepackaging and

irradiation; packaging of vegetables, post- harvest, diseases and prevention from infestation, principles of transport; Methods and practices of storage-ventilated, refrigerated, MA, CA storage, hypobaric storage, pre-cooling and cold storage, zero energy cool chamber; storage disorders.

Unit 9: Organic Vegetable Production Technology

Importance, principles, prospective, concept and component of organic production of vegetable crops, managing soil fertility, pest, disease and weed problem in organic farming system, crop rotation in organic vegetable production. Method of enhancing soil fertility, mulching, raising green manure crops, indigenous methods of compost, panchgavya, biodynamics preparation, ITKs organic farming. Role of botanicals and bio-control agents. GAP and GMP, opportunity and challenges in organic production of vegetables.

Unit 10: Hi-tech Production Technology of Vegetable Crops

Importance and scope of protected cultivation of vegetable crops, principles used in protected cultivation and greenhouse technology, effect of temperature, carbon dioxide, humidity; energy management, low cost structures, training methods, engineering effects, Use of plastics, structures including low cost poly- house/green houses and other structures in vegetable production. Drip and sprinkler irrigation, fertigation, shading, hydroponics and other production technologies for enhancing productivity and off-season of high value vegetable crops like tomato, capsicum and cucumber.

FRUIT SCIENCE

Unit 1. Tropical and Dry Land Fruit Production

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bio-regulators, abiotic factors limiting fruit production, physiology of flowering, pollination, fruit set and development, honeybees in cross pollination, physiological disorders – causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones (AEZ) and industrial supports.

Crops: Mango, banana, citrus, papaya, guava, sapota, jackfruit, pineapple, annonas, avocado, aonla, ber and minor fruits of tropics.

Unit 2. Subtropical and Temperate Fruit Production

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination, fruit set

and development, honeybees in cross pollination, physiological disorders – causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones (AEZ) and industrial supports.

Crops: Apple, pear, quince, grapes, plums, peach, apricot, cherries, litchi, loquat, persimmon, kiwifruit, strawberry, walnut, almond, pistachio, hazelnut, mangosteen, carambola, bael, wood apple, fig, jamun, rambutan and pomegranate.

Unit 3. Biodiversity and Conservation

Biodiversity and conservation; issues and goals, centres of origin of cultivated fruits; primary and secondary centres of genetic diversity; present status of gene centres; exploration and collection of germplasm; conservation of genetic resources – conservation *in situ* and *ex situ.* Germplasm conservation– problem of recalcitrancy – cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine; intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group; GIS and documentation of local biodiversity, geographical indication.

Crops: Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard apple, ber, aonla, Malus &*Prunus* sp., litchi and nuts.

Unit 4. Canopy Management in Fruit Crops

Canopy management – importance and advantages; factors affecting canopy development; Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies; Spacing and utilization of land area – canopy classification; Canopy management through rootstock and scion; Canopy management through plant growth inhibitors, training and pruning and management practices; Canopy development and management in relation to growth, flowering, fruiting and fruit quality in temperate fruits, grapes, mango, sapota, guava, citrus and ber.

Unit 5. Breeding of Fruit Crops

Origin and distribution, taxonomical status – species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideo types, approaches for crop improvement – introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.

Crops: Mango, banana, pineapple, citrus, grapes, guava, sapota, jackfruit, papaya, custard apple, aonla, avocado, ber, litchi, jamun, phalsa, mulberry, raspberry, apple, pear, plums, peach, apricot, cherries and strawberry.

Unit 6. Post-harvest Management

Maturity indices, harvesting practices and grading for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, transpiration; Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-

harvest loss, pre-cooling; Treatment prior to shipment, viz., chlorination, waxing, chemicals, bio-control agents and natural plant products, fungicides, hot water, vapour heat treatment, sulphur fumigation and irradiation. Methods of storage – ventilated, refrigerated, MAS, CA storage, physical injuries and disorders; Packing methods and transport, quality evaluation, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies; Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

Unit 7. Growth and Development

Definition, parameters of growth and development, growth dynamics, morphogenesis; Annual, semi- perennial and perennial horticultural crops, environmental impact on growth and development, effect of light, photosynthesis and photoperiodism, vernalisation, effect of temperature, heat units, thermoperiodism; Assimilate partitioning during growth and development, influence of water and mineral nutrition during growth and development, biosynthesis of auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids, growth inhibitors, morphactins, role of plant growth promoters and inhibitors, developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development; Growth and developmental process during stress – manipulation of growth and development, impact of pruning and training, chemical manipulations in horticultural crops, molecular and genetic approaches in plant growth development.

Unit 8. Biotechnology of Fruit Crops

Harnessing bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture; Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis; Use of bioreactors and *in vitro* methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, *ex vitro*, establishment of tissue cultured plants; Physiology of hardening – hardening and field transfer, organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion; Construction and identification of somatic hybrids and cybrids, wide hybridization, *in vitro* pollination and fertilization, haploids, *in vitro* mutation, artificialseeds, cryopreservation, rapid clonal propagation, genetic engineering and transformation in horticulture crops, use of molecular markers. *In vitro* selection for biotic and abiotic stress, achievements of biotechnology in horticultural crops.

Unit 9. Protected Fruit Culture

Greenhouse – world scenario, Indian situation; present and future, different agro-climatic zones in India, environmental factors and their effects on plant growth; Basics of greenhouse design, different types of structures – glasshouse, shade net, poly tunnels – Design and development of low cost greenhouse structures; Interaction of light, temperature, humidity, CO_2, water on crop regulation – Greenhouse heating, cooling, ventilation and shading; Types of ventilation – Forced cooling techniques – Glazing materials – Micro irrigation and Fertigation; Automated greenhouses, microcontrollers, waste water recycling, management of pest and diseases - IPM.

Unit 10. Principles and Practices of Plant Propagation

Introduction, life cycle in plants, cellular basis for propagation. Sexual propagation – apomixis, polyembryony, chimeras. Factors influencing seed germination, hormonal regulation of germination and seedling growth. Seed quality, treatment, packing, storage, certification and testing. Rooting of cuttings under mist and hot beds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Selection of elite mother plants. Establishment of bud wood bank. Stock, scion and interstock relationship and incompatibility. Physiology of dwarfing rootstocks. Rejuvenation, progeny orchard and scion bank. Micropropagation ---- in vitro clonal propagation, direct organogenesis, embryogenesis, micrografting and meristem culture. Hardening, packing and transport of micro-propagules.

AGRONOMY

Unit 1 : Crop Ecology and Geography

Principles of crop ecology; Ecosystem concept and determinants of productivity of ecosystem; Physiological limits of crop yield and variability in relation to ecological optima; Crop adaptation; Climate shift and its ecological implication; Greenhouse effect; Agro-ecological and agro climatic regions of lndia; Geographical distribution of cereals, legumes, oilseeds, vegetables, fodders and forages, commercial crops, condiments and spices, medicinal and aromatic plants; Adverse climatic factors and crop productivity; Photosynthesis, respiration, net assimilation, solar energy conversion efficiency and relative water content, light intensity, water and CO2 in relation to photosynthetic rates and efficiency; Physiological stress in crops; Remote sensing: Spectral indices and their application in agriculture, crop water stress indices and crop stress detection.

Unit 2 : Weed Management

Scope and principles of weed management; Weeds' classification, biology, ecology and allelopathy; Crop weed competition, weed threshold; Herbicides classification, formulations, mode of action, selectivity and resistance; Persistence of herbicides in soils and plants; Application methods and equipment; Cultural, physical, mechanical weed control, Biological weed control, bio-herbicides: Integrated weed management; Special weeds, parasitic and aquatic weeds and their management in cropped and non-cropped lands; weed control schedules in field crops, vegetables and plantation crops; Role of GM crops in weed management.

Unit 3 : Soil Fertility and Fertilizer Use

History of soil fertility and fertilizer use; Concept of essentiality of plant nutrients, their critical concentrations in plants, nutrient interactions, diagnostic techniques with special emphasis on emerging deficiencies of secondary and micro-nutrients; Soil fertility and productivity and their indicators; Fertilizer materials including liquid fertilizers, their composition, mineralization, availability and reaction products in soils; Water solubility of phosphate fertilizers; Slow release fertilizers, nitrification inhibitors and their use for crop production; Principles and methods of

fertilizer application including fertigation; Integrated nutrient management and bio-fertilizers; Agronomic and physiological efficiency and recovery of applied plant nutrients; Criteria for determining fertilizer schedules for cropping systems direct, residual and cumulative effects; Fertilizer related environmental problems including ground water pollution; Site-specific nutrient management; Contamination of heavy metals in peri-urban soils and theirremediation.

