

नेपाल सरकार
नेपाल कृषि अनुसन्धान परिषद्
पदपूर्ति समिति

वरिष्ठ वैज्ञानिक, एस-३ (Senior Scientist, S-3) पद/तहको खुला तथा आन्तरिक प्रतियोगितात्मक
लिखित परीक्षाको पाठ्यक्रम एवं परीक्षा योजना

यस पाठ्यक्रम योजनालाई दुई चरणमा विभाजन गरिएको छ ।

प्रथम चरण: लिखित परीक्षा (Written Examination)

पूर्णाङ्क - २००

द्वितीय चरण: अन्तरवार्ता (Interview)

पूर्णाङ्क - ३०

१. प्रथम चरण (First Phase): लिखित परीक्षा (Written Examination)

पूर्णाङ्क: २००

| Paper | Subject | Mark | Full Mark | Pass Mark | No. Questions (Q) x Mark (M) = Total Marks | Time Allowed |
|-------|--|------|-----------|-----------|--|---------------|
| I | Part-I: Management | 15 | 75 | 30 | 5 Q x 3 M = 15 (Short Answer) | 2.00 Hours |
| | Part-II: Agriculture Research and development Issues | 60 | | | 4 Q x 6 M = 24 (Short Answer) 3 Q x 12 M = 36 (Long Answer) | |
| II | Technical Subject | | 125 | 50 | 5Q x 15 M= 75 (Critical Analysis) 2Q x 25M = 50 (Problem Solving) | 3.30 Hours |

२. द्वितीय चरण(Second Phase): Interview

पूर्णाङ्क: ३०

| Subject | Full Marks | System |
|-----------|------------|--------|
| Interview | 30 | Oral |

द्रष्टव्यः

- यो पाठ्यक्रम योजनालाई प्रथम चरणमा लिखित परीक्षा र द्वितीय चरणमा अन्तरवार्ता परीक्षा गरी दुई चरणमा विभाजन गरिएको छ ।
- लिखित परीक्षाको माध्यम भाषा नेपाली वा अंग्रेजी अथवा नेपाली र अंग्रेजी दुबै हुन सक्ने छ ।
- समान पद/तहको प्रथम पत्र सबै उपसमूहको लागि पाठ्यक्रम एउटै भएको कारण एकिकृत परीक्षा सञ्चालन हुनेछ । तर द्वितीय पत्र Technical Subject को पाठ्यक्रम उपसमूह अनुरूप फरक फरक हुनेछ ।
- प्रथम र द्वितीय पत्रको लिखित परीक्षा छुट्टाछुट्टै हुनेछ ।
- प्रथम पत्रको Part-I का लागि एक वटा र Part-II का लागि छुट्टाछुट्टै एक एक वटा उत्तर पुस्तिका हुनेछन् ।
- यस पाठ्यक्रम योजना अन्तर्गतका पत्र/विषयका विषयबस्तुमा जेसुकै लेखिएको भएतापनि पाठ्यक्रममा परेका कानून, ऐन, नियम, विनियम तथा नीतिहरू परीक्षाको मिति भन्दा ३ महिना अगाडि (संशोधन भएका वा संशोधन भई हटाइएका वा थप गरी संशोधन भई) कायम रहेकालाई यस पाठ्यक्रममा परेको सम्झनु पर्दछ ।
- परीक्षामा कुनै प्रकारको विद्युतीय उपकरण तथा क्याल्कुलेटर (Calculator) प्रयोग गर्न पाइने छैन ।
- पाठ्यक्रममा भएका यथासम्भव सबै पाठ्याशंहरूबाट प्रश्नहरू सोधिने छ । प्रथम चरणको लिखित परीक्षाबाट छनौट भएका उम्मेदवारहरूलाई मात्र द्वितीय चरणको अन्तरवार्तामा सम्मिलित गराइने छ ।

नेपाल सरकार
नेपाल कृषि अनुसन्धान परिषद्
पदपूर्ति समिति

९. प्रथम चरणको लिखित परीक्षाबाट छनौट भएका उम्मेदवारको प्राप्ताङ्क र द्वितीय चरणको अन्तरवार्तामा प्राप्त गरेको अंक जोडी योग्यताक्रम अनुसार सफल उम्मेदवारको सिफारिस गरिनेछ ।
१०. यो पाठ्यक्रम तुरुन्त लागू हुने छ
११. यस भन्दा अगाडि लागू भएको पाठ्यक्रम खारेज गरिएको छ ।

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), पद/तहको खुला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको पाठ्यक्रम एवं परीक्षा योजना

Paper: I

**Management and Agricultural Research and Development
(Common For all Sub-groups)**

Part-I: Management

A. Management:

1. Concept, principles, functions, scope, type, role, level and skills of managers
2. Time management: concept, advantages and disadvantages
3. Conflict management: concept, approaches to conflict, levels of conflict, causes of conflict and strategies for conflict management
4. Stress management: Concept, causes and sources of stress, techniques of stress management

B. Finance and Human Resouce:

1. Financial management: concept, approaches, budget formulation, and implantation, auditing and topics related to financial management
2. Human resouce management: concepts, functions, and different aspects
3. Leadership: concept, functions, leadership styles, leadership and management effectiveness
4. Coordination: concept, need, types, techniques and approaches for effective coordination
5. Motivation: Concept, theories of motivation, reasons for low productivity, techniques of employ motivation

C. Agricultural Related Issues:

1. Use of Information and Communication Technologies (ICTs): concept, types, advantages & disadvantages, impact, status in Nepal
2. Agricultural research project planning and management: concepts, principles, nature, instruments and steps

3. Decision making: importance, types, rational process of decision process
4. Agriculture research farm management

Part-II: Agricultural Research and Development

Common for all sub-groups

1. Constitution of Nepal: Food, agriculture and natural resources related issues
2. Current national agricultural policies, strategies and plans: National Agriculture Policy, Agricultural Biodiversity Policy, National Climate Change Policy, Agriculture Development Strategy (ADS), Seed Vision, Fertilizer Policy, National Land Use Policy and agriculture related issues in development plans
3. Nepal Agricultural Research Council (NARC) as a National Agricultural Research System (NARS) in the context of national and global perspectives
4. International Agricultural Research Organizations: CGIARs and IARCs -CIAT, CIMMYT, CIP, ICRISAT, ICARDA, World Fish, ICRAP, IFPRI, IITA, ILRI, Bioversity International, IRRI, IWMI, AVRDC, ICIMOD, ICRAF, IFDC, IFAD and FAO
5. Agricultural Innovation System: concept, accountability, relationship with actors and stakeholders
6. Agricultural research project management: Problem & objective tree analysis, logframe development, effect and impact assessment and its linkage with technology users.
7. Coordination and partnership of Nepal Agricultural Research Council with national organizations, international organizations, civil societies, entrepreneurs and agri-business
8. Implementation and impact of Agricultural Research in Nepal
9. Agricultural research and its contribution in GDP
10. Agricultural statistics: Production, productivity, import/export trend of major agricultural commodities
11. Agricultural marketing and networking
12. Agricultural research system tools (ICTs, GIS, GPS, Remote Sensing, Satellite, Drone and Models) and their integrated use in agriculture research, technology transfer and development

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), एग्रोनोमी उप-समूहको
खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub Group: Agronomy

1. Crop Production

Rice, wheat, maize, finger millet, barley, buckwheat, amaranths, lentil, soybean, chickpea, pigeon pea, mungbean, rapeseed, mustard, groundnut, sugarcane, jute, tobacco, cotton, potato, with respect to

1.1 Introduction, origin, and distribution

1.2 Botany, morphology, and growth stages

1.3 Climate and soil

1.4 Recommended and pipe-line cultivars and their characters.

1.5 Cultural practices: - land preparation, seed treatment, planting methods (spacing), planting time, seed rate, inter-culture operations, harvesting, drying, cleaning, transportation, and storage.

1.6 Weed and weed control: Importance of weed recommended herbicides and their use, method, and time of application.

1.7 Manures and fertilizers: recommended doses, method of application, time of application

1.8 Water management: time and frequency of water application, irrigation methods, water requirement, drainage

1.9 Typical cropping calendars and cropping patterns in hills, mid-hills, Terai and inner-Terai.

1.10 Economics of crop production of major crops (rice, maize, wheat, sugarcane, tobacco, cotton, jute, potato, lentil)

1.11 Plant protection measures: causal agent, symptoms and control measures, IPM, use of plant pesticides

2. Climate, Weather and Crop

2.1 Climate: temperature, humidity, wind pressure, rainfall, effective rainfall, sunshine hours, soil temperature and their effect in crop production

2.2 Climate of Nepal: climatic zones, moisture classes their features and vegetation

2.3 Effects of adverse climate and weather in different crops

2.4 Climate change, global warming, and greenhouse gases: Definition and impact in different crops

2.5 Agro-climatic normal for different crops

2.6 Weather forecasting and its implication in crop production

3. Tillage

- 3.1 Tillage: objective, significance, limitations and importance in crop production
- 3.2 Zero tillage, minimum tillage and optimum tillage
- 3.3 Condition of soil suitable for cultivation
- 3.4 Tillage and crop establishment methods

4. Land Resources

- 4.1 Physiographic land distribution system of Nepal
- 4.2 Land capability classification and utilization and irrigation suitability
- 4.3 Soil of Nepal and their classifications

5. Weed and Weed Control

- 5.1 Classification of weeds, its importance in crop production, pattern of weed distribution
- 5.2 Common weeds found in major field crops
- 5.3 Herbicides: types of herbicides, herbicide formulation, mode of action, physiology of herbicides, application method and type of nozzle for herbicides, herbicides use in Nepal
- 5.4 Integrated weed management practices in major crops
- 5.5 Economic use of herbicides
- 5.6 Crop-weed completion

6. Soil and Fertilizer

- 6.1 Soil: definition, soil and sub-soil, importance of top soil and sub-soils
- 6.2 Soil texture, soil structure, soil bulk density, soil consistency and their importance in agriculture
- 6.3 Classification of essential elements on the basis of their functions
- 6.4 Functions and deficiency symptoms of essential elements
- 6.5 Determination of nutrient requirement of major crops
- 6.6 Soil pH, its measurement, liming material for correcting soil pH, liming materials and their reactions in soil
- 6.7 Soil organic matter, nutrient content of different manures and importance of organic matter
- 6.8 Recommended dose of nutrients, method of application and time of application
- 6.9 Recommendation of nitrogen, phosphorous and potassium based on soil analysis
- 6.10 Green manure: benefit of green manure, green manuring and green leaf manuring, influence of leguminous green, manure, desirable characteristics of green manure, plant suitable for green manure, aerobic and anaerobic decomposition, and its effect on soil, constrains of green manuring.
- 6.11 Soil fertility and productivity and their indicators

7. Farming System and Outreach Research

- 7.1 Introduction to farming system, system approach in agriculture, and component/determinants of farming system
- 7.2 Social, economic, and institutional aspects of farming system

- 7.3 Intensive cropping, sequential cropping systems, management of different cropping systems and evaluation of cropping systems
- 7.4 On-farm farming system research: methodology, characteristics of FSR, frame work of FSR methodology, diagnostic phases (RRA, Agro ecosystem, analysis, conventional survey)
- 7.5 Gender perspective of technology generation and adoption

8. Sustainable Agriculture

- 8.6 Definitions
- 8.7 Differences between modern and sustainable agriculture
- 8.8 Problem of modern agriculture and management practices
- 8.9 Positive and negative implication of sustainable and modern agriculture
- 8.10 Impact of green revolution in food and nutritional security
- 8.11 Role of agro-forestry and its management for sustainable crop production

9. Principles of Plant Breeding

- 9.1 Definition, importance, history, and achievement of plant breeding
- 9.2 Heredity, growth, and assimilation
- 9.3 Genotypes and phenotypes
- 9.4 Mode of reproduction in crop plant
- 9.5 Methods of breeding in field crops
- 9.6 Classification of crops according to pollination
- 9.7 Germplasm collection, evaluation, utilization, and conservation
- 9.8 Varietal improvement work procedure in Nepal
- 9.9 Method of hybridization to improve major field crops.