Unit 4 : Dryland Agronomy

Concept of dryland farming; dryland farming vs rainfed farming; History, development, significance and constraints of dryland agriculture in India; Climatic classification and delineation of dryland tracts; Characterization of agro-climatic environments of drylands; Rainfall analysis and length of growing season; Types of drought, drought syndrome, effect on plant growth, drought resistance, drought avoidance, drought management; Crop Planning including contingency, crop diversification, varieties, cropping systems, conservation cropping and mid-season corrections for aberrant weather conditions; Techniques of moisture conservation in-situ to reduce evapotranspiration, runoff and to increase infiltration; Rain water harvesting and recycling concept, techniques and practices; Timelines and precision key factors for timely sowing, precision in seeding, weed control; Fertilizer placement, top dressing and foliar application, aqua-fertigation; Concept and importance of watershed management in dryland areas.

Unit 5 : Crop Production in Problem Soils

Problem soils and their distribution in India, acid, saline, waterlogged and mined - soils; Response of crop to acidity, salinity, sodicity, excess water and nutrient imbalances; Reclamation of problem soils, role of amendments and drainage; Crop production techniques in problem soils - crops, varieties, cropping system and agronomic practices; Effects of water table fluctuation on crop growth; Degraded lands and their rehabilitation.

Unit 6 : Crop Production

Crop production techniques for cereals, millets, legumes, oilseeds, fiber crops, sugarcane, tobacco, fodder and pasture crops including origin, history, distribution, adaptation, climate, soil, season, modern varieties, Seed rate, fertilizer requirements, crop geometry, intercultural operations, water requirement. weed control, harvest, quality components, industrial use, economics and post-harvest technology.

Unit 7 : Agricultural Statistics

Frequency distribution, standard error and deviation, correlation and regression analyses, co-efficient of variation; Tests of significance-t, F and chi-square (X2); Data transformation and missing plot techniques; Design of experiments and their basic principles, completely randomized, randomized block, split plot, strip-plot, factorial and simple confounding designs; Efficiency of designs; Methods of statistical analysis for cropping systems including intercropping; Pooled analysis.

Unit 8 : Sustainable Land Use Systems

Concept of sustainability; Sustainability parameters and indicators; Conservation agriculture; Alternate land use systems; Types, extent and causes of wasteland; Shifting cultivation; Agro forestry systems; Agricultural and agro-industrial residues and its recycling, safe disposal; Allelopathy and biomass production.

Unit 9 : Basics of Soil and Water

Soil and water as vital resources for agricultural production; Occurrence of groundwater, groundwater aquifers, exploration of groundwater; Hydrological cycle; Soil-plant water relationship; Fate of rain waterreceived at the soil surface, runoff and infiltration reciprocity, factors affecting infiltration, means to enhance infilterability of soil, mechanical and biological means to reduce runoff and soil loss; Water harvesting for crop lifesaving irrigations; watershed management; Soil and water conservation; Contingent crop plans and other strategies for aberrant weather conditions; Cropping patterns, alternate land use and crop diversification in rainfed areas; Analysis of hydrologic data and their use.

Unit 10 : Soil Water Relationship

Soil water relations, water retention by soil, soil moisture characteristics, field capacity, permanent wilting point, plant available water and extractable water; Soil irrigability, classifications, factors affecting profile water storage; Determination of soil water content, computation of soil water depletion, soil water potential and its components, hydraulic head; Movement of soil water saturated and unsaturated water flow; Field water budget, water gains and water losses from soil, deep percolation beyond root zone, capillary rise; Evapotranspiration (ET), scope for economizing water, measures for reducing direct evaporation from soil and crop canopies; Soil physical properties in relation to plant growth and development; Erodability of soils and their prevention.

Unit 11 : Plant Water Relationship

Plant water relations: Concept of plant water potential, cell water relations, plant water potential and its components; Significance of osmotic adjustment, leaf diffusive resistance, canopy temperature, canopy temperature depression (CTD); Water movement through soil - plant atmosphere systems, uptake and transport of water by roots; Development of crop water deficit, crop adaptation to water deficit, morpho- physiological effect of water deficit; Drought tolerance, mechanisms of drought tolerance, potential drought tolerance traits and their measurements. management and breeding strategies to improve crop productivity under different patterns of drought situations of limited water supplies; Effect of excess water on plant growth and production; Types of droughts, drought indices.

Unit 12 : Irrigation Water Management

Management of irrigation water; History of irrigation in India; Major irrigation projects in India; Water resources development; Crop water requirements; Concepts of irrigation scheduling, Different approaches of irrigation scheduling; Soil water depletion plant indices and climatic parameters; Concept of critical stages of crop growth in relation to water supplies; Crop modeling, crop coefficients, water production functions; Methods of irrigation *viz.* surface methods, overhead methods, drip irrigation and air conditioning irrigation, merits and demerits of various methods, design and evaluation of irrigation methods; Measurement of irrigation water, application and distribution efficiencies; Management of water resources (rain, canal and ground water) for agricultural production; Agronomic considerations in tile-design and operation of irrigation projects, characteristics of irrigation and family systems affecting irrigation management; irrigation legislation; Water quality, conjunctive use of water, irrigation strategies under different situation of water availability, optimum crop plans and cropping patterns in canal command areas; Socio-economic aspects of on-farm water management; Irrigation water distribution, Estimation of ET by direct and indirect methods, Irrigation efficiencies; Design of irrigation canals, design of irrigation structures; Interaction between irrigation and fertilizers.

Unit 13 : Management of Problematic Soils and Water

Problem soils and their distribution in India; Salt-affected, acidic, water logged soils; Ground water resources, water quality criteria and use of brackish waters in agriculture; Excess salt and salt tolerant crops; Hydrological imbalances and their corrective measures; Concept of critical water table depths for crop growth; Contribution of shallow water table to crop water requirements; Management strategies for flood prone areas crop and crop calendar for flood affected areas; Drainage for improving water logged soils for crop production; Crop production and alternate use of problematic soils and poor quality water for agricultural and fish production; Amelioration of salt affected soils.

OIL SCIENCES/SOIL SCIENCE & AGRICULTURAL CHEMISTRY

Unit 1: Pedology

Concept of land, soil and soil science. Composition of earth crust and its relationship with soils; Rocks, minerals and other soil forming materials; Weathering of rocks and minerals; Factors of soil formation; Pedogenic processes and their relationships with soil properties; Soil development; Pedon, polypedon, soil profile, horizons and their nomenclature. Soil Taxonomy - epipedons, diagnostic subsurface horizons and other diagnostic characteristics, soil moisture and temperature regimes, categories of the system and their criteria; Interpretation of soil survey data for land capability and crop suitability classifications, Macro-morphological study of soils, Application and use of global positioning system for soil survey. Soil survey- types, techniques. Soil series-characterization and procedure for establishing soil series, benchmark soils and soil correlations. Study of base maps: cadastral maps, toposheets, aerial photographs and satellite imageries. Use of geographical information system for preparing thematic maps. Application of Remote Sensing in soil survey and mapping.

Unit 2: Soil Physics

Soil physical constraints affecting crop production. Soil texture – textural classes. Soil structure – classification, soil aggregation and significance, soil consistency, soil crusting, bulk density and particle density of soils and porosity, their significance and manipulation. Soil water- retention and potentials. Soil moisture constants. Movement of soil water - infiltration, percolation, permeability, drainage and methods of determination of soil moisture. Darcy's law. Thermal properties of soils, soil temperature, Soil air- composition, gaseous exchange, influence of soil temperature and air on plant growth. Soil erosion by water- types, effects, mechanics. Rain erosivity and soil erodibility. Runoff - methods of measurement, factors and management, runoff farming. Soil conservation measures.

Characterization and evaluation of soil and land quality indicators; Causes of land degradation; Management of soil physical properties for prevention/restoration of land degradation; Identification, monitoring and management of waste lands; Land use-land cover mapping and land use planning using conventional and remote sensing techniques; Concept of watershed – its characterization and management.

Unit 3: Soil Chemistry

Chemical composition of soil; Soil colloids - structure, composition, constitution of clay minerals, amorphous clays and other non-crystalline silicate minerals, oxide and hydroxide minerals; Charge development on clays and organic matter; pH-charge relations; Buffer capacity of soils.

Elements of equilibrium thermodynamics, chemical equilibria , electrochemistry and chemical kinetics. Inorganic and organic colloids- surface charge characteristics, diffuse double layer theories, zeta potential stability, coagulation/ flocculation, peptization, electrometric and sorption properties of soil colloid. Soil organic matter-fractionation, clay-organic interactions. Cation exchange- theories, adsorption isotherms, Donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, anion and ligand exchange- inner sphere and outer-sphere surface complex formation, fixation of oxyanions , hysteresis in sorption-desorption of oxy-anions and anions. Nitrogen, potassium, phosphate and ammonium fixation in soils and management aspects. Chemistry of acid, salt-affected and submerged soils and management aspects.