10. Seed Technology

- 10.1 Seed formation, development, and composition
- 10.2 Physiology of seed
- 10.3 Seed quality and seed classes and their purity maintenance
- 10.4 Principles and practices of seed production and seed testing
- 10.5 Seed certification procedures and seed certification standards in major crop in Nepal

11. Crop Physiology: Photosynthesis, respiration, photo-periodic, transpiration, physiological stress in crops, crop water stress indices and crop stress detection

12. Statistics

- 12.1 Probability and simple statistics
- 12.2 Estimate of error: replication and randomization
- 12.3 Control error: blocking, field plot technique, data analysis
- 12.4 Complete randomized design (CRD): randomization, layout, analysis of variance, interpretation of results.
- 12.5 Randomized complete block design (RCBD): layout, randomization, analysis of variance and interpretation of results.

- 12.6 Latin square design: randomization, layout, analysis of variance, efficiency of row and column, blocking and interpretation of results
- 12.7 Lattice design: balanced lattice design, partially balance lattice - layout, randomization, analysis of variance and interpretation of results
- 12.8 Two factorial experiments: randomization, layout, analysis of variance, interactions and interpretation of results
- 12.9 Split plot design - randomization, layout, analysis of variance, interaction of factors and interpretation of result
- 12.10 Strip-plot design: randomization, layout, analysis of variance, interaction of factors and interpretation of result
- 12.11 Comparison: least significant difference (LSD) and Duncan's Multiple Range Test (DMRT), group comparison-between-group, within group, trend, and factorial and interpretation of results
- 12.12 Regression and correlation and their use in agronomic research
- 12.13 Importance and validity of statistics in agriculture
- 12.14 Methods of statistical analysis for cropping systems
- 12.15 Data transformation and missing plot techniques
- 12.16 Test of significance: t, F and Chi-square

13. Others

- 13.1 Importance of agronomical research in relation to WTO
- 13.2 Agricultural marketing and agri-bussiness of field crops
- 13.3 Importance of commercial field and industrial crops for commercialization
- 13.4 Major constrains and opportunities of crops production in Nepal
- 13.5 Climate smart agronomical research

-----*-----

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), प्लाण्ट ब्रिडिङ एण्ड जेनेटिक्स उपसमूहको
खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject

Sub Group: Plant Breeding and Genetics

1. Plant Genetics

- 1.1 Cell division
- 1.2 Linkage and crossing over
- 1.3 Probability and its application in plant breeding
- 1.4 Gene action and partition of genetic variance
- 1.5 Heterosis and inbreeding
- 1.6 Heritability
- 1.7 Quantitative and qualitative traits, their gene action and interaction
- 1.8 Gene interaction
- 1.9 Combining ability
- 1.10 Basic concept of molecular biology – gene structure, regulation, and manipulation
- 1.11 Population genetics and its structure
- 1.12 Quantitative genetics and Hardy-Weisberg law

2. Plant Breeding

- 2.1 Self and cross pollinated crops
- 2.2 Breeding methods for self and cross pollinated crops and vegetatively propagated crops
- 2.3 Breeding objective and priority setting
- 2.4 Breeding for insect and disease resistance
- 2.5 Breeding for stress factors
- 2.6 Mutation in crop improvement
- 2.7 Poliploidy and its use in plant breeding
- 2.8 Distant hybridization in plant breeding
- 2.9 Male sterility and its application in crop improvement
- 2.10 Genotype x Environment interaction
- 2.11 Hybrid seed production

3. Plant Genetic Resources

- 3.1 Germplasm collection, conservation and utilization
- 3.2 Biodiversity and its significance to community and country
- 3.3 WTO: its significance to Nepal
- 3.4 Plant breeders' right / Intellectual property right
- 3.5 Patents hip of variety and product – significance to Nepal

4. Biotechnology in crop improvement

- 4.1 Genes and molecular basis of inheritance of characters
- 4.2 DNA, RNA gene structure and their regulation

- 4.3 Plant biotechnology
- 4.4 Tissue culture, cell culture, embryo culture, anther culture
- 4.5 Somatic hybridization
- 4.6 Genetic engineering in plants
- 4.7 Molecular markers and their use in plant breeding
- 4.8 Achievements and future of molecular breeding

5. Seed Technology

- 5.1 Seed act in Nepal
- 5.2 Seed classes, seed production, certification
- 5.3 Formal and informal seed production system in Nepal
- 5.4 Community level seed production –constraints and opportunity
- 5.5 Seed production: self and cross pollinated crops

6. Agricultural Statistics

- 6.1 Field plot techniques
- 6.2 Experimental designs
- 6.3 Chi-square test, probability
- 6.4 Analysis of variance and covariance
- 6.5 Correlation and regression analysis
- 6.6 Stability and adaptability analysis-new techniques
- 6.7 Computer packages and its role in data processing

7. Others

- 7.1 Status of plant breeding activities in Nepal - Rice, Wheat, Maize, Minor cereals
Legumes, Oilseeds, Potato and Vegetables
- 7.2 Areas of collaborations with IARCs in crop improvement
- 7.3 Participatory plant breeding
- 7.4 Participatory on farm research
- 7.5 Stakeholders in research and development in Nepal
- 7.6 Improved varieties, release processes
- 7.7 National Seed Act: types of seeds production in Nepal

-----*

Paper: II

Technical Subject
Sub-Group: Agronomy, Plant Breeding and Genetics

A. Agronomy

1. Crop Production

Rice, maize, wheat, finger millet, barley, buckwheat, amaranthus, lentil, soybean, chickpea, pigeonpea, mung-bean, rapeseed mustard, sunflower, mustard, groundnut, sugarcane, jute, cotton with respect to:

- 1.1 Introduction, origin and distribution
- 1.2 Botany, physiology, morphology and growth stages
- 1.3 Climate and soil
- 1.4 Released, recommended registered and pipe-line cultivars and their characteristics
- 1.5 Cultivation practices: land preparation, seed treatment, planting methods, planting time, seed rate, inter-culture operations and harvesting indices (maturity), package of practices and Integrated Crop Management (ICM)
- 1.6 Organic manures and chemical fertilizers: recommended doses, method of application, time of application and fertilizer use efficiency
- 1.7 Water management: time and frequency of water application during critical stages, irrigation methods, water requirement, and drainage
- 1.8 Plant protection measures: major insects and diseases, causal agents, symptoms and control/management practices, IPM, use of safe chemical pesticides/ non-chemical pesticides, pesticides residues and storage pests
- 1.9 Harvesting, post-harvest technologies, cleaning, transportation, storage, and marketing intelligence
- 1.10 Economics of crop production of major crops and cost-benefit

2. Climate, Land Resources and Agro-Biodiversity

- 2.1 Climate: temperature, humidity, wind pressure, rainfall, effective rainfall, sunshine hours, solar radiation and its importance in crop productivity and production
- 2.2 Climate of Nepal : climatic zones, their features and vegetation; and crop zoning
- 2.3 Physiographic distribution of Nepal
- 2.4 Land capability and irrigation suitability
- 2.5 Soils of Nepal and their classification, soil carbon sequestration and carbon trading
- 2.6 Importance of agro-biodiversity and approaches for conservation and utilization
- 2.7 Climate change and challenges in food and nutritional security

- 2.8 Greenhouse Gases (GHGs) emission, approaches to mitigate methane gas emission from paddy fields in Nepal, climate smart agriculture and its application in Nepal
 - 2.9 Adaptation and mitigation measures and strategies concerning the climate change impacts
 - 2.10 Agro-climatic normal for different crops
 - 2.11 Concept of weather forecasting and its implication in crop production

 - 2.12 Weather and climatic abnormalities and natural calamities and its impact on crop production and food security
- 3. Soil and Plant Nutrition Management**
- 3.1 Soil formation and morphology
 - 3.2 Soil physical properties: soil sampling, soil texture, particle density, porosity and friability
 - 3.3 Soil chemical properties: cation exchange, soil reaction (pH), organic carbon and available nitrogen, phosphorus and potassium, clay minerals, organic colloids (humus), soil testing
 - 3.4 Organic matter, decomposition and Vermi-compost
 - 3.5 Macro and micronutrients deficiency symptoms and their corrections
 - 3.6 Balancing the plant nutrients, INM, IPNS, soil health
 - 3.7 Bio-fertilizers and green manuring for soil improvement
- 4. Soil Water and Water Management for Plants**
- 4.1 Soil water classification for water management
 - 4.2 Water flow into soil, its uptake by plants
 - 4.3 Reducing water losses and managing in field crops
 - 4.4 Water requirements of crops, water table, water-harvesting and water use efficiency.
 - 4.5 Innovative irrigation techniques and irrigation efficiency
 - 4.6 Drainage systems and its management in field crops
 - 4.7 Water-saving technologies
- 5. Tillage, Weed and Weed Management**
- 5.1 Conservation Agriculture (CA) and Resource Conservation Technologies (RCTs)
 - 5.2 Weed problems and their management in crop production
 - 5.3 Pattern of weed distribution and common weeds of major field crops
 - 5.4 Herbicides: types of herbicides, herbicide formulation, application, mode of action, physiology of herbicides and herbicides use in Nepal
 - 5.5 Integrated weed management in important crops: rice, maize, wheat, finger millet, lentil, soybean
 - 5.6 Economic use of herbicides

6. Sustainable Agriculture, Agro-ecologies and Food Security

- 6.1 National food production, requirement and balance
- 6.2 Agro industry and commercialization
- 6.3 Sustainable agriculture and agro-ecologies
- 6.4 Traditional and modern sustainable agriculture
- 6.5 Environmental-friendly technologies
- 6.6 Positive and negative aspects of sustainable and modern agriculture
- 6.7 Pros and cons of green revolution
- 6.8 Technology generation, adaptation and adoption for sustainability in agriculture in Nepal
- 6.9 Organic and precision farming for sustainable and maximization of crop yield
- 6.10 Food Security: concept, basis principles, issues related to national and global food production and consumption, challenges in food and nutritional security - nationally and globally
- 6.11 Weather and climate hazards and its impact on food and nutritional security
- 6.12 Sustainable crop production under rainfed condition and different agro-ecologies
- 6.13 Agro-forestry system for sustainable agriculture

7. Crop Physiology

- 7.1 Growth and development: stages, cell division, enlargement and differentiation crop growth stages, LAI, and HI
- 7.2 Photo-periodic, photosynthesis, photorespiration, transpiration, respiration absorption and translocation
- 7.3 Stress physiology: cold and heat stresses, low and high moisture stresses