Unit 4: Soil Fertility

Essential elements in plant nutrition; Nutrient cycles in soil; Transformation and transport of nutrients (Macro and micro nutrients) in soil; Manures and fertilizers; Fate and reactions of fertilizers in soils; Chemistry of production of different fertilizers; Slow release fertilizers and nitrification retarders; Qualitycontrol of fertilizers.

Soil fertility evaluation – soil testing, plant and tissue tests and biological methods; Common soil test methods for fertilizer recommendation; Soil test-crop response correlations; Integrated nutrient management; Use of isotopic tracers in soil research; Nature, properties and development of acid, acid sulphate, saline and alkali and their management; Lime and gypsum requirements of soils; Irrigation water quality - EC, SAR, RSC and specifications. Fertility status of major soil

groups of India. Application of Remote Sensing in Soil fertility mapping, Watershed management, Degraded land and soilerosion studies. Remote sensing and GIS in Carbon sequestration studies.
Pollution: types, causes, methods of measurement, standards and management. Heavy metal toxicity and soil pollution; Chemical and bio-remediation of contaminated soils; Soil factors in emission of greenhouse gases; Carbon sequestration in mitigating greenhouse effect; Radio-active contamination of soil.

Unit 5: Soil Microbiology

Soil biota, soil microbial ecology, types of organisms. Soil microbial biomass, microbial interactions, unculturable soil biota. Microbiology and biochemistry of root-soil interface. Phyllosphere. Soil enzymes, origin, activities and importance. Soil characteristics influencing growth and activity of microflora. Microbial transformations of N, P, K, S, Fe and Zn in soil. Biochemical composition and biodegradation of soil organic matter and crop residues. Humus formation. Cycles of important organic nutrients. Biodegradation of pesticides, organic wastes and their use for production of biogas and manures. Biofertilizers – definition, classification, specifications, method of production and role in crop production.
Methods of soil analysis - particle size distribution, bulk and particle density, moisture constants, Modern methods of soil, plant and fertilizer analysis; Flame photometry and inductively coupled plasma optical emission spectroscopy; Spectrophotometry - visible, ultra-violet and infrared; Atomic absorption spectrophotometry; Potentiometry and conductimetry; X-ray diffractometry; Mass spectrometry.

Unit 6: Statistics

Experimental designs for pot culture and field experiments; Statistical measures of central tendency and dispersion; Correlation and regression; Tests of significance - t and F tests; Computer use in soil research,Geostatistics.

AGRICULTURAL ECONOMICS

Unit 1: Economic Theory

Scope and methods of economics and agricultural economics, Characteristics of modern production, Problems of application of economic theory of agriculture. Production and consumption units and their peculiarities, Basic economics concepts - statistics. Comparative statics and dynamics equilibrium. Comparative economic systems, Development of economic theory and models. Themes of consumer behaviour -marginal utility, indifference curve (IC) and other models of utility maximization. Price and income consumption curves, Engel curves Elasticity of demand-substitution and income effects, Application of IC analysis -rationing, taxation and subsidy. Theory of production and cost optimizing behaviour of firm, output maximization, cost minimization and profit maximization. Elasticity of supply- substitution, output and profit maximization and profit maximization. Elasticity of supply-substitution, output and profit maximization effects. Optimally approach for joint products. Market classification-pure and perfect competition. Behaviour of the firm and industry. Supply-demand functions. Imperfect competition, monopolistic competition,

monopoly, duopoly. Pricing and output decisions. Pricing and output decisions. Price discrimination. Product differentiation applications. Micro and macroeconomic analysis. Working of macro-economic systems. National income accounting. Theory of employment- classical. Keynesian and post Keynesian theories of income determination. Optimal saving and investments. Theory of income distribution and factor shares inflation, deflation, inflationary gap, monetary policy and banking systems**.**

Unit 2: Economic and Agricultural Development

Concept of economic and agricultural development, characteristics of developing countries, dualism and development, stages and theories of economic development, economic growth models, neo-classical growth models, role of technology in development and choice of techniques, human capital and development, inequality, poverty and migration in developing countries, trade and development, capital and growth, development challenges in developing countries, role of state, markets and civil society in development, institutions and economic development, international development institutions. Objective and processes for economic planning in India, economic and trade reforms in India.

Role of agriculture in economic development, theories of agricultural development, agricultural development challenges, planning and techniques for agricultural development, agricultural development, poverty and environment, application of institutional economics in agricultural development, institutional issues in natural resource management, agricultural policies (price, land, credit, R&D, trade, subsidy, etc.), role of innovations, investment and institutions in agricultural development, agricultural development programmes in India, issues of water, energy, environment, food and nutrition security, agro-eco -regional planning, assessment of ecosystem services, farm-non-farm linkages. Agricultural development in India, China, Latin America and East Asian countries.

Unit 3: Public Finance and International Economics

Public Finance: Public and private finance. General principles of public finance. Principle of maximum social advantage. Public revenue. Incidence of tax and financial policies. Public expenditure and economic development. Balanced and unbalanced budgets. Limitations of fiscal policies. Fiscal policy as an instrument of development. Structure of development taxation. Public debt policy and economic development, international Economics: Principle of comparative advantage. Factor endowment theory, Balance of payments. Problems of international monetary systems, Foreign trade and foreign capital. Export promotion and input substitution. Past experiences and future strategies.

Unit 4: Farm Management Economics

Definition of farm management and its relationship to technical and social sciences. Characteristics of modern farming. Role and functions of farm management under Indian condition. Measurement of management. Measures of farm efficiency. Cost concepts. Evaluation of farm assets and liabilities. Decision theory and decision making models. Decision making under different knowledge situations. Tools and techniques in farm decision making. Farm planning and budgeting-sources of data and illustration. Linear programming. Problem formulation in farm planning. Farm

records and accounts. Farm inventory with applications to farming enterprises. Farm cost accounting for managerial analysis. Management of farm resources-land, labour, capital and machinery. Review of farm management research, education and extension in relation to changing needs. Systems approach in agriculture. Farming systems, identification of farming system inputs and outputs, sub-systems and the circuitry connecting these systems. Systems analysis to find out needed changes in policies and programmes.

Unit 5: Agricultural Production Economics

Nature and scope of agricultural production economics vis-à-vis farm management. Relative importance of farm production economics and farm management in developed and developing countries. Economics of farm production- resource allocation and use under static and dynamic conditions. Resource — product relationships in agriculture. Types of production functions. General rules of their economics application. Technological change and production function analysis. Principles of choice and allocation of resources. Resource combination and cost minimization. Types of risk in agriculture, resource allocation and enterprise combination under risk and risk diffusion mechanisms. Nature of costs and family farm theory. Returns to scale and farm size. Derivation of cost and supply functions.

Unit 6: Agricultural Finance and Co-operation

Role of credit in agriculture and rural development. Estimates of agricultural credit requirements-investment, production, marketing and consumption. Role of public and private section banks and cooperatives in development financing. Classification of agricultural credit. Rural credit structure. Principles of agricultural finance and financial management. Agricultural finance as a part of public finance. Agricultural taxation and subsidies, capital in agriculture and sources of capital. Credit and saving -legal aspects of credit. Credit instruments. Farm planning as a basis for extension of agriculture credit. Nexus between commercial banks and cooperative credit institutions. Recent innovations in extension of credit to agriculture. Rural credit supply and credit gap. Multiagency approach and coordination of credit structure at different levels. Agriculture credit policy. Principles and practices of cooperation. Success and failure of cooperative sector in India. Credit and non-credit institutions. National federations of cooperative organizations. Review of reforms in cooperative structure. Single window approach in agricultural input supply and output marketing. Bureaucracy and cooperatives. Management of cooperative institutions. Professionalization and revitalization of cooperatives. Role of cooperatives under new economic policy.

Unit 7: Agricultural Marketing

Nature and scope of marketing in a developing economy. Classification of markets. Problems of marketing agricultural produce. Functions of marketing. Marketable surplus and marketed surplus. Channels of marketing agricultural produce and price spread. Marketing institutions, their role and functions. Regulated markets and other state interventions in agricultural marketing. Role of commission on agriculture cost and prices and parastatal organizations in agricultural marketing. Cooperative marketing. Marketing practices and cost-marketing of grains, pulses, commercial crops, fruits, vegetables, livestock and livestock products and inputs. Processing, transportation,

storage and warehousing, equity aspects of marketing. Marketing efficiency. Marketing finance-methods and practices. Forward trading and speculation. Future markets. Market management. Agricultural price analysis. Seasonal and spatial variations in prices in agricultural price policy. Agricultural exports, problems and prospects.

Unit 8: Agricultural Project Analysis

Definition of project in agriculture. Need for project approach for agricultural development. Project cycle. Project identification and formulation. Project appraisal-ex-ante and ex-post. Projection worth measures-discounting techniques. Project monitoring and mid-course corrections. Project funding.