8. Farming System and Outreach Research

- 8.1 Crop rotation, relay cropping, cropping intensity and farming system.
- 8.2 Socio-economic and institutional aspects of farming system
- 8.3 On-farm farming system research methodology, characteristics of FSR, and diagnostic phase of FSR (RRA, agro-ecosystem analysis, RRA, conventional survey)
- 8.4 Gender perspective of technology generation and adoption
- 8.5 Out-reach research: definition, concept, importance
- 8.6 Out-reach research as means of technology transfer and dissemination.
- 8.7 Indexes of different cropping sequences

9. Agri-mechanization

- 9.1 Agri-mechanization for Terai and Hills: Prospects, objectives, concepts, opportunities, and limitations
- 9.2 Agri-mechanization in the perspective of gender and youth farmers
- 9.3 Agri-mechanization and commercial farming

B. Plant Breeding and Genetics

1. Plant Genetic Resources and Ecosystems

- 1.1 Plant distribution and their limiting factors
- 1.2 Origin of cultivated plants and the ecotype concept
- 1.3 Crop germplasm conservation, evaluation and their utilization
- 1.4 Crop ecosystem

2. Plant Genetics

- 2.1 Reproductive systems:
 - 2.1.1 Sexual Reproduction
 - 2.1.2 Asexual Reproduction
- 2.2 Male sterility, self-incompatibility, and techniques of hybridization
- 2.3 Genetic basis of plant breeding
 - 2.3.1 Variation
 - Environmental variations
 - Agro-ecotypic variations
 - 2.3.2 Ecotypes
 - 2.3.3 Heredity
 - Inheritance of qualitative characters
 - Inheritance of quantitative characters
 - 2.3.4 Methods of estimating genetic parameters
- 2.4 Heterosis
- 2.5 Selection
 - 2.5.1 Natural selection
 - 2.5.2 Directional selection
 - 2.5.3 Genetic advance under selection
- 2.6 Inter-specific and inter-generic hybridization

3. Methods of Plant Breeding

- 3.1 Pure line selection
- 3.2 Pedigree method
- 3.3 Bulk population method
- 3.4 Backcross method
- 3.5 Population improvement
 - 3.5.1 Intra-population methods
 - 3.5.2 Inter-population methods
- 3.6 Recurrent selection
- 3.7 Composite and synthetic varieties
- 3.8 Asexually propagated crops
- 3.9 Apomictic grasses
- 3.10 Maize hybrids
- 3.11 Hybrid varieties
- 3.12 Mutation Breeding
- 3.13 Polyploid Breeding

- 3.14 Disease resistance breeding
- 3.15 Insect resistance breeding
- 3.16 Abiotic stresses
- 3.17 Breeding for specific traits
- 3.18 Plant tissue culture
 - 3.18.1 Micro-propagation
 - 3.18.2 Production of virus free plants.
 - 3.18.3 Embryo culture
 - 3.18.4 Anther culture
 - 3.18.5 Ovule culture
- 3.19 Genetic Engineering
 - 3.19.1 Gene cloning
 - 3.19.2 Gene transfers in plants
 - 3.19.3 Application and use of genetic engineering in plant breeding
 - 3.19.4 GMOs for crop improvement
- 4. National Seed Production System**
 - 4.1 Plant variety release, National seed act and National Agricultural Extension System
 - 4.2 Plant varieties diffusion through private sector: current status and future scope
 - 4.3 Plant variety protection
 - 4.4 Hybrid seed production
- 5. Agricultural Statistics**
 - 6.8 Field plot techniques
 - 6.9 Experimental designs
 - 6.10 Chi-square test, probability
 - 6.11 Analysis of variance and covariance
 - 6.12 Correlation and regression analysis
 - 6.13 Stability and adaptability analysis
 - 6.14 Statistical methods for cropping systems research.
- 6. Others**
 - 6.1 Status of plant breeding activities in Nepal
 - 6.2 Collaboration with IARCs in crop improvement: their scope and limitations
 - 6.3 Bio-Technology Revolution: Implications for Agriculture
 - 6.4 Bio-Technology Policy: Public Perception, Participation, and the Law
 - 6.5 International Dimensions of Biotechnology

-----*

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), एग्री एक्सटेन्शन एग्री इकोनोमिक्स एण्ड मार्केटिङ
उपसमूहको खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject

Sub-Group: Agri Extension, Agri Economics and Marketing

1. Agricultural Extension

1.1 Concept of extension:

- 1.1.1 Importance of extension in agriculture
- 1.1.2 Concept, scope, principles, philosophy and objectives of extension education
- 1.1.3 Historical perspective of agricultural extension in Nepal

1.2 Teaching learning process in extension:

- 1.2.1 Extension teaching methods-their effectiveness and limitation
- 1.2.2 Criteria for effective extension teaching
- 1.2.3 Adult learning – theories and principles
- 1.2.4 Effective learning

1.3 Communication in agriculture extension:

- 1.3.1 Communication process and methods
- 1.3.2 Critical factors in extension communication
- 1.3.3 Usage of audio – visual aids
- 1.3.4 Communication skills

1.4 Innovation, technology transfer/adoption:

- 1.4.1 Technology innovation process, generation, and development process
- 1.4.2 Diffusion, dissemination, and adoption of innovation/technology
- 1.4.3 Adoption process, stages of adoption, adopter categories and factors affecting adoption.
- 1.4.4 Traditional and recent approaches in transfer of agricultural technology
- 1.4.5 Role of extension, research and farmer in technology generation and diffusion

1.5 Group dynamics and leadership in extension:

- 1.5.1 Group dynamics and leadership development in agriculture extension
- 1.5.2 Farmer's group formation, mobilization, and characteristics of effective group
- 1.5.3 Leadership style, typology, and behavior
- 1.5.4 Conflict management, sources, and resolution techniques

1.6 Agricultural extension program planning:

- 1.6.1 Participatory program planning- planning methodology, planning cycle and stages
- 1.6.2 Bottom-up planning
- 1.6.3 Projectization concept in program planning
- 1.6.4 Participatory monitoring and evaluation-concept and process

2. Agricultural Economics and Marketing

2.1 Production economics and farm management:

- 2.1.1 Nature and process of demand and supply of agricultural inputs

- 2.1.2 Agricultural land use pattern and cropping system
- 2.1.3 Use of agricultural inputs and productivity in Nepal
- 2.1.4 Status of seed production of different crops and its supply management
- 2.1.5 Market globalization

- 2.2 Agricultural market and price:
 - 2.2.1 Agricultural price policy
 - 2.2.2 Relation between agricultural production and market management
 - 2.2.3 Agricultural marketing research
 - 2.2.4 Bilateral treaty/ Negotiation between India, China and Bangladesh in relation to export of different agricultural commodities from Nepal
 - 2.2.5 Role of agriculture market and economic liberalization
 - 2.2.6 Agricultural market management
 - 2.2.7 Concept of co-operative market system
 - 2.2.8 Role of private sector and women's participation in agricultural production and market management

- 3. Public Policy Analysis**
 - 3.1 Concept and importance of Policy Analysis
 - 3.2 The Process of Policy Making
 - 3.3 Methods of policy analysis
 - 3.4 Institutional analysis models

- 4. Statistics/Econometrics**
 - 4.1 Analytical tools used in technology adoption and Impact assessment and gender analysis
 - 4.2 Demand and supply forecasting models
 - 4.3 Behavioral analysis models

- 5. Environmental Economics**
 - 5.1 Public bads and market failure in agriculture and related natural resources
 - 5.2 Types of risks in agriculture, and their management strategies including agricultural insurance
 - 5.3 Assessing risk and uncertainty in agriculture
 - 5.4 Environmental valuation techniques

--
-

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), एग्री इंजिनियरिङ्ग उपसमूहको
खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Agri-Engineering

1. Policies and Plans for Agriculture Development in Nepal

- 1.1. Agricultural development history
- 1.2. Agricultural development policy, strategy, and institutional arrangements
- 1.3. Perspective plans and focuses of perspective plans of agriculture and rural development.
- 1.4. Key focus of 15th plan in federal governance architecture

2. Agricultural Research and Developments

- 2.1. Problems identification, formulation, and development of researchable research agenda
- 2.2. Priority and needs of agricultural research in Nepal.
- 2.3. Established practices of agricultural research in Nepal
- 2.4. Objectives, functions, and structures of National Agriculture Research Council (NARC) and National Agriculture Research Institute (NARI)
- 2.5. Research, Development and Extension system in Nepal
- 2.6. Research designs, data collection, analysis, and presentation
- 2.7. Projects concept notes, project proposals and appraisal

3. Farm Power and Machinery

- 3.1. Sources of farm power and scope of mechanization in Nepal
- 3.2. Work, power, and energy.
- 3.3. Management of workshops and related services
- 3.4. Fluid mechanics (compressible and incompressible fluids, viscosity, Bernoulli theorem, Archimedes's principle, buoyancy)
- 3.5. Thermodynamics (laws of thermodynamics, entropy, enthalpy, kinetic theory of gases)
- 3.6. Basic knowledge on thermal energy conversion, fossil fuels, bio-fuels and refrigerants.
- 3.7. Introduction to theory machines
- 3.8. Machine elements
- 3.9. Design criteria of agricultural machines
- 3.10. Internal combustion engines (petrol and diesel engines)
- 3.11. Engine terminologies
- 3.12. Cam, gears, flywheels, governors, clutch, brakes, bearings, belt drives, threaded fasteners, conveyors, riveted and welded joints
- 3.13. Power trains and traction devices in farm tractors and power tillers
- 3.14. Types of earth moving machinery

- 3.15. Seedbed preparation machinery
 - 3.16. Seeding, planting, harvesting and threshing machinery
 - 3.17. Primary and secondary processing machinery
 - 3.18. Dairy machinery
 - 3.19. Machine and equipment for intercultural operation and plant protection
 - 3.20. Resource conservation technology- zero tillage and minimum tillage
 - 3.21. Testing, modification, adaptation, safety measures and extension of agricultural machinery
 - 3.22. Analysis of cost of operation of agricultural machinery
 - 3.23. Criteria for the selection of appropriate farm machinery and their combinations
 - 3.24. Storage and management of agricultural machinery
 - 3.25. Identification of research issues pertinent to mechanization, agricultural and labor productivity, and value chain development of agricultural commodities
- 4. Post-Harvest and Processing**
- 4.1. Grain drying, theory and practice.
 - 4.2. Technology of parboiling and milling of rice
 - 4.3. Processing and preservation of foods and seeds
 - 4.4. Design, construction, testing and evaluation of solar dryer of vegetables and fruits.
 - 4.5. Unit operation in processing of cereals, pulses, oilseeds, vegetables, and fruits
 - 4.6. Cleaning, grading, preservation and packaging of cereals, fruits, and vegetables
 - 4.7. Storage requirements for cereals grain, fruits, and vegetables
 - 4.8. Design requirements for fruit and vegetable processing equipment
 - 4.9. Value addition on agricultural and food products
- 5. Farmstead Planning and Agricultural Structures**
- 5.1. Planning of farmstead (farm buildings, farm roads, fishponds, electricity, water supply, storage structures, sewer lines/ drainage)
 - 5.2. Design and construction of animal shelters, poultry house, swine, sheep and goat house, grain, feed, and fodder storage structures
 - 5.3. Engineering materials (sand, stone, aggregate, brick, cement, steel, timber, paints)
 - 5.4. Design of steel and RCC structures
 - 5.5. Surveying (measurement of horizontal and vertical distance, angles and distance, topographic survey)
 - 5.6. Preparation of farm layout plans
 - 5.7. Building construction technology (brick and stone masonry, concreting, damp proofing, flooring, plastering, and painting)
 - 5.8. Environment control in farm buildings and animal shelter
 - 5.9. Planning, design, and development of crops production system in controlled environment- green house, screen house, mist house, phytotron
 - 5.10. Rate analysis, estimating and costing of engineering structures.
- 6. Soil, Water, Irrigation and Drainage**
- 6.1. Soil-water-plant-environment relationship, evaporation, transpiration, consumptive use, estimation of evapo-transpiration and crop water requirements