Unit 9: Research Methodology and Econometrics

Agricultural economics research, steps and themes, collection and analysis of economic data, scientific report writing. Optimization, econometric and statistical methods, differential and integral calculus; sampling methods, probability theory. Multiple regression analysis, ordinary and generalized least squares estimators, multicollinearity, heteroscedasticity, autocorrection, dummy variable. Simultaneous equation methods.

AGRICULTURAL EXTENSION/EXTENSION EDUCATION

Unit 1: Fundamentals of Extension and Communication

Concepts and scope of extension and communication particularly for primary and secondary agriculture. Historical and emerging perspectives of agricultural, veterinary and animal husbandry extension education in India and other countries. Community Development and Integrated Rural Development- concept, principles and objectives. Role of agricultural extension in different sectors of agriculture and rural development. Agricultural Extension in the context of enhancing productivity, Quality, Nutrition, post-harvest technology, product processing, Profitability, Income and Employment. Concepts of yield gaps. FLD and OFT in relation to TOT programmes. Farming System Research and Extension (FSR&E) and participatory development approaches. Concept and modules of communication, credibility, fidelity, empathy and feedback in communication. Similarities and dissimilarities among extension education, adult education and continuing/distance education. Andragogy and theories of adult learning. Human behavioural dimensions and gender sensitivity in extension education programmes. Meaning and characteristics of attitude, factors affecting attitude change; Understanding of basic rural institutions, social structure, culture and norms. Social and technological change processes, group dynamics, concepts and theories of rural leadership. Group and mass communication, Interpersonal and Intrapersonal Communication Skills, Key communicators and their role in agriculture and animal husbandry development. Acquiring communication skills for development of local leaders and key communicators for agriculture and livestock development. Organizational communication. Rapport building with clientele. Problems and barriers in communication; distortion and noise in communication. Importance of feedback in agriculture and veterinary extension, impact analysis of extension programmes.

Unit 2: Extension Methods & Farm Journalism

Concepts of teaching and learning processes–principles of learning as applied to agricultural extension. Individual, group and mass approaches in extension, audio-visual aids- classification, selection, use and production. Traditional media for communication in development programmes. Modularized communication- concept, approach, need, process of designing instruction for transfer of communication. Basics of agricultural journalism, types of publications – bulletins, folders, leaflets, booklets, newsletters,popular and scientific articles. Selection, planning and use of different extension teaching methods like demonstration, exhibition, farmers fairs, field days, tours, extension literature, etc. Preparation andpresentation of different projected and non-projected audio-visual aids. Public speaking. Preparation of radio/*vide*o script. Principles of photography and its use in extension.

Unit 3: Information Communication Technologies (ICT)

Concept of ICT and its role in agriculture and rural development. ICT tools- print and electronic media, e-mail, Internet, use of multimedia, use of mobile phony, *vide*o and teleconferencing, computer-assisted instructions, touch screens, micro-computers, web technologies and information kiosks. Networking system of information and challenges in the use of ICT. E-learning, information resources, sharing and networking. Types of network – PAN, LAN, WAN, Internet, AGRINET, AKIS, Indian National Agricultural Research database. ICT programmes in agriculture and livestock development, Problemsand prospects of ICTs in agriculture and livestock development, Digitization, Simulation models, Utilization of Internet for promoting advanced agriculture, veterinary and animal husbandry practices; communication with farmers and rural, semi-urban and urban livestock owners.

Unit 4: Training & Human Resource Development

Human resources and their importance in agricultural development. Concept of human resource management. Training and development of human resources. Identifying training needs and assessment of training impact. Training – principles, importance, methods and factors. Phases of training - pre training and post training. Developing training modules, training requirements, training methods. Lecture cum demonstration method, case method, group brain storming, syndicate method, business games, simulation exercises, in basket exercise, programmed instruction, experiential learning techniques such as sensitivity training, T-group, transactional analysis and fish bowl exercise. Evaluation of training - types and techniques of training evaluation. Motivation, stress management and organizational behaviour as facilitators of human resource development. Capacity Building in relation to agriculture, Dairying, Poultry, Piggery, Goat and Sheep farming, cottage industries, Rabbit farming, Apiculture, Sericulture, Biofertilizer, Floriculture, and Biopesticides.

Unit 5: Research Methodology in Extension Education

Social research- concept, principles and approach. Selection and identification of research problems, methods of data collection- interview method and mailed questionnaires, variables - meaning and types, independent, dependent and intervening variables. Hypothesis – concept, characteristics, types and testing. MAXMINCON principle, Research design - concept and types, field studies, case studies and survey method. Measurement – meaning and levels. Methods of sampling and statistical tests. Reliability and validity of tests, normal distribution, tests of significance, ANOVA, correlation and regression, scaling techniques. Processing of data, coding - tabulation. Analysis and interpretation. Writing scientific reports, citing references. Participatory approaches, PRA, RRA, PLA and PTD.

Unit 6: Programme Planning, Evaluation & Diffusion and Adoption of Innovations

Concept, steps, principles and theories of programme planning. Steps in programme planning for agriculture and livestock development, organizing campaigns, mass vaccination programmes and variety of extension activities, evaluation of veterinary extension programmes, compilation and report writing. Evaluation of agriculture and animal husbandry development programmes and schemes. Monitoring and evaluation – concept, significance, types, methods and tools. Theoretical models of programme planning. Felt needs; need-based programmes. Social action. Five Year Plans – critical analysis with special reference to programmes for women, children and youth. SWOT/TOWS analysis of development programmes. Concept and elements of diffusion and adoption for social change. Diffusion process, adoption process, models of diffusion and adoption, adopter categories and their characteristics. Factors influencing adoption and attributes of innovations. Concept and stages of Innovation-decision process, consequences of innovations.

Unit 7: Extension Management

Concept and principles of administration and management, classical and modern theories, schools of management thought. Functions of management – planning, organizing, staffing, directing and leading, controlling, coordinating, reporting and budgeting. Types and methods of administrative communication. Decision-making in organization. Organizational effectiveness, organizational climate, organizational behaviour, organizational development, job satisfaction and morale. Time management. Performance appraisal. Coordination at different levels of extension management, methods of coordination. Management by Objective (MBO) and Total Quality Management (TQM). Project Evaluation and Review Technique (PERT). Logical Frame Working (LFW) and Project Management Techniques. Personal management, scope of Agribusiness Management and Institutions - National Institute of Agricultural Extension and Management (MANAGE). Indian Institute of Plantation Management (IIPM), NIRD, EEl and NAARM. Monitoring, evaluation and impact analysis of extension programmes. Critical analysis of organizational set up of extension administration at various levels. Agricultural Technology Information Centers (ATIC). Technology Parks. Management Information System. Management of Agricultural Knowledge System (MAKS) and use of Expert System. Traditional media for communication in development programmes. Problem Solving Techniques / Negotiation , Motivational Theories & Techniques, Work motivation

Organizational climate; Resource management: concept and methods; Team building: process and strategies at organizational and village levels. Mobilization and empowerment skills: concept and strategies in mobilization, concretisation and empowerment of rural people.

Unit 8: Entrepreneurial Development

Concept, significance and scope. Programmes and agencies promoting entrepreneurship. Types and techniques of training for developing entrepreneurial activities in various areas. Self Help Groups – concepts, organization, mobilization, micro-finance and functioning of SHG for empowerment and sustainability. Agripreneurship- agriclinics and agribusiness centers. International cooperation in agriculture - SAIC, Commonwealth, FAO, USAID, DFID and CGIAR system. Critical analysis of extension systems of SAARC, BRICS and other selected countries (USA, UK, Japan, Philippines, Israel etc.).

Unit 9: Developmental Strategies and Issues in Extension

Extension policies. National Agricultural Extension System and Networking of State development Departments, NARS, NGOs, Farmers Organizations, producers companies, agricultural cooperatives, rural banks, insurance and private sectors. History of Agriculture and Veterinary extension programmes- NPCBB, PM assistance livestock development programmes and rural development programmes. Developmental strategies such as Watershed Development Programmes; Technology Mission, Horticulture Mission. Front Line Extension Programmes of ICAR/TAR-IVLP, NATP, NAIP, IRDP, ATMA, ITD, SREP, Research-Extension-Farmer-Interface. Identification, characterization, documentation and validation of ITKs. Privatization of extension, market led extension, production to consumption and end to end innovative approaches. Issues related to globalization and IPR. Rural, Agricultural, Animal Husbandry, Dairy and Women Developmental Programmes implemented by Govt. of India. Krishi Vigyan Kendras (KVKs).

Unit 10: Gender Sensitization and Empowerment

Gender and empowerment: meaning, gender related definitions and importance for empowering women; need and focus on gender sensitization, gender in community diversity and its implication for empowerment. Gender perspectives in development of women, social characteristics, roles, responsibilities, resources, constraints, legal issues and opportunities; economical, educational and other parameters. Gender tools and methodologies: Dimensions and methodologies for empowerment; gender budgeting; gender analysis framework- context, activities, resources and programme action profile; technologies and empowerment - gender specific technologies, household technology interface, socio- cultural interface and women as consumer of technologies. Gender issues and development: health and nutrition, violence, governance, education and media, Gender Audit.