- 6.2. Soil water retentions and movement-saturated and unsaturated flow
- 6.3. Soil moisture tension, infiltration, and permeability
- 6.4. Ground water recovery, aquifers, hydraulics of wells, design of irrigation wells and well construction
- 6.5. Irrigation water lifting devices, centrifugal pump, turbine pump, submersible pump.
- 6.6. Pump selection, power requirement, efficiency, and economics of irrigation pumps
- 6.7. Measurement of irrigation water- weirs, Parshall flume, orifices, meter-gates, flowmeter, tracer technique
- 6.8. On-farm water distribution system, surface water distribution system, underground pipeline, design of open channel and water control system
- 6.9. Irrigation water application methods- check basin, border strip, furrow, pressurized methods of water application, irrigation efficiencies
- 6.10. Land leveling, grading and field layout,
- 6.11. Salinity in irrigated agriculture
- 6.12. Plant response to saline and alkaline soils and reclamation of saline soils.
- 6.13. Quality of irrigation water
- 6.14. Drainage investigation and effect on crop production
- 6.15. Methods of drainage
- 6.16. Layout of fields for efficient irrigation and drainage performance

7. Others

- 7.1. Principles of crop husbandry
- 7.2. Crop calendar, cropping pattern and cropping intensity.
- 7.3. Cropping systems by ecological zones and farming systems in Nepal
- 7.4. Production systems and practices of major cereal crops
- 7.5. Cultivation of major vegetables, fruits, and cash crops
- 7.6. Agro-meteorological data recording, analysis and integration in crop planning and decision making.

**

*

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), इण्टोमोलोजी उपसमूहको
खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Entomology

1 Insect Systematics

- 1.1 Survey of class insecta
- 1.2 Major tasks of systematics
 - 1.2.1 Identification
 - 1.2.2 Purpose of identification
 - 1.2.3 Methods of identification
 - 1.2.4 Problems encountered in identification.
- 1.3 Description: morphological, physiological, ecological, ethological, geographical, and molecular genetic characters
- 1.4 Concern with the proper application of the rules of nomenclature study of speciation
- 1.5 Classification
- 1.6 Nomenclature
- 1.7 Insect dominancy on the earth

2 Insect Physiology

- 2.1 Integument – cuticle structure and formation
- 2.2 Moulting physiology
- 2.3 Hemolymph physiology – composition, function, hemocytes and immune response
- 2.4 Neuroendocrine glands
- 2.5 Hormones: structures and functions
- 2.6 Endocrinology of moulting and metamorphosis
- 2.7 Central nervous system – structure and function
- 2.8 Sensory physiology – vision, mechanical and chemical
- 2.9 Semiochemicals – pheromones
- 2.10 Diapauses physiology

3 Insect Ecology

- 3.1 Ecological role of insect pests
- 3.2 Dynamics of insect life systems
- 3.3 Effects of environment on insect development
- 3.4 Regulation of insect population

4 Biological Control of Insect – pests

- 4.1 Brief history of biological control
- 4.2 Theory behind classical biological control
- 4.3 Agents of biological control
 - 4.3.1 Parasites and parasitoids

- 4.3.2 Predators
- 4.3.3 Pathogenic microorganisms
- 4.4 Practice of biological control
 - 4.4.1 Introduction
 - 4.4.2 Augmentation
 - 4.4.3 Conservation of natural enemies
- 5 Insecticide Toxicology**
 - 5.1 Principles of insecticide toxicology
 - 5.2 Insecticide classification, Mode of action, Metabolisms
 - 5.3 Environmental Effects of Insecticide
 - 5.4 Selectivity and Resistance to Insects.
 - 5.5 Insecticides in Nepal and Their Classification by Hazard
 - 5.6 Pesticide residue in plants and their products
 - 5.7 Pesticide Act, 2048 and Rules 2050
 - 5.8 FAO's International Code of Conduct on the Distribution and Uses of Pesticides
 - 5.9 GIFAP Code of Pesticide formulation
 - 5.10 Insecticides and Issues on Persistent Organic Pollutants (POPs)
 - 5.11 Developing pesticide resistance insects and their management
- 6 National Insect Pests of Agriculture, Their Life Histories, ecology and Management**
 - 6.1 Stem borers: (*Chilo partellus*) in maize; *Chilo suppressalis*) in rice; *Sesamia inferens*) in wheat
 - 6.2 Brown plant hopper (*Nilaparvata lugens*) in rice
 - 6.3 Gandhi bug (*Leptocorisa chinensis*) in rice
 - 6.4 White grubs (*Melolontha sp.*; *phyllophaga sp.*; *Holotrichia sp.*) in maize
 - 6.5 Cutworm (*Agrotis ipsilon*; *A. segetum*) in potato
 - 6.6 Peach-potato aphid (*Myzus persicae*) in potato
 - 6.7 Pumpkin fruitfly (*Bactrocera cucurbitae*) in cucurbit vegetable fruits
 - 6.8 Red ants (*Dorylus orientalis*) in potato
 - 6.9 Shoot and fruit borer (*Leucinodes orbonalis*) in eggplant
 - 6.10 Tomato fruit worm (*Helicoverpa armigera*) in tomato
 - 6.11 Oriental fruitfly (*Bactrocera dorsalis*) in sub-tropical fruits
 - 6.12 Citrus psylla (*Diaphrina citri*) in citrus
 - 6.13 Banana weevil (*Cosmopolites sordidus*; *Odoiporus longicolis*) in banana
 - 6.14 Pomegranate butterfly (*Deudorys epijarbas*; *virachola isocrates*) in pomegranate
 - 6.15 Apple wooly aphid (*Eriosoma lanigerum*) in temperate fruits
 - 6.16 San Jose scale (*Quadraspidiotus perniciosus*) in temperate fruits
 - 6.17 Grain weevil (*Sitophilu oryzae*) in stored wheat grain
 - 6.18 Grain legume bruchid (*Callasobruchus chinensis*) in stored grain legume
 - 6.19 Pest lists and regulated/non-regulated quarantine insect pests of Nepal.
- 7 Insect Vectors of Plant Pathogens**
 - 7.1 Aphids
 - 7.2 Leafhoppers

- 7.3 Planthoppers
- 7.4 Whiteflies and
- 7.5 Beetles

8 Biotechnology in Entomology

- 8.1 Plant Protection Tool to suppress insect pests
- 8.2 Merit and demerit of the technology
- 8.3 Genetically modified organism (GMO) issues
- 8.4 Living modified organism (LMO) issues

9 Integrated Pest Management (IPM)

- 9.1 The pest – management concept
- 9.2 Ecological aspects of pest management and Agro Ecosystem Analysis
- 9.3 Economic decision levels for pest populations
- 9.4 Tactics of pest management
 - 9.4.1 Plant resistance in pest management
 - 9.4.2 Parasitoids and predators in pest management
 - 9.4.3 Use of diseases in pest management
 - 9.4.4 Use of botanicals
 - 9.4.5 Insecticide in pest management
 - 9.4.6 Attractant, repellents and genetic control in pest management
 - 9.4.7 Integration of different pest management options.
- 9.5 The quantitative basis of pest management: sampling and measuring
- 9.6 History and Progress of IPM in Nepal
- 9.7 Farmer Field School

10 Insect Pest Management in Organic Farming

- 10.1 Bio-rational and Bio-intensive Approaches
- 10.2 Bio-technological Approaches
- 10.3 Bio-pesticides
- 10.4 Graft technology with resistant materials
- 10.5 Ecosystem Management and Biodiversity

11 Industrial Entomology

- 11.1 Sericulture
 - 11.1.1 Silk Worms
 - 11.1.2 Mulberry Silkworm, its biology, rearing silkworm, diseases and natural enemies
 - 11.1.3 Eri silkworm and Tassar silkworm
 - 11.1.4 Potential of sericulture development in Nepal
 - 11.1.5 Problems and constraints in sericulture industry
- 11.2 Apiculture
 - 11.2.1 Kinds and distribution of honey bees in Nepal
 - 11.2.2 Morphology and structural adaptations in honey bee
 - 11.2.3 Behaviour and activities of honey bees in bee colony

- 11.2.4 Foraging of bees and bee pasturage
- 11.2.5 Types of bee hives and other accessories
- 11.2.6 Care and management of an apiary
- 11.2.7 Enemies and diseases of honey bees and ways to avoid them to care bee colony
- 11.2.8 Uses of hive products and their marketing
- 11.2.9 Bee poisoning and ways to protect honey bees from pesticides
- 11.2.10 Honey bee pollination ecology

12 General Laboratory Techniques in Entomology

- 12.1 Insect rearing in natural and artificial diet
- 12.2 Simple methods of preparing insect collecting and rearing apparatuses in laboratory
- 12.3 Laboratory chemicals and glassware
- 12.4 Use of microscope
- 12.5 Insect preservation
- 12.6 Slide preparation
- 12.7 Dispatching insects to experts for authentic identification
- 12.8 Function and maintenance of laboratory equipments

13 Application of Statistics in Entomological Research

- 13.1 Elements of experimentation
- 13.2 Single factor Experiments, randomization, layout and analysis of variance
 - 13.2.1 Completely randomized design
 - 13.2.2 Randomized complete block design
 - 13.2.3 Latin square design
- 13.3 Data transformation
 - 13.3.1 Logarithmic transformation
 - 13.3.2 Square-root transformation
 - 13.3.3 Arc sine transformation
- 13.4 Comparison between treatment means
 - 13.4.1 Least significance difference
 - 13.4.2 Duncan's multiple range tests
 - 13.4.3 Regression and correlation analysis
- 13.5 Chi-square test

--
-
-

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), फूड टेक्नोलोजी उपसमूहको
खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Food Technology

1. Post-harvest and Food Technology

- 1.1 History of post harvest and food processing technology
- 1.2 Principles of food processing and preservation
- 1.3 Development in the areas of post harvest and food processing technology
- 1.4 Current use of post harvest and food processing technology
- 1.5 Emerging technologies for the preservation and processing of food: of hurdle technology, high pressure technology, microwave heating, ohmic heating, pulsed electric field, radiation, encapsulation, nano technology
- 1.6 Aseptic techniques in food processing
- 1.7 Packaging Technology- principles, materials and methods, products packaging compatibility, packaging and food safety, packaging technologies for emerging commodities marketing trend such as bio degradable packaging, edible packaging
- 1.8 Effect of various food processing technologies on nutritional quality of food
- 1.9 Minimal processing of food
- 1.10 Post-harvest physiology of various food commodities
- 1.11 Post harvest handling of different food products: cereal grains, pulses and oilseeds, fruits, vegetables, spices, tea, coffee
- 1.12 Post harvest and processing losses of various food commodities, their assessment and estimation. Methods for minimizing post harvest and processing losses and waste