AGRICULTURAL STATISTICS

Unit 1: Statistical Methods I

Descriptive statistics. Elements of probability theory, conditional probability, Bayes' theorem. Random variable-discrete and continuous. Mathematical expectation. Moment generating and characteristic functions. Laws of large numbers. Central limit theorem. Discrete probability distributions: binomial, Poisson, negative binomial, geometric, multinomial and hypergeometric. Continuous probability distributions: normal, rectangular, Cauchy, exponential, gamma and beta. Sampling distributions: chi-square, t, and F. Bivariate normal distribution: conditional and marginal. Point estimation: unbiasedness, consistency, efficiency, sufficiency. Completeness. Minimum variance unbiased estimator. Cramer-Rao Inequality. Rao-Blackwell theorem and Lehman- Scheffe theorem. Methods of point estimation like Maximum likelihood, Moments, Minimum chi-square. Confidence interval estimation. Testing of hypotheses - two types of errors, level of significance and power of a test. Neyman-Pearson Lemma. Uniformly most powerful tests and their construction. Unbiased test, Likelihood ratio test. Tests of significance based on Z, t, chi-square and F distributions.

Unit 2: Statistical Methods

Correlation, rank correlation, correlation ratio, intra-class correlation. Simple and multiple regression analysis, partial and multiple correlation. Examination of residuals. Model-adequacy, Selecting best regression. Compound and truncated distribution, Order statistics. Non-parametric tests: run, sign, rank, Wilcoxon, Kruskal-Wallis, Mann-Whitney, Cochran and Friedman's tests. Contingency tables. Log linear models. Sequential analysis, sequential probability ratio test. Components of time series. Multivariate normal distribution: estimation of mean vector anddispersion matrix. Wishart distribution, Hotelling T , multivariate analysis of variance, principal component analysis, factor analysis, discriminant analysis, cluster analysis. Linear Programming: formulation and graphical solution, simplex method, duality, transportation and assignment problems.

Unit 3: Statistical Genetics

Statistical analysis of segregation, detection and estimation of linkage. Gene and genotypic frequencies. Random mating and equilibrium in large populations. Disequilibrium due to linkages for two pairs of genes and for sex linked genes. Selection, mutation and migration. Equilibrium between forces in large population. Polymorphism. Fisher's fundamental theorem of natural selection. Polygenic systems for quantitative characters, Concepts of breeding value, dominance, average effect of gene and epistatic interactions. Genetic variance and its partitioning. Correlation between relatives. Regular system of inbreeding, effects of inbreeding. Genotype and environment interaction, stability parameters. Estimation of heritability, repeatability and genetic correlation. Path coefficient analysis. Heterosis, concepts of general and specific combining abilities. Diallel crosses and line × tester analysis. Response due to selection. Prediction of response to individual,

family and combined selections. Construction of selection index.

Unit 4: Design of Experiments

Linear models: Random, fixed and mixed effects. Nested and crossed classifications. Gauss-Markoff theorem. Analysis of variance. Principles of design of experiments. Uniformity trials. Completely randomized design. Randomized complete block design. Latin square design. Factorial experiments: 2^n and 3^n series and asymmetrical factorial experiments, confounding in 2^n and 3^n experiments, split and strip-plot designs, crossover designs. Multiple comparison procedures. Missing plot techniques. Analysis of covariance. Variance stabilizing transformations. Analysis of general block design. Balanced incomplete block designs: construction and analysis. Partially balanced incomplete block designs with two associate classes, lattice designs. Youden square design. Groups of experiments.

Unit 5: Sample Surveys

Sampling versus complete enumeration. Concept of probability sampling. Simple random sampling. Stratified sampling, allocation in stratified sampling, choice of strata, construction of strata boundaries and collapsing of strata. Use of auxiliary information in sample surveys, ratio and regression methods of estimation. Systematic sampling. Cluster and multi-stage sampling with equal probability. Sampling with unequal probabilities with and without replacement, sampling schemes with inclusion probabilities proportional to size. Double sampling, sampling on successive occasions. Non-sampling errors: sources and classification. Randomized response techniques, imputation methods. Design and organization of pilot and large scale surveys. National sample surveys. Agricultural statistics system in the country-land use statistics, crop estimation surveys, livestock and fishery statistics.

MOLECULAR BIOLOGYAND BIOTECHNOLOGY

Unit 1: Comprehensive Overview of Biotechnology

History, scope, and importance of Biotechnology; Specializations in Agricultural Biotechnology (e.g., Genomics, Genetic engineering, Tissue Culture, Bio-fuel, Microbial Biotechnology, Food Biotechnology); Basics of Biotechnology, Primary metabolic pathways, Enzymes, and their activities; Structure of DNA, RNA, and proteins, along with their properties; DNA function: Expression, exchange of genetic material, mutation; DNA modifying enzymes and vectors; Methods of recombinant DNA technology; Nucleic acid hybridization; DNA/RNA libraries; Applications of gene cloning in basic and applied research; Plant transformation: Gene transfer methods and GM crops applications; Molecular analysis of nucleic acids, including PCR and its

applications; Introduction to Molecular markers (e.g., RFLP, RAPD, SSR, SNP) and their applications; DNA sequencing methods; Plant cell and tissue culture techniques and applications; Introduction to genomics, transcriptomics, ionomics, metabolomics, and proteomics; Emerging topics: Genome editing, gene silencing, Plant microbial interactions; Success stories in Biotechnology; Careers and employment; Public perception, bio-safety, and bioethics issues; Intellectual property rights.

Unit 2: Fundamentals of Molecular Biology

Historical developments in molecular biology; Nucleic acids as genetic material; Chemistry, Nomenclature of nucleic acids; Structure of DNA: primary, secondary; Forms of DNA: A, B, Z; Structure, Types of RNA; Genome organization: prokaryotes, eukaryotes; DNA Topology; DNA re-association kinetics; Repeat sequences; Central dogma; DNA replication: Models, Origin, Steps - initiation, elongation, termination; Enzymes, accessory proteins; Eukaryotic DNA replication; DNA damages, mutations; DNA repair mechanisms; Recombination: Homologous, non-homologous; Genetic consequences; Prokaryotic transcription: Initiation, elongation, termination, promoters; Eukaryotic transcription: RNA polymerase I, II, III, Elongation, Termination, Promoters, enhancers, Transcription factors, Post-transcriptional processing, Splicing, RNA stability, transport, editing; Genetic code: Universal, modified code, Wobble hypothesis; Translational machinery; Ribosomes: prokaryotes, Eukaryotes; Initiation complex formation; Cap-dependent, Cap-independent initiation in eukaryotes; Elongation: Translocation, transpeptidation, termination of translation; Co-, Post-translational modifications of proteins; Translational control; Protein stability: Turnover, degradation; Gene regulation: Prokaryotes - Constitutive, Inducible expression, small molecule regulators, Operon concept; Eukaryotes - Regulatory RNA, RNA interference mechanisms, Silencers, insulators, enhancers, mechanisms of silencing, activation; DNA binding transcription factors: Helix-turn-helix, helix-loop-helix, etc.; Epigenetic regulations.

Unit 3: Molecular Cell Biology

Origin of life; History of cell biology; Evolution of the cell: Endosymbiotic theory, tree of life; General structure and differences between prokaryotic and eukaryotic cells; Similarities and distinctions between plant and animal cells; Cell types in plant and animal tissues; Cell wall, cell membrane; Structure, composition of bio-membranes; Major organelles: Endoplasmic reticulum, Ribosomes, Golgi apparatus, Mitochondria, Chloroplasts, Lysosomes, Peroxisomes, Micro-bodies, Vacuoles, Nucleus, Cyto-skeletal elements; Membrane transport: Diffusion, osmosis, ion channels, active transport, protein sorting, regulation of intracellular transport, transmembrane, vesicular transport - endocytosis, exocytosis; Cell communication: Hormones, receptors, G-protein coupled receptors, enzyme-linked receptors; Signal transduction mechanisms, regulation; Cell junctions, Cell adhesion, Cell movement; Extracellular matrix; Chromatin structure; Cell division, regulation of cell cycle; Mechanisms, Molecular events at M phase, mitosis, cytokinesis; Ribosomes, cell growth, division; Control of Cell Division; Abnormal cell division: Cancer- hallmarks, role of oncogenes, tumor suppressor genes, Programmed cell death (Apoptosis); Morphogenetic

movements, shaping of the body plan; Cell diversification, cell memory, cell determination, positional values; Differentiated cells, maintenance of tissues, organ development; Stem cells: Types, applications; Basics of Animal development in model organisms (C. elegans, Drosophila); Plant development.