2. Food Chemistry

- 2.1 Moisture in foods, free and bound water, moisture determination
- 2.2 Chemistry of : fats and oils, carbohydrates, proteins, vitamins and other nutrients
- 2.3 Chemistry of flavor and aroma in foods
- 2.4 Chemistry of: milk and milk products; meat and meat products; fruit, vegetable and their products; cereals, pulses/legumes and their products
- 2.5 Chemistry of food additives and preservatives
- 2.6 Chemistry of pesticides, veterinary drugs
- 2.7 Methods of chemical analysis of various food commodities, food additives, preservatives and contaminants

3. Policies, Plans and Legislation (related to production, processing, preservation and commercialization of food products in Nepal)

- 3.1 Food and Nutrition Security plans, policies and strategies
- 3.2 Bio-safety policy, Food Safety Policy 2075
- 3.3 Current food and feed acts regulation

3.4 Current consumers' protection act and regulation

3.5 Slaughterhouse and Meat Inspection Act

4. Development of Food Industries in Nepal

4.1 History, current status and prospects of food industries

4.2 Existing food safety and quality situation in Nepali food industries

4.3 Situation of food safety and quality management in Nepali food industries

4.4 Current Industrial Policy

4.5 Foreign Investment and Technology Transfer Act and Industrial Enterprises Act

4.6 Environment for the development of agro-food-industries

4.7 Feasibility study for the establishment of food-industry

4.8 Major issues and challenges of food processing industries

4.9 Current export promotion policy and strategies

4.10 Environmental pollution control and environmental protection including IEE and EIA for food industries

4.11 Current efforts by various government as well as non-governmental organizations including development partners for the development of agro-industries

5. Food Safety and Quality

5.1 Concept of Risk Analysis; Risk Assessment (hazard identification, exposure assessment, hazard characterization and risk characterization); Total Diet Study approach for risk assessment, risk management, risk communication.

5.2 Risk based Food Inspection System

5.3 Generic and horizontal standards of food, international, regional and national mandatory food standards

5.4 Bio-safety and GM foods

5.5 Role of Codex Alimentarius Commission for the development and harmonization of food standards

5.6 Food Import/Export Inspection and Certification Systems

5.7 Traceability System in food business

5.8 Food safety and quality regulation in federal system

5.9 Role of state and local government for the regulation of food safety and quality

5.10 Impact of food borne illnesses in health and nutritional status of vulnerable groups

5.11 Issues and challenges of food safety and quality in Nepal

5.12 Assurance of good practices in food testing laboratories such as GLP, ISO 17025

5.13 Making food value chain safe with the application of GAP, GVP, GHP, GMP, HACCP and ISO 22000

5.14 Importance of food/nutrition labeling for consumer awareness and better regulation

5.15 Implementation status of INFOSAN and WTO/ SPS/ TBT

6. Technological Research and Development

6.1 Research needs and priorities in the area of agro-food processing in Nepal

6.2 Adaptive and action research

6.3 Project concept and proposal writing

6.4 Logical framework approach for project development

- 6.5 Technological problems in the existing food industries of Nepal
- 6.6 Role of various organizations for the development and promotion of post-harvest and food processing technologies in Nepal
- 6.7 Research needs for traditional/indigenous food processing technologies of Nepal and their role in national economy
- 6.8 Issues and challenges of technological (food and post-harvest) development in Nepal

7. Food and Nutrition

- 7.1 Food, nutrients and their functions
- 7.2 Various types and forms of malnutrition
- 7.3 Assessment of nutritional status of vulnerable groups especially women and children: various methods and indicators. Anthropometric, biochemical, clinical and dietary methods for the assessment of nutritional status survey
- 7.4 Anti-nutritional factors and their effect on health and nutrition Role of diet in prevention and control of lifestyle related non-communicable diseases such as cardiovascular diseases, cancer and diabetes. Hidden hunger and double burden of mal-nutrition
- 7.5 National and International organizations/institutions working in the field of nutrition.
- 7.6 Existing policies, plans and programs on nutrition: Multi sectoral Nutrition Plan, Zero Hunger Challenge Initiative and Action Plan, Food and Nutrition Security Plan of Action
- 7.7 Challenges and issues of solving mal-nutrition problem in Nepal

8. Basic, Food and Biochemical Engineering

- 8.1 Use of engineering concepts in developing appropriate technologies in post-harvest, food processing and packaging of agro-products
- 8.2 Importance of scaling up in food plant design
- 8.3 Basic concepts of machine and building drawing
- 8.4 Wastewater engineering, BOD, COD
- 8.5 Genetic engineering and recombinant DNA technology
- 8.6 Enzyme engineering
- 8.7 Reactor/ Fermenter and design
- 8.8 Engineering factors in food processing and concept of unit operation and unit processes
- 8.9 Material and Heat balances
- 8.10 Kinetics of chemical reactions in foods
- 8.11 Thermal process calculation, drying/dehydration
- 8.12 Refrigeration
- 8.13 Fluid flow
- 8.14 Evaporation

9. Food / Industrial Microbiology and Food Biotechnology

- 9.1 Major causes of food spoilage and various methods of preservation of foods
- 9.2 Food borne infections and intoxications caused by microorganisms
- 9.3 Pure culture methods

- 9.4 Food fermentation and reaction kinetics
- 9.5 Food fermentations- dairy products, lactic fermentation of vegetables, sausage, oriental and Nepalese fermented foods
- 9.6 Single Cell Protein, production of yeast enzyme, citric acid, vinegar and amino acid
- 9.7 Production, processing and analysis of Genetically Modified Foods

10. Food Product Technologies

- 10.1 Fruits and vegetable processing technology
- 10.2 Spices technology
- 10.3 Tea and coffee processing technology
- 10.4 Meat, fish and poultry technology
- 10.5 Dairy technology
- 10.6 Cereal technology
- 10.7 Legumes and oilseed technology
- 10.8 Storage and packaging technology
- 10.9 Chocolate and confectionery technology
- 10.10 Alcoholic and non-alcoholic beverages production technology

11. Research Methods and Statistics

- 11.1 Introduction to research methodology : logical argument, research contexts, research ethics, formulating research questions, research approaches, utilization of research approaches, case research designs
- 11.2 Problem identification and hypothesis setting
- 11.3 Sampling and sample design
- 11.4 Data collection, processing and analysis
- 11.5 Hypothesis testing, Chi-square test, variance and covariance and multivariate analysis techniques
- 11.6 Measure of central tendencies : mean, mode and median
- 11.7 Correlation and regression analysis
- 11.8 Index numbers, time series analysis
- 11.9 Probability, theoretical distributions
- 11.10 Interpolation and extrapolation
- 11.11 Statistical quality control

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), प्लाण्ट प्याथोलोजी उपसमूहको
खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Plant Pathology

1. General Plant Pathology

- 1.1 Importance and History of Plant Pathology
- 1.2 Knowledge of Plant Diseases, their Identification and Classification
- 1.3 Different Agents causing Plant Diseases
 - 1.3.1 General characteristics (morphology, growth, reproduction), isolation, purification, taxonomy, nomenclature, classification of different fungi, bacteria, mycoplasmas and mycoplasma-like organisms
 - 1.3.2 General characteristics (morphology, growth, anatomy), isolation, taxonomy, nomenclature and classification of nematodes
 - 1.3.3 General characteristic (morphology, chemical composition, ultrastructure), isolation, purification, multiplication, transmission, serology, classification, nomenclature or grouping (cryptograms) of virus, viroid and virus-like organisms and
 - 1.3.4 Characteristics of non-infectious plant disease-causing agents (environments, nutrients, pollution, improper agricultural practices, etc.)
- 1.4 Infection and Disease Development
 - 1.4.1 Different mechanisms of infection by plant pathogens (Example: mechanical, chemicals, enzymes, toxins, growth regulators, etc.)
 - 1.4.2 Stages in development of plant diseases: Growth and reproduction (multiplication), dissemination (dispersal) and survival of plant pathogens
- 1.5 Effects of Plant Pathogens on Host Physiology (Effects on structure, growth and reproduction, photosynthesis, respiration and translocation of water and nutrients in the host plant)
- 1.6 Principles and practices of Plant disease management
 - 1.6.1 Principles and different methods
 - 1.6.2 Problems and progress in plant diseases management with special reference to Nepal
 - 1.6.3 Use of disease resistant varieties in Nepal: past experience and future strategy
- 1.7 Economic importance, distribution, disease symptoms, casual agents, disease cycle, predisposing factors of disease developments and adopted control measures of some nationally and internationally important diseases of major crop plants caused by:
 - 1.7.1 Fungi
 - 1.7.2 Bacteria
 - 1.7.3 Viruses and viroids
 - 1.7.4 Mycoplasma and mycoplasma-like organisms

- 1.7.5 Nematodes
- 1.7.6 Environmental factors and physiological disorder
- 2. Plant Disease Epidemiology and Early Warning**
 - 2.1 Effects of Environment on Plant Disease Development e.g. temperature, moisture, wind, light, soil pH, host plant nutrition and other environmental factors.
 - 2.2 Plant Disease Epidemiology and Forecasting
 - 2.2.1 Development of plant disease epidemiology
 - 2.2.2 Elements or essential conditions for plant disease epidemics
 - 2.2.3 Forecasting of plant diseases and their epidemics, and
 - 2.2.4 Simulation models for plant diseases forecasting
 - 2.3 Effects of Climate Change on Plant Disease epidemics
 - 2.4 Recent Disease Outbreaks of Economic Importance in Nepal
- 3. Genetics and Variability of Plant Pathogens**
 - 3.1 Genetics and variability of viruses
 - 3.2 Genetics and variability of bacteria
 - 3.3 Genetics and variability of fungi
 - 3.4 Mechanism of variability in fungi
- 4. Disease Management through Host Resistance**
 - 4.1 Types of host resistance
 - 4.2 Development of resistant varieties
 - 4.3 Testing of resistant varieties
 - 4.4 Recent advancements in breeding for resistance to plant pathogens in Nepalese context which have economic implications
- 5. Plant Disease Management**
 - 5.1 Pesticides in Plant Disease Control
 - 5.1.1 History, classification and formulation of pesticides
 - 5.1.2 Evaluation of pesticides, mode of action, and factors affecting the field performance of pesticides
 - 5.1.3 Application methods and appropriate application equipment and materials for pesticide application
 - 5.1.4 Storage, handling and disposal of pesticides
 - 5.2 Integrated Disease Management: Principles and application in Nepal with some important examples
- 6. Laboratory Plant Pathology**
 - 6.1 Plant pathological equipment and chemicals
 - 6.1.1 General and specific equipment and machineries used in plant pathology
 - 6.1.2 General and specific glass-wares used in plant pathology
 - 6.1.3 Various media to grow fungi, bacteria and other plant pathogens
 - 6.1.4 Commonly used chemicals and their uses in plant pathological laboratory
 - 6.2 Laboratory techniques