Unit 4: Omics and Systems Biology

Methods of genome sequencing; Principles of sequencing chemistries; Physical and genetic maps; Comparative and evolutionary genomics; Organelle genomics; Applications in phylogenetics; Case studies of completed genomes; Preliminary genome data analysis; Basics of ionomics analysis; Protein basics: primary, secondary, tertiary structure; Basics of X-ray crystallography, NMR; Mass spectrometry: Principles, Applications; Proteomics: Gel-based, gel-free methods; Software basics: MASCOT, PD-Quest, etc.; Protein interactions study; Prokaryotic, yeast-based expression system, purification; Metabolomics and applications; 1D/2D NMR, MS in metabolome analysis; Multivariate analysis, metabolite biomarkers; Ionome study: ICP-MS, XRF, NAA; Data integration: genome, transcriptome, proteome, metabolome, ionome with phenome; Introductory systems Biology: Biochemical, genetic, systems model; Molecules to Pathway; Equilibrium binding, cooperativity, Michaelis-Menten Kinetics; Biological oscillators, Genetic oscillators; Quorum Sensing, Cell-cell communication; Drosophila Development; Pathways to Network; Gene regulation at single cell level; Transcription network, Regulatory Circuits; Negative, positive auto-regulation; Alternative Stable States; Bimodal Switches; Network building, analysis.

Unit 5: Molecular Biology Techniques

Lab practices, buffer, reagent preparation; Centrifugation, spectrophotometry principles; Bacterial culture growth, growth curve preparation, Genomic DNA isolation; Plasmid DNA isolation; Lambda phage growth, phage DNA isolation; Plant DNA isolation, restriction; DNA quantification: Agarose Gel electrophoresis, Spectrophotometry; PCR with isolated DNA; PAGE Gel electrophoresis; Plasmid, phage DNA restriction digestion, ligation, Recombinant DNA construction; E. coli Transformation, transformant selection; Chromatographic techniques: TLC, Gel Filtration, Ion exchange, Affinity Chromatography; Dot blot analysis, Southern hybridization, Northern hybridization; Western blotting, ELISA; Radiation safety, non-radio isotopic procedures.

Unit 6: Gene Regulation

Transcriptional regulation: Regulatory proteins, Activators, Repressors; RNA polymerase binding; Allosteric regulation; DNA looping; Cooperative binding; Anti-termination; Combinatorial control - lac, trp, ara Operons regulation; Gene regulation in Lambda phage - lytic, lysogenic establishment; Regulatory sequences: Promoters, Enhancers, Silencers, Insulators, Locus Control Region; Activator proteins, binding sites; DNA binding domains - Homeodomain, Zinc proteins, Leucine Zipper, Helix-Loop-Helix, HMG proteins; Recruitment of RNA polymerase; Nucleosomes, modifiers; Signal integration; Signal transduction, transcriptional regulation; Gene Silencing; Epigenetic gene regulation; RNA regulation in prokaryotes, eukaryotes; RNA as defense agents;

Riboswitches; Gene Silencing by RNA: siRNA, miRNA - synthesis, function; Non-coding RNAs impact, categories, role in gene regulation, chromatin assembly; Negative, Positive auto-regulation; Bistable, Bimodal switch; Oscillating gene expression pattern.

Unit 7: Plant Genetic Engineering

Historical background; Restriction Enzymes; DNA modifying enzymes; Cohesive, blunt end ligation; DNA labeling: Nick translation, Random priming, Hybridization techniques: Northern, Southern, Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions: Electromobility shift assay; Plasmids; Bacteriophages; Vectors: M13, Phagemids, Lambda, Cosmids, Artificial chromosome (YACs, BACs); Animal Virus derived vectors-SV-40; Expression vectors: pMal, pET-based; Protein purification: His-tag, GST-tag, MBP-tag, etc.; Baculovirus vectors; Plant-based vectors: Ti, Ri plasmids; Yeast vectors; Transformation; Library construction; mRNA, total RNA isolation; cDNA, genomic libraries; cDNA, genomic cloning; Protein-protein interactive cloning, Yeast two-hybrid system; Phage display; Gene expression optimization; DNA introduction into mammalian cells; Transfection techniques; PCR principles, Primer design, DNA polymerases; Types of PCR: multiplex, nested, real-time, touchdown, colony; PCR applications: gene recombination, Site-specific mutagenesis, molecular diagnostics; Viral, bacterial detection; Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay; Genetic transformation of plants: DNA delivery - Agrobacterium, chemical, electroporation, particle bombardment; Promoters, Marker genes; Chloroplast transformation; Marker-free plants; Transgenic plants analysis: molecular, Biochemical assays, gene integration site identification; Advanced methods: cisgenesis, intragenesis, targeted genome modification - ZFN, TALENS, CRISPR; Transgenic technology applications.

Unit 8: Molecular Plant Breeding

Inheritance of qualitative, quantitative traits; Heritability estimation; Population structure of self-, cross-pollinated species; Factors affecting selection efficiency; Segregating populations development: F2, F3, BC1F1, BC1F2, BC4F2, RIL, AIL, DH, NIL, NAM, MAGIC; Causes, types of sequence variation; Molecular markers types: RFLP, AFLP, SCARs, CAPS, SSRs, STMS, SNPs, DARTseq; Marker inheritance; Linkage analysis: test cross, F2, F3, BC1F, RIL; Genetic map construction; Mapping genes for qualitative traits; Genotyping: sequencing, chip arrays; QTL mapping: structured populations; Association mapping: unstructured populations; GWAS principle, SNP genotyping methods; Genomic Selection principles, methods; Fine mapping of genes/QTL; Gene-based markers development; Allele mining by TILLING, Eco-TILLING; Tagging, mapping of genes; Bulk segregant, co-segregation analysis; Marker-assisted selection (MAS); Foreground, background selection; MAS for gene introgression, pyramiding; Haplotype concept, breeding; Genetic variability, DNA fingerprinting; Molecular markers in Plant variety protection, IPR issues, hybrid purity testing, clonal fidelity testing, transgenic testing.

Unit 8: Molecular Plant Breeding

Different stresses (biotic, abiotic) and adaptation strategies; Plant cell as sensor of environmental changes; Role of cell membranes in signal perception; Signal transduction in cells, whole plants response to external factors. Abiotic stresses affecting plant productivity: Drought, salinity, water logging, temperature, light, nutrient stresses; Drought stress: Effects on growth, development; Components of drought resistance; Physiological, biochemical, molecular basis of tolerance mechanisms; Biotic stress (insect, pathogen) resistance mechanisms; Strategies to manipulate drought tolerance: Osmotic adjustment, Osmoprotectants - praline, glycine betaine, polyamines, sugars; ROS, antioxidants; Hormonal metabolism - ABA signaling; Transcription factors. Water logging stress: Effects on growth, metabolism; Adaptation, tolerance mechanisms - hormones, flooding tolerance; Strategies for improving submergence tolerance. Salinity stress: Effects on physiology, metabolism; SOS pathways, ion homeostasis; Strategies for salinity tolerance improvement. High & low temperature stress: Physiological, biochemical changes; Thermo tolerance molecular basis. Light stress: Morphological, physiological changes; Photo oxidation, plastid development; Heliophytes, sciophytes characters; Solar tracking, sieve effect, light channeling. Heavy metal stress: Al, Cd effects on growth, development; Strategies to overcome heavy metal stress. Nutrient stress: Effects on growth, development; Genetic manipulation strategies; Genomics, transcriptomes, small RNAs, epigenomes; Functional genomics; Transfer of tolerance/resistant genes, validation of gene function. Functional validation techniques; Signaling pathway related to defense gene expression; R proteins, RNAi approach, genes from pathogens, coat protein genes, detoxification genes, transgenic, disease management. Bt proteins, resistance management in transgenic crops; Ecological impact of transgenic crops field release. Bioinformatics approaches: Gene function, network determination in model plants under stress.

FLORICULTURE AND LANDSCAPING

UNIT: I Systematics of Ornamental Plants

Nomenclature: History, origin, hotspots, classification, and nomenclature systems. International Code, Treaties, International and National Organisations, Biodiversity Act, Identification features, descriptors. Red Book, Registration (NBPGR, PPVFRA, NBA).Description of families and important genera Rosaceae, Asteraceae, Caryophyllaceae, Orchidaceae, Aracaceae, Liliacae, Acanthaceae, Palmaceae, Asparagaceae, Malvaceae, Musaceae, Oleaceae, Iridaceae.

UNIT: II Breeding of Ornamental Crops

Principles of plant breeding; Origin, evolution, distribution, introduction, domestication and conservation of ornamental crops. Introduction and initiatives in IPR and PBR of ornamental crops. Breeding objectives, reproductive barriers (Male sterility, incompatibility) in major ornamental crops. Inheritance of important traits, Genetic mechanisms associated withflower colour, size, form, doubleness, fragrance, plant architecture, post-harvest life, abiotic and biotic stress tolerance/

resistance. Breeding methods suitable for sexually, asexually propagated flower crops, self- and cross-pollinated crops- pedigree selection, backcross, clonal selection, polyploidy and mutation breeding,heterosis and F1 hybrids.Role of biotechnology in improvement of flower crops including somaclonal variation, *in-vitro* mutagenesis, *in-vitro*selection, genetic engineering, molecular markers, etc.