- 6.2.1 Survey, collection of disease specimens, specimen preservation and cataloguing
 - 6.2.2 General lab technique: Disinfection, sterilizing, isolation, staining, fixing, culturing, purification, maintenance and other lab-techniques
 - 6.2.3 Disease diagnosis, pathogenicity test (Koch's Postulate), host range studies
 - 6.3 Critical assessment of service delivery efficiency and effectiveness of public sector laboratories and scope for private sector laboratories
- 7. Scope of Biotechnology in Plant Pathology**
- 7.1 Use of molecular techniques in pathogens characterization and identification
 - 7.2 Uses in resistant breeding
 - 7.3 Uses in various methods of disease management
- 8. Post-Harvest Pathology**
- 8.1 Seed Pathology
 - 8.1.1 Seed borne diseases and seed health testing for major pathogens
 - 8.1.2 Nepal Seed Act in relation to seed pathology (Plant Pathology)
 - 8.2 Storage Fungi and Mycotoxins
 - 8.3 Importance of post-harvest pathology in agricultural trade
- 9. Plant Pathology and WTO**
- 9.1 Plant Protection and Plant Quarantine in Nepal
 - 9.1.1 Organizations, activities and act and rules
 - 9.1.2 Pesticide act and rules
 - 9.2 Plant Pathology/Plant Protection in relation to WTO and SAPTA
 - 9.3 Assessment of the Nepalese capacity in meeting WTO requirements in the case of plant disease control
- 10. Industrial Plant Pathology**
- 10.1 Mushroom: Importance of some edible mushroom, their identification and cultivation
 - 10.2 Mycorrhiza and their uses in plant pathology
 - 10.3 Potential of industrial plant pathology to develop as a competitive agro-enterprises in Nepal
- 11. Cross-cutting Areas having Implications in Plant Pathology Development**
- 11.1 Research designs and Statistical tools for Plant Pathological research
 - 11.2 General Knowledge of Nepal Agricultural Research Council
 - 11.2.1 Its organizations, roles, objectives, importance, major activities
 - 11.2.2 Its linkages within disciplinary divisions, commodity programs, R/ARS
 - 11.2.3 Its linkages with agricultural sectors of federal government, provincial government, local government, IAAS, and other national and International organizations
 - 11.3 Plant Pathology in relation to 20 years Agricultural Perspective Plan, recent past Five Year Plan of Nepal and agricultural policy of Government of Nepal

नेपाल सरकार
नेपाल कृषि अनुसन्धान परिषद्
पदपूर्ति समिति

(Candidates who likes to join NARC, should have some knowledge of different agricultural plans made from to time to time.)

- 11.4 Publication and Scientific Report Writing (Being in a scientific organization, one must have knowledge of scientific report writing and adequate knowledge to write and publish research articles in journals or periodicals based on publisher's instruction)
- 11.5 Project Concept notes
 - 11.5.1 Project cycle
 - 11.5.2 Different aspects of project preparation
- 11.6 Project Appraisal
 - 11.6.1 Project appraisal -what, why and how?
 - 11.6.2 Some important consideration in project appraisal
 - 11.6.3 Project appraisal techniques
- 11.7 Three Years Concept in Agriculture
- 11.8 Scientific Project Proposal Writing
- 11.9 Logical Framework Approach (LFA) of Project Formulation
 - 11.9.1 Basic principle and importance of LFA
 - 11.9.2 Process of LFA
 - 11.9.3 Component of log frame matrix
- 11.10 Constructing Log Frame Matrix
- 11.11 GIS and Remote Sensing: concept and application
 - 11.11.1 GIS functions with emphasis on spatial analysis
 - 11.11.2 GIS application in agricultural planning and plant pathology
 - 11.11.3 Use of remote sensing in agricultural planning
- 11.12 National Agriculture Extension Strategy (NAES)
- 11.13 Strength, Weakness, Opportunity and Threat (SWOT) analysis

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), स्वायत्त साइन्स उपसमूहको
खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Soil Science

- 1. Importance of Soil for the Existence of Plant and Animal Kingdoms**
- 2. Soil Genesis and Classification**
 - 2.1. Weathering and soil forming process
 - 2.2. Factors of soil formation
 - 2.3. Development of soil profiles
- 3. Soil Survey and Mapping**
 - 3.1. Base maps, and soil mapping
 - 3.2. Methods of soil survey and classification
 - 3.3. Application of Soil taxonomy in land use and crop production
 - 3.4. Remote sensing and geographic information system (GIS) in soil survey and classification
 - 3.5. Major soil classes and their characters in Nepal
 - 3.6. World Reference Base (WRB) soil classification system
- 4. Soil Physical Properties**
 - 4.1. Soil texture
 - 4.2. Soil structure
 - 4.3. Soil porosity, density and consistence
 - 4.4. Soil temperature, moisture and colour
 - 4.5. Infiltration, percolation and hydraulic conductivity
 - 4.6. Importance of soil physical properties in land use planning and crop production management
 - 4.7. Techniques for measuring soil physical properties
- 5. Soil Chemical Properties**
 - 5.1. Soil reaction (pH) and its importance in soil fertility and crop production
 - 5.2. General pH status of Nepal soils
 - 5.3. Soil organic matter and its importance in soil health, crop production and environmental protection
 - 5.4. General soil organic matter status in Nepal soils
 - 5.5. Clay mineralogy and its major types in Nepalese soils
 - 5.6. Cation exchange capacity and its importance in soil fertility management
 - 5.7. General cation exchange capacity status in Nepalese soils
 - 5.8. Factors affecting the cation exchange capacity in soils

6. Soil Fertility and Plant Nutrition

- 6.1. Basic concept of soil fertility and plant nutrition
- 6.2. Essential plant nutrients, their major function and visual deficiency symptoms
- 6.3. Plant uptake of the nutrients
- 6.4. Factors affecting the availability and uptake of the plant nutrients
- 6.5. The nitrogen, phosphorus and potassium cycle
- 6.6. Nutrient requirements and supply
- 6.7. Soil fertility evaluation techniques and their importance in crop production and environmental protections
- 6.8. Soil fertility status of Nepal and its implication in agriculture and environment
- 6.9. Strategy to be taken for maintaining / improving soil fertility for sustaining increased productivity under Nepalese conditions

7. Soil Acidity and Liming

- 7.1. Factors affecting soil acidity
- 7.2. Causes of acid soil infertility
- 7.3. Lime requirement and liming materials
- 7.4. Potential of commercial lime production in Nepal
- 7.5. Constraints to commercial use of lime in Nepal

8. Manures and Fertilizers

- 8.1. Production, storage, handling and application of manures in Nepal
- 8.2. Green manures and their popularity in Nepalese agriculture
- 8.3. The desirable characters of green manure crops
- 8.4. Fertilizer use and crops production status in Nepal
- 8.5. Fertilizer recommendation for major crops of Nepal
- 8.6. Fertilizer handling and storage situation in Nepal
- 8.7. Fertilizer quality control issues in Nepal
- 8.8. Crop response to fertilizers, manures and green manures under Nepalese conditions
- 8.9. Major types of fertilizer products available in Nepalese market
- 8.10. Problems emerging to the use of manures and fertilizers worldwide and particularly in Nepalese perspective

9. Soil Biology / Microbiology

- 9.1. Soil microorganism and their importance in soil health and fertility
- 9.2. Biological nitrogen fixation and its potential use in Nepalese agriculture
- 9.3. Popular microbiological inoculum potential for commercial production and distribution in Nepal
- 9.4. Major crops benefiting from biological N fixation

10. Soil and Water Conservation

- 10.1. Concepts and principles of soil and water conservation

- 10.2. Causes and effects of Soil erosion
- 10.3. Soil and water conservation: traditional methods, modern technologies, watershed management approach, bioengineering approach
- 10.4. Importance of soil and water conservation in the hill and mountain region of Nepal
- 10.5. Soil erosion assessment

11. Soil Management for Sustainable Agriculture and Environment

- 11.1. Sloping agriculture land techniques (SALT)
- 11.2. Integrated Plant Nutrition Management System (IPNMS)
- 11.3. Problem soils (saline, alkaline, acid soils etc) management techniques

12. Statistics

- 12.1. Elements of experimentation, complete randomized design-randomization, layout and analysis of variance
 - 12.1.1. Randomized complete block design-layout, randomization, and analysis of variance
- 12.2. Latin square design-randomization, layout, analysis of variance, efficiency of row and column-blocking of variance, efficiency of row column-blocking and lattice design-balance lattice designs partially balance lattice
- 12.3. Two factorial experiment randomization, layout analysis of variance, interaction
- 12.4. Split-plot design-randomization, analysis of variance
- 12.5. Three or more factorial design-split-split plot design, two or three factorial design, strip-split-plot design
- 12.6. Comparison-pair comparison by least significant deferent (LSD) and Duncan's Multiple Range Test (DMRT), group comparison-between-group comparison, within group comparison, trend comparison and factorial comparison
- 12.7. Regression and correlation- simple linear regression and correlation, multiple-linear regression and correlation, simple non-linear regression, multiple nonlinear regressions
- 12.8. Farmer's field as the test site
- 12.9. Importance and validity of statistical analysis in agriculture.

13. Others

- 13.1. Nepal Agricultural Research Council: establishment, objective, role and activities
- 13.2. Agriculture in recent five-year plan in Nepal
- 13.3. Present agricultural issues in different agro-ecological zones of Nepal
- 13.4. Fertilizer distribution sources and government policy in Nepal
- 13.5. Nepal Agricultural Research Council (NARC) guidelines and directives for sustainable agricultural development in Nepal
- 13.6. Main constraints for agricultural research and agricultural productivity in Nepal
- 13.7. Future scopes and strategies of advance agriculture research in Nepal
- 13.8. Strategies for soil fertility improvement and land degradation control management
- 13.9. Nutrient management using local resources

--

-

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), पोमोलोजी उपसमूहको
खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Pomology

1. Fundamentals of Fruit Production

- 1.1 Importance and scope of fruit production in Nepal
- 1.2 Opportunity of fruits crops in Nepal
- 1.3 Climate of Nepal
 - 1.3.1 Temperature
 - 1.3.2 Humidity
 - 1.3.3 Pressure
 - 1.3.4 Rainfall
 - 1.3.5 Sunshine hours
 - 1.3.6 Soil temperature
 - 1.3.7 Weather observation
 - 1.3.8 Climatic zones and their features in Nepal
 - 1.3.9 Climate change and its effect on fruit cultivation
- 1.4 Soils of Nepal and their classification
- 1.5 Land resources
 - 1.5.1 Physiographic distribution of Nepal
 - 1.5.2 Land systems, land use and land capability
- 1.6 Factors to be considered during Orchard establishment including site selection, lay out and planting of fruit plants
- 1.7 Nursery management
 - 1.7.1 Propagating structure
 - 1.7.2 Media
 - 1.7.3 Fertilizers
 - 1.7.4 Soil mixtures
 - 1.7.5 Stratification of seeds of different fruits
 - 1.7.6 Nursery bed preparation
 - 1.7.7 Planting of grafted plants in the beds
- 1.8 Propagation
 - 1.8.1 Sexual propagation
 - 1.8.1.1 Development of fruits and seeds
 - 1.8.1.2 Production of genetically pure seeds
 - 1.8.1.3 Techniques of seed production and handling
 - 1.8.1.4 Principles of propagation by seeds
 - 1.8.1.5 Techniques of propagation by seeds
 - 1.8.2 Asexual Propagation
 - 1.8.2.1 General aspects of Asexual propagation – importance of asexual propagation, reasons, changes in clones associated with age,

- production and maintenance of true to type clones, influence of scions in root stocks and influence of root stock on scions
- 1.8.2.2 Different types of rootstocks
 - 1.8.2.3 Different types of scions and their methods of collection and preservation for later use
 - 1.8.2.4 Cuttings
 - 1.8.2.5 Grafting
 - 1.8.2.6 Budding
 - 1.8.2.7 Layering
 - 1.8.2.8 Propagation by Specialized stems and roots
 - 1.8.2.9 Micro propagation
 - 1.8.2.10 Tissue culture
- 1.9 Cultural practices
- 1.10 Factors for fruit production
- 1.10.1 Human Resource
 - 1.10.2 Soils
 - 1.10.3 Water
 - 1.10.4 Climate
 - 1.10.5 Wind
 - 1.10.6 Light
 - 1.10.7 Temperature
 - 1.10.8 Frost
 - 1.10.9 Environmental potential
 - 1.10.10 Other factors
- 1.11 Training and pruning of the fruit trees
- 1.11.1 Importance of training and pruning
 - 1.11.2 Different methods of training and pruning
 - 1.11.3 Effects of pruning on plant growth
- 1.12 Problems of Fruiting
- 1.13 Mango malformation
- 1.14 Citrus decline
- 1.15 Post-harvest technology for minimizing the post-harvest loss.
- 2. Study on Major Fruit Crops like mango, banana, litchi, guava, papaya, pomegranate, jack fruit aonla, apple, pear, peach, plum, walnut, pecan nut, almond, apricot, cherry, persimmon, avocado, grapes and citrus fruits on the following aspects:**
- 2.1 Introduction, origin and distribution
 - 2.2 Taxonomy, Morphology and growth stages of plants
 - 2.3 Climate and soil requirement
 - 2.4 Cultivars
 - 2.5 Propagation techniques
 - 2.6 Planting method
 - 2.7 Cultural practices
 - 2.8 Weed control practices
 - 2.9 Manures and fertilizers management
 - 2.10 Pests and diseases control
 - 2.11 Harvesting, post-harvest handling and marketing

3. Weed and Weed Control

- 3.1 Classification of weeds and their distributions
- 3.2 Importance of weed control in fruit production
- 3.3 Common weeds of fruit orchard
- 3.4 Methods of weed control in fruit orchard

4. Soils and Fertilizers

- 4.1 Soil classification
- 4.2 Soil moisture
- 4.3 Surface tension
- 4.4 Water holding capacity
- 4.5 Water movement in soil
- 4.6 Essential plant nutrients
- 4.7 Classification of plant nutrients
- 4.8 Functions of macro and micro nutrients symptoms and deficiency
- 4.9 Forms of nutrients utilized by plants
- 4.10 Chemical fertilizers- composition, classification and their uses
- 4.11 Process of absorption of nutrients by plant
- 4.12 Loss of plant nutrients from soil
- 4.13 Determination of nutrient requirements of the soils
- 4.14 Response of N.P.K. in major fruit crops
- 4.15 Soil pH, its measurement, limiting materials available for correcting soil pH, reaction of liming materials when applied in the soils
- 4.16 Liming and liming materials
- 4.17 Soil organic matters
- 4.18 C: N ratio
- 4.19 Recommended doses of nutrients, time and methods of application
- 4.20 Soil organism and their functions
- 4.21 Green manuring
- 4.22 Farm yard manure and compost
- 4.23 Compost preparation

5. Plant Breeding

- 5.1 Definition and importance of plant breeding
- 5.2 Genotypes and phenotypes
- 5.3 Methods of breeding of fruit crops
- 5.4 Germplasm collection, evaluation and utilization
- 5.5 Methods of hybridization to improve fruit crops.
- 5.6 Maintenance of fruit varieties
- 5.7 Application of biotechnology and tissue culture in fruit crop breeding.

6. Growth Regulation

- 6.1 Photosynthesis, respiration and transpiration
- 6.2 Dynamics of growth
 - 6.2.1 Growth of individual plants
 - 6.2.2 Growth of plant community
 - 6.2.3 Differential growth
 - 6.2.4 Polarity and differentiation
- 6.3 Growth regulators

- 6.3.1 Auxin, Gibberellins, and cytokines
 - 6.3.1.1 Occurrences
 - 6.3.1.2 Distribution
 - 6.3.1.3 Metabolism
 - 6.3.1.4 Degradation
 - 6.3.1.5 Sources and relation to growth
 - 6.3.1.6 Transport
 - 6.3.1.7 Effect
 - 6.3.1.8 Synthetic
 - 6.3.1.9 Mechanism of action

- 6.3.2 Ethylene
 - 6.3.2.1 Occurrence
 - 6.3.2.2 Movement
 - 6.3.2.3 Structure and activity
 - 6.3.2.4 Regulatory action
 - 6.3.2.5 Mechanism of action

- 6.3.3 Inhibitors
 - 6.3.3.1 Chemical nature of inhibitors
 - 6.3.3.2 Abscisic acid
 - 6.3.3.3 Phenolic inhibitors
 - 6.3.3.3 Other inhibitors

- 6.4 Development
 - 6.4.1 Germination and dormancy of seeds
 - 6.4.2 Juvenility, maturity and senescence
 - 6.4.3 Photoperiodism and flowering
 - 6.4.4 Vernalisation and flowering
 - 6.4.5 Genetic mechanism of flowering
 - 6.4.6 Substance regulating flowering
 - 6.4.7 Fruiting – pollination, fruit set, fruit growth, fruit ripening

7. Statistics

- 7.1 Mean, median, mode, standard deviation, standard error, frequency, probability, distribution, sampling theory, test of hypothesis, confidence interval
- 7.2 Estimate of error- replication and randomization
- 7.3 Experimental designs- complete randomized, Randomized complete block, Latin square, lattice, two factorial experiment, split plot and three or more factorial designs
- 7.4 Comparison
- 7.5 Regression and correlation
- 7.6 Importance and validity of statistics in agriculture

8. Others

- 8.1 Planning, monitoring and evaluation
- 8.2 Research project proposal preparation
- 8.3 Motivation and development
- 8.4 How to be a successful scientist in Nepalese condition
- 8.5 Report writing
- 8.6 Leadership
- 8.7 Linkage of research, extension and training

नेपाल सरकार
नेपाल कृषि अनुसन्धान परिषद्
पदपूर्ति समिति

- 8.8 NARC, its establishment, objectives and activities
- 8.9 Diversions and Agriculture Research stations involved in fruit research and development in NARC
- 8.10 Main constraints for agricultural research and development in Nepal

*

NARC पदपूर्ति समिति

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), ओलरिकल्चर उपसमूहको
खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Olericulture

1. Vegetable Production

Production practices of following vegetables relating to location, altitude, aspect, soil, climate, seed, open pollinated & hybrid cultivar, sowing and transplanting time, spacing, irrigation, drainage, manure, fertilizer micro-nutrients, mulching, harvesting time, inter-cropping, mix-cropping and relay-cropping on production, productivity and quality of fresh vegetables

- 1.1 Potato, sweet potato, yam, colocasia
- 1.2 Tomato, brinjal, hot chilly, sweet pepper okra
- 1.3 Cauliflower, cabbage, Chinese cabbage and broccoli
- 1.4 Bean, pea, cowpea, broad bean and vegetable soybean
- 1.5 Radish, turnip and carrot
- 1.6 Onion and garlic
- 1.7 Cucumber, bottle gourd, sponge gourd, bitter gourd, pointed gourd, ridge gourd, snake gourd, pumpkin and squash
- 1.8 Broad leaf mustard, Swiss chard, cress, spinach, fenugreek, coriander and lettuce
- 1.9 Ginger and cardamom
- 1.10 Asparagus, artichoke, drumstick and tree tomato

2. Organic Vegetable Production

- 2.1 Constraints and potentialities of organic vegetable production and marketing
- 2.2 Need of research and development activities on organic vegetable production
- 2.3 Use of non-chemical methods and means for disease management
- 2.4 Use of non-chemical methods and means for insect pest management.
- 2.5 Use of non-chemical methods and means for soil fertility management.
- 2.6 Quality standard of organic vegetables and system of organic certification
- 2.7 Economics of organic vegetable production

3. Off-season Vegetables Production

- 3.1 Present status, constraints and potentiality
- 3.2 Utilization of diverse agro-climatic zones for off-season vegetables production
- 3.3 Suitable crops, varieties and months for off-season production
- 3.4 Protected cultivation:- Green house, lath house, plastic tunnel, hot beds, cold frame
- 3.5 Improved cultural and management technologies and practices for off-season production
- 3.6 Cost and benefits of off-season vegetable production
- 3.7 Marketing strategies for off-season vegetable production

4. Seed Production Technology

- 4.1. Influence of location, aspects, altitude, temperature, light, daylight, spacing irrigation, manures, fertilizers, micro nutrients, hormone, direct seeding, stickling-transplanting, seeding and planting time on seed yield and seed quality
- 4.2. Breeder, nucleus and foundation and improved seed production
- 4.3. Pollination, fertilization, seed development, dormancy and germination
- 4.4. Variety maintenance methods
- 4.5. Seed standard and field standard
- 4.6. Seed testing, certification and field inspection
- 4.7. Seed production methods for open pollinated and hybrid cultivars
- 4.8. Effects of harvesting time, threshing, drying, grading, packing and storage on quality of vegetable seed
- 4.9. Existing vegetable seed production zones and potential areas of the country
- 4.10. Present production, supply, demand, export and import situation of vegetable seed in Nepal
- 4.11. Major problems and weakness of vegetable seed research, vegetable seed production and marketing in Nepal
- 4.12. Disease free seed potato production technology
- 4.13. Economics of vegetable seed production
- 4.14. Srijana F1 hybrid tomato seed production technology

5. Post-harvest Technology of Vegetables

- 5.1. Post harvest physiology- respiration, transpiration and ethylene production
- 5.2. Method of harvesting, cleaning, grading, and packaging
- 5.3. Post harvest handling, transportation and marketing
- 5.4. Harvesting of vegetables for local and distant markets
- 5.5. Causes of deterioration in harvested vegetables
- 5.6. Consumer's acceptability and quality evaluation of vegetables
- 5.7. Processing and preservation of vegetables, potato, ginger and cardamom
- 5.8. Concept of collection centers and market structures
- 5.9. Available post-harvest technologies on major vegetables

6. Modern Technology of Vegetable Production

- 6.1. Tissue culture and bio-technology
- 6.2. Drip and other micro irrigation
- 6.3. Plastic tunnel, plastic house and plastic mulching
- 6.4. Micro-nutrient, multi-nutrient, liquid fertilizers and bio-fertilizers
- 6.5. Latest recommended superior hybrid and superior open pollinated cultivars
- 6.6. Biological methods for disease and pest management
- 6.7. Integrated disease and pest management
- 6.8. Integrated soil and plant nutrient management
- 6.9. Hydroponics pre basic seed potato production technology
- 6.10. Good agriculture practice (GAP) in safe vegetable production

7. Indigenous Technology

- 7.1 Local and wild edible vegetables, species, cultivars and their usefulness
- 7.2 Indigenous practices of vegetable cultivation
- 7.3 Indigenous methods of disease and pest control and preventive measure
- 7.4 Indigenous methods of soil fertility improvement and management
- 7.5 Indigenous methods and management of water conservation and utilization