Crops-Rose, Chrysanthemum, Carnation, Gerbera, Gladiolus, Orchids, Anthurium, Lilium, Marigold, Jasmine, Tuberose, Dahlia, Gaillardia, Aster. Flowering Annuals: Petunia, Zinnia, Snapdragon, Stock, Pansy, Calendula, Balsam, Dianthus. Important Ornamental Crops Like Aglaonema, Diffen bachia, Hibiscus, Bougainvillea, Kalanchoe.

Unit: III Commercial Production of Cut Flowers

National and International scenario, importance and scope of cut flower trade, constraints for cut flower production in India. Soli analysis, soil health card, Growing environment, open cultivation, protected cultivation, soil/ media requirements, land preparation, planting methods, influence of light, temperature, moisture, humidity and microclimate management on growth and flowering. Commercial Flower production – Commercial varieties, water and nutrient management, fertigation, weed management, crop specific practices, ratooning, training, and pruning, pinching, deshooting, bending, desuckering, disbudding. Use of growth regulators, physiological disorders and remedies, IPM and IDM.Flower forcing and year-round/ offseason flower production through physiological interventions, chemical regulation, environmental manipulation. Cut flower standards and grades, harvestindices, harvesting techniques, post-harvest handling, Methods ofdelaying flower opening, Pre-cooling, pulsing, packing, storage, and transportation. Marketing, export potential, institutional support, Agri Export Zones, 100% Export Oriented units, Crop Insurance.

Crops- Rose, Chrysanthemum, Gladiolus, Tuberose, Carnation, Gerbera, Orchids, Lilium, Anthurium, China Aster, Alstroemeria, Bird of Paradise, Heliconia, Alpinia, Ornamental Ginger, Dahlia, Gypsophila, Solidago, Limonium, Stock, Cut Greens, and Fillers.

Unit: IV Commercial Production of Loose

Scope, scenario and importance of loose flowers, constraints, and opportunities in loose flower production. Nursery management, pro-tray nursery under shade nets, soil and climate requirement, Field preparation, systems of planting. Soli analysis, soil health card, water and nutrient management, weed management, training and pruning, special horticultural practices such as pinching and disbudding, use of growth regulators, physiological disorders and remedies, INM, IPM and IDM. Flower forcing and year-round flowering, production for special occasions through physiological interventions, chemical regulation. Harvest indices, harvesting techniques post-harvest handling and grading, pre-cooling, packaging, and storage. Important local markets, Export potential, transportation, and marketing, APMC and online trading, institutional support, Crop Insurance.

Crops- Rose, Jasmine, Chrysanthemum, Marigold, Tuberose, China Aster, Crossandra, Gaillardia, Spider Lily, Hibiscus, Nerium, Barleria, Celosia, Gomphrena, Madar (*Calotropis Gigantea*), Nyctanthes (Harsingar), Tabernaemontana (Chandni), Lotus,Water Lily, Michelia (Champa), Gardenia, Ixora and Balsam.

UNIT: V Ornamental Gardening and Landscaping

Historical background of gardening, Importance and scope of ornamental gardening, styles and types of gardens, formal and informal style gardens. English, Mughal, Japanese, Persian, Spanish, Italian, French, Hindu, and Buddhist gardens. Garden components- arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, colour wheels, clock garden, bamboo groves, bonsai, path, garden gate, fencing, paving, fountains, garden seating, swings, lanterns, basins, bird baths, sculptures, waterfalls, bridge, steps, ramps. Lawn -genera and species, establishment, and maintenance. Specialised gardens such as vertical garden, roof garden, terrace garden, water garden, sunken garden, rock garden, shade garden, temple garden, sacred gardens (with emphasis on native plants), Zen Garden. Basic drawing skills, use of drawing instruments garden symbols, steps in preparation of garden
design, programmes phase, design, phase, etc. Elements and principles of landscape design. Organization of spaces, visual aspects of plan arrangement- view, vista, and axis. Principles of circulation, site analysis and landscape, water requirement, use of recycled water. Urban landscaping, Landscaping for specific situations such as residential, farm houses, institutions, corporate sector, industries, hospitals, roadsides, traffic islands, Children parks, public parks,xeriscaping, airports, railway station and tracks, river banks and dam sites and IT/ SEZ parks. Bio-aestheticplanning, eco-tourism, theme parks, indoor gardening, the rapeutic gardening. CAD basics and applications.

UNIT: VI Turf grass Management

History, present status, and prospects of turf industry; basic requirements, site selection and evaluation, concepts of quality of soil pertaining to turf grass establishment, criteria for evaluation of turf quality. Types, species, varieties, important breeders, grasses for different locations and conditions and their compatible groupings as per climatic conditions; Turfing for roof gardens. Preparatory operations; Turf establishment methods such as seeding, sprigging/ dibbling, plugging, sodding/ turfing, turf plastering, instant turfing (portable), hydro seeding, synthetic turfing. Turf management – Irrigation, drainage, nutrition, special practices like aerating, rolling, coring, dethatching, verticutting, soil top dressing, use of plant growth regulators and micronutrients, Turf mowing – mowing equipments, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs, standards for turf, use of recycled water.

UNIT VII: Value Addition in Floriculture

Scope and prospects of value addition, National and global scenario, production, and exports. Types of value-added products, techniques of value addition including tinting. Value addition in loose flowers and product development- Gulkhand, floral tea, rose oil, rose water, Pankhuri, floral dyes, rose sherbet, floral ice creams, sweets, etc. Selection of containers and accessories for floral products and decorations. Flower arrangement, styles, ikebana schools (*ikenobo*, *ohara*, *sogetsu*, etc.), Ikebana- moribana, nagiere, contemporary style. Dry flowers–Identification and selection of

flowers and plant parts; Raw material procurement, preservation, and storage; tipsfor collecting dry flower making, selection of stages for picking offlowers for drying, Techniques in dry flower making – Drying, glycerising, bleaching, dyeing, embedding, pressing; Accessories; Designing and arrangement – dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths; petal embedded and made papers, Packaging, and storage. Post drying management including moisture, pests, and molds. Essential oils, Selection of species and varieties(including non-conventional species), extraction methods, Packing and storage, Aromatherapy. Types of pigments, carotenoids, anthocyanins, chlorophyll, betalains; Significance of natural pigments as nutraceuticals, Extraction methods and applications in food, pharmaceutical and poultry industries. Synthetic and Natural dyes, dying techniques, colour retention,

Plant Physiology and Biochemistry

Unit 1: Cell Organelles and Water Relations Cell and its type, cell organelles and their physiological functions. Water and its role in plants water relations, water potential, water loss from plants, energy balance, solar energy, input energy dissipation at crop canopy level. Evapotranspiration, factors influencing transpiration rate. Stomata, structure function, movement, antitranspirants.

Unit 2: Metabolic Process Free energy and chemical potential, redox reactions and electrochemical potential. Enzymes, Gene expression. Photosynthesis and bioproductivity. Translocations of photosynthates towards sink. Respiration, cyanide resistant respiration and its significance. Nitrogen metabolism. N2,.NO3, NH3; reduction, protein synthesis. Sulphate and Lipid metabolism. Secondary metabolites and their significance in plant defence mechanism.

Unit 3: Crop Productivity and Modelling Plant density and crop productivity; strategies for maximizing solar energy utilization; leaf area; interception of solar radiation and crop growth; physiological limitations to crop yield; solar radiation concept and agro techniques for harvesting solar radiation. Light interception as a major function of leaf area-index, LAD canopy architecture-Light extinction coefficient relative growth rate. Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and Limitations in interpreting crop growth and development; crop growth models describing yield, Ideo type concept selection- indices for improving crop productivity.

Unit 4: Abiotic Stress Responses in Plants Biotic and abiotic stresses affecting plant productivity. Drought and its resistance mechanisrns, resurrection plants. Osmotic adjustment, Osmoprotectants, stress proteins. Stress and homones. Oxidative stress: reactive oxygen species and scavenging systems. High temperature stress: tolerance mechanisms- role of membrane lipids in high temperance tolerance. Functions of HSPs chilling stress; Salinity: species variation in salt tolerance. Salinity effects at cellular and whole plant level, tolerance mechanisms. Heavy metal stress: aluminium and cadmium toxicity in acid soils. Role of phytochelatins.

Unit 5: Plant Growth Regulators and Plant Development Plant growth regulators Hormones, type and its role in plant development and agriculture Brassinosteriods, triacontanol, phenols polyamines, jasmonates, concept of death hormone. Classification, site of synthesis, biosynthetic

pathways and metabolism and influence on plam growth and development by auxins, gibberellins, cytokinins, abscisic acid and ethylene. Concept of hormone action - hornone receptors and signal transduction. Homonal regulation of gene expressions at various developmental stages of plant-flowering, seed maturity, seed dormancy. Fruit growth and development, physiological and molecular aspects of ripening processes and improving postharvest life of fruits. Induction and breaking dormancy in seeds and buds Synthetic growth regulators. Practical utility in agriculture and horticulture. Herbicides classification and their mode of action.

Unit 6: Mineral Nutrition Importance of mineral nutrition in plant growth. Classification and essentiality criteria. Heavy metal toxicity and concept of phytoremediation Interaction of phytohormones and nutrients. Molecular aspects- uptake and transport, role o transporter genes, genetics of nutrient uptake, identification and transter of genes for tolerance to nutrient deficiencies, etc. Soil less culture Hydroponics Role of Macro, Micro and beneficial nutrients- identification of nutrient deficiencies and toxicities.

Unit 7: Climate and Climate Change Climate-Analytical methods to determine long term changes in environment. The greenhouse gases and global warning. CO2 as an important greenhouses gas, global carbon deposits, fluxes in the sinks and sources. Effect of elevated CO; on plant growth and development. Methane as a greenhouse gas. Prediction on global warming, GCA models, effects on climate and biota. Effects of UV radiation on plant ecosystem, repair and acclimation to UV-B damage.

Unit 8: Seed Physiology Structure of seeds and their storage. Seed, embryonic development, and endosperm and its type. Chemical composition of seeds. Storage of carbohydrates, proteins and fats in seeds. Seed respiration, mitochondrial activity Mobilization of stored resource in seeds. Chemistry of oxidation of starch, proteins and fats. Utilization of breakdown products by embryonic axis. Control processes in mobilization of stored reserves. Gibberellins and alpha-amylase and other hydrolytic activity. Seed maturation phase and desiccation damage, role of LEA proteins. Seed viability. Seed dormancy. Means to overcome seed dormancy.

Unit 9: Physiology of Flowering and Reproduction Classification of plants and Evolutionary history, reproduction, monocarpic and perennial Semelparous and iteroparous etc. of flowering plants. physiology of flowering: photoperiodism (SDP , LDP and DNP plants) Gene expression in flowering. Vernalization-mechanism. Photomorphogenesis, photoreceptors, phytochrome, cryptochrome, Mating strategy in plants, selfincompatibility responses, physiological processes mediating fertilization (pollen-stigma interactions), seed and fruit development, seed and fruit abortion and means to overcome it. Molecular biology of seed development, physiological basis of cytoplasmic male sterility and fertility restoration. Physiology of heterosis.

Unit 10: Physiology of Horticultural and Plantation Crop Species Growth and development of horticultural and plantation crop species. Juvenility, Physiological aspects of pruning and dwarfing. Growth measurements. water use efficiency. Sexual and asexual propagation. Rootstock and scion interactions. Training and pruning physiology. Physiological constraints and remedial measures of horticultural and plantation crops.

Unit 11: Post-Harvest Physiology Senescence and ageing in plants. Ethylene, senescence, post-

harvest life of cut flowers. Physical, physiological and chemical control of post harvest deterioration of fruits, vegetables and cut flowers. Biochemistry and molecular biology of flower senescence. Concept of physiological maturity of seeds- post harvest changes, loss of viability, loss of nutritive value. Physiological and biochemical changes during fruit ripening and storage. Senescence and Edible vaccine.

Unit 12: Morphogenesis, Tissue Culture and Plant Transformation Morphogenesis; cell division and differentiation, totipotency, cell differentiation, in organ, tissue and cultures, micropropagation strategies, application of tissue culture. plant transformation: transformation vectors, concept of selectable and scorable markers. Agrobacterium mediated transformation, binary vectors, biolistics. Electroporation, PCR, Southern analysis evaluation of transgenic plants

Unit 13: Phenomics Phenotyping methods, phenotyping under different abiotic stress like drought, High temp. salinity etc. Image based phenotyping traits, Use of UAV in phenotyping and trait dissection under field conditions.

Unit 14: Taxonomy and Biodiversity The principles and practices of Taxonomy. Biodiversity and its measures, diversity indices. biodiversity values, use and importance of biodiversity, threatened biodiversity, major causes of biodiversity loss.

Unit 15: Analytical Methods and Statistical Methods Basic knowledge of working in laboratory; Basic principles of laboratory techniques commonly used in physiological research; Laboratory and Microscopic Techniques. Spectrophotometry: Electromagnetic spectrum, construction of calorimeter and spectrophotometer, Applications. Analytical techniques: GC-MS, HPLC, FT-IR, Maldi, Raman, Etc. Data analysis variables. numerical, categorical Central measures (mean, medium, mode); Dispersion measures (range, standard deviation), probability, co- relation and regression, Binomial position and normal distribution, parametric and non parametric tests t-test, f-test, chisquare test, ANOVA.

POSTHARVEST MANAGEMENT

Unit 1: Postharvest Physiology and Biochemistry of Perishables

Introduction, biochemical structure and composition of fruits, vegetables and ornamentals. Biochemical changes during development and ripening. Structural Deterioration of the Produce-cell wall degradation, change in membrane lipid.: Biosynthesis of ethylene and its regulation. Ethylene action and ripening processes, its perception-action and regulation. Determining maturity and maturity indices. Ripening processes: events of ripening and factors affecting them. Physiology of preharvest and postharvest; factors affecting shelf-life and quality of fruits, vegetables and ornamentals. Respiration: respiratory climacteric, its significance. Transpiration and water stress during postharvest. Postharvest oxidative stress: active oxygen species, AOS generation, physiological effects on horticultural commodity, control of oxidative injury.

Unit 2: Postharvest Management of Horticultural Produce

History, Importance and scope of Postharvest technology of horticultural produce. Nature and structure of horticultural produce. Pre and Postharvest losses and their causes. Climacteric and non-climacteric fruits. Regulation of ripening by use of chemicals and growth regulators. Control of sprouting, rooting and discoloration in vegetables. Maturity indices for harvest. Harvesting and harvesting tools. Curing in roots and tubers. Prepackage Operation: Preecooling, washing, sorting, grading of horticultural perishables for local markets and export. Postharvest handling of spices, plantation crops, medicinal and aromatic plants. Equipments for washing, sizing, grading. Pre and Postharvest treatments for extending storage life/ vase life. VHT, irradiation treatment, skin coating, degreening, etc. Prepackaging, Packaging techniques for local market and export. Standards and specifications for fresh produce. Postharvest handling system for horticulture crops of regional importance. Principles of transport, modes of transportation, types of vehicles and transit requirements for different horticultural produce. Marketing: Factors influencing marketing of perishable crops, marketing systems and organizations.

Unit 3: Packaging and Storage Of fresh Horticultural

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. 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. 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. 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, Barrier properties of packaging materials. New technology in packaging – stretch wrapping system, vacuum packaging, gas packaging, controlled atmosphere (active and intelligent) packaging, vibra packaging, skin packaging, shrink packaging, form- fill-seal packaging, Packaging machines. Quality control and safety aspects of packaging materials.

Unit 4: Principles and Methods of Fruit and Vegetable Preservation

Historical development in food processing, type of food and causes for food spoilage. Basic principles of fruits and vegetables processing; 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, containers – types; flexible packaging materials, Composite can, specification, corrosion of cans, heat penetration into containers and methods for determination of process time. 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. 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. Food irradiation, principles, types and sources of radiation, mode of action of ionizing radiation; radiation effect on food constituents and regulation.

Unit 5: Quality Assurance, Safety and Sensory Evaluation of Fresh and Processed Horticultural Produce

Concept of quality: Quality attributes- physical, chemical, nutritional, microbial, and sensory; their measurement and evaluation. Concepts of quality management: Objectives, importance and functions of quality control; Quality management systems in India; Sampling procedures and plans. Food laws and regulations in India, Quality management standards, ISO,BIS, PFA, AGMARK and QMS standards, quality system components and their requirements. Food safety and standards act (FSSA,2006); Strategies for compliance with international agri-food standards; Export specification and guidelines by APEDA. Hazard analysis and critical control points (HACCP), design and implementation of an HACCP system, steps in the risk management process. Traceability in food supply chains. Organic Certification, GAP, GMP, TQM. Indian and International quality systems and standard like, Codex Alimentarius, ISO, etc. Methods of sensory evaluation of different food products. Designing of experiments. Handling and interpretation of Data. Role of sensory evaluation in product optimization. Relationship between objective and subjective methods. Sensory analysis for consumer evaluation. Computer-aided sensory evaluation of food and beverage.

NOTE: The syllabus mentioned above is illustrative only. Questions relating to recent/current developments taking place in agriculture and allied sciences in general and in the concerned subject areas in particular can also be included in the question papers as may be deemed appropriate by subject-paper experts.

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Registrar

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