8. Plant Genetic and Improvement

- 8.1 Genes and their action
- 8.2 Genotypes phenotype and its heritability
- 8.3 Homozygous and heterozygosity
- 8.4 Improvement of variation
- 8.5 Breeding methods: self-pollinated crops, cross pollinated crops
- 8.6 Concept of heterosis and development of hybrid variety
- 8.7 Mutation breeding
- 8.8 Genetic erosion and transformation
- 8.9 Use of transgenic plants

9. Vegetable Crop Physiology

- 9.1 Photosynthesis
- 9.2 Respiration
- 9.3 Transpiration and translocation
- 9.4 Growth and development: cell division, enlargement and differentiation
- 9.5 Photoperiodism, light intensity and quality
- 9.6 Stress physiology - temperature stresses, moisture stresses and nutrient stresses
- 9.7 Physiological disorders in vegetable crops

10. Research Methods and Management

- 10.1 Researchable area identification
- 10.2 Research project prioritization
- 10.3 Research project proposal preparation
- 10.4 Design of experiments and its basic characters
- 10.5 Exploratory research
- 10.6 Academic research
- 10.7 Multi-disciplinary research
- 10.8 Multi-location research
- 10.9 Outreach research
- 10.10 Farmers' participatory research
- 10.11 Socioeconomic and market research
- 10.12 Collaborative research
- 10.13 Multi-partnership research
- 10.14 Data base preparation
- 10.15 Data analysis, technical report writing and presentation

11. Biological Statistics

- 11.1 Need of biological statistics for research
- 11.2 Probability, frequency, mean, median, mode, standard deviation, standard error, normal distribution, sampling theory, test of hypothesis, and confidence interval, T-test, F Test and Chi-square test
- 11.3 Estimate of error: Replication and randomization
- 11.4 Control error: Blocking, proper plot technique and data analysis
- 11.5 Complete randomized design: Randomization, layout and analysis of variance
- 11.6 Randomized complete block design: - Layout, randomization, analysis of variance.
- 11.7 Latin square design:- Randomization, layout, analysis of variance and efficiency of row and column- blocking.
- 11.8 Incomplete block design:- Layout, randomization and analysis of variance.
- 11.9 Two or more factorial experiment-randomization, layout, analysis of variance and interaction.
- 11.10 Split plot design: Randomization, analysis of variance and interaction of factors.
- 11.11 Strip-plot design: Randomization, layout analysis of variance.
- 11.12 Comparison: Pair comparison by Least Significant Different (LSD) and Duncan's Multiple Range Test (DMRT), group comparison - between- group comparison, within group comparison, trend comparison and factorial comparison.
- 11.13 Regression and correlation: Simple linear regression and correlation, multiple-linear regression and correlation, simple non-linear regression, multiple nonlinear regression.
- 11.14 Co-variance, bi-variate and multi-variate analysis.
- 11.15 Non-parametric tests.
- 11.16 Qualitative data analysis.
- 11.17 Use of statistical tools in data analysis.

12. Others

- 12.1 History, impact and importance of horticultural research and development plans and programs in Nepal.
- 12.2 Production constraints to horticultural crops production in Nepal and possible remedies.
- 12.3 History, objective, role and activities of Nepal Agricultural Research Council (NARC).
- 12.4 Organizational structure of NARC and activities of major institutions under it.
- 12.5 National and international linkages for horticultural research and development
- 12.6 Prospects of horticultural crops production.
- 12.7 Prioritization of horticulture crops for research and development in Nepalese context.
- 12.8 Planning, implantation and monitoring of horticultural research programs for Nepal.
- 12.9 Concept of pocket area development and satellite farming.

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), ओलरिकल्चर/ पोमोलोजी उप समूहको
खुला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject: Olericulture/Pomology

A : Olericulture

1. Vegetable Production

Production practices of following vegetables relating to location, altitude, aspect, soil, climate, seed, open pollinated & hybrid cultivar, sowing and transplanting time, spacing, irrigation, drainage, manure, fertilizer micro-nutrients, mulching, harvesting time, inter-cropping, mix-cropping and relay-cropping on production, productivity and quality of fresh vegetables

- 1.11 Potato, sweet potato, yam, colocasia
- 1.12 Tomato, brinjal, hot chilly, sweet pepper okra
- 1.13 Cauliflower, cabbage, Chinese cabbage and broccoli
- 1.14 Bean, pea, cowpea, broad bean and vegetable soybean
- 1.15 Radish, turnip and carrot
- 1.16 Onion and garlic
- 1.17 Cucumber, bottle gourd, sponge gourd, bitter gourd, pointed gourd, ridge gourd, snake gourd, pumpkin and squash
- 1.18 Broad leaf mustard, Swiss chard, cress, spinach, fenugreek, coriander and lettuce
- 1.19 Ginger and cardamom
- 1.20 Asparagus, artichoke, drumstick and tree tomato

2. Organic Vegetable Production

- 2.1 Constraints and potentialities of organic vegetable production and marketing
- 2.2 Need of research and development activities on organic vegetable production
- 2.3 Use of non-chemical methods and means for disease management
- 2.4 Use of non-chemical methods and means for insect pest management.
- 2.5 Use of non-chemical methods and means for soil fertility management.
- 2.6 Quality standard of organic vegetables and system of organic certification
- 2.7 Economics of organic vegetable production

3. Off-season Vegetables Production

- 3.8 Present status, constraints and potentiality
- 3.9 Utilization of diverse agro-climatic zones for off-season vegetables production
- 3.10 Suitable crops, varieties and months for off-season production
- 3.11 Protected cultivation: - Green house, lath house, plastic tunnel, hot beds, cold frame
- 3.12 Improved cultural and management technologies and practices for off-season production
- 3.13 Cost and benefits of off-season vegetable production
- 3.14 Marketing strategies for off-season vegetable production

4. Seed Production Technology

- 4.15. Influence of location, aspects, altitude, temperature, light, daylight, spacing irrigation, manures, fertilizers, micro nutrients, hormone, direct seeding, stickling-transplanting, seeding and planting time on seed yield and seed quality
- 4.16. Breeder, nucleus and foundation and improved seed production
- 4.17. Pollination, fertilization, seed development, dormancy and germination
- 4.18. Variety maintenance methods
- 4.19. Seed standard and field standard
- 4.20. Seed testing, certification and field inspection
- 4.21. Seed production methods for open pollinated and hybrid cultivars
- 4.22. Effects of harvesting time, threshing, drying, grading, packing and storage on quality of vegetable seed
- 4.23. Existing vegetable seed production zones and potential areas of the country
- 4.24. Present production, supply, demand, export and import situation of vegetable seed in Nepal
- 4.25. Major problems and weakness of vegetable seed research, vegetable seed production and marketing in Nepal
- 4.26. Disease free seed potato production technology
- 4.27. Economics of vegetable seed production
- 4.28. F1 hybrid tomato and cucumber seed production technology in Nepal

5. Post-harvest Technology of Vegetables

- 5.10. Post harvest physiology- respiration, transpiration and ethylene production
- 5.11. Method of harvesting, cleaning, grading, and packaging
- 5.12. Post harvest handling, transportation and marketing
- 5.13. Harvesting of vegetables for local and distant markets
- 5.14. Causes of deterioration in harvested vegetables
- 5.15. Consumer's acceptability and quality evaluation of vegetables
- 5.16. Processing and preservation of vegetables, potato, ginger and cardamom
- 5.17. Concept of collection centers and market structures
- 5.18. Available post-harvest technologies on major vegetables

6. Modern Technology of Vegetable Production

- 6.11. Tissue culture and bio-technology
- 6.12. Drip and other micro irrigation
- 6.13. Plastic tunnel, plastic house and plastic mulching
- 6.14. Micro-nutrient, multi-nutrient, liquid fertilizers and bio-fertilizers
- 6.15. Latest recommended superior hybrid and superior open pollinated cultivars
- 6.16. Biological methods for disease and pest management
- 6.17. Integrated disease and pest management
- 6.18. Integrated soil and plant nutrient management
- 6.19. Hydroponics pre basic seed potato production technology
- 6.20. Good agriculture practice (GAP) in safe vegetable production

7. Indigenous Technology

- 7.1 Local and wild edible vegetables, species, cultivars and their usefulness
- 7.2 Indigenous practices of vegetable cultivation
- 7.3 Indigenous methods of disease and pest control and preventive measure
- 7.4 Indigenous methods of soil fertility improvement and management
- 7.5 Indigenous methods and management of water conservation and utilization

8. Plant Genetic and Improvement

- 8.1 Genes and their action
- 8.2 Genotypes phenotype and its heritability
- 8.3 Homozygous and heterozygosity
- 8.4 Improvement of variation
- 8.5 Breeding methods: self-pollinated crops, cross pollinated crops
- 8.6 Concept of heterosis and development of hybrid variety
- 8.7 Mutation breeding
- 8.8 Genetic erosion and transformation
- 8.9 Use of transgenic plants

B : Pomology

9. Fundamentals of Fruit Production

- 1.16 Importance and scope of fruit production in Nepal
- 1.17 Opportunity of fruits crops in Nepal
- 1.18 Climate of Nepal
 - 1.18.1 Temperature
 - 1.18.2 Humidity
 - 1.18.3 Pressure
 - 1.18.4 Rainfall
 - 1.18.5 Sunshine hours
 - 1.18.6 Soil temperature
 - 1.18.7 Weather observation
 - 1.18.8 Climatic zones and their features in Nepal
 - 1.18.9 Climate change and its effect on fruit cultivation
- 1.19 Soils of Nepal and their classification
- 1.20 Land resources
 - 1.20.1 Physiographic distribution of Nepal
 - 1.20.2 Land systems, land use and land capability
- 1.21 Factors to be considered during Orchard establishment including site selection, layout and planting of fruit plants
- 1.22 Nursery management
 - 1.22.1 Propagating structure
 - 1.22.2 Media
 - 1.22.3 Fertilizers
 - 1.22.4 Soil mixtures
 - 1.22.5 Stratification of seeds of different fruits
 - 1.22.6 Nursery bed preparation
 - 1.22.7 Planting of grafted plants in the beds
- 1.23 Propagation

- 1.23.1 Sexual propagation
 - 1.8.1.1 Development of fruits and seeds
 - 1.8.1.2 Production of genetically pure seeds
 - 1.8.1.3 Techniques of seed production and handling
 - 1.8.1.4 Principles of propagation by seeds
 - 1.8.1.5 Techniques of propagation by seeds
 - 1.23.2 Asexual Propagation
 - 1.8.2.1 General aspects of Asexual propagation – importance of asexual propagation, reasons, changes in clones associated with age, production and maintenance of true to type clones, influence of scions in root stocks and influence of root stock on scions
 - 1.8.2.2 Different types of rootstocks
 - 1.8.2.3 Different types of scions and their methods of collection and preservation for later use
 - 1.8.2.4 Cuttings
 - 1.8.2.5 Grafting
 - 1.8.2.6 Budding
 - 1.8.2.7 Layering
 - 1.8.2.8 Propagation by Specialized stems and roots
 - 1.8.2.9 Micro propagation
 - 1.8.2.10 Tissue culture
 - 1.24 Cultural practices
 - 1.25 Factors for fruit production
 - 1.10.11 Human Resource
 - 1.10.12 Soils
 - 1.10.13 Water
 - 1.10.14 Climate
 - 1.10.15 Wind
 - 1.10.16 Light
 - 1.10.17 Temperature
 - 1.10.18 Frost
 - 1.10.19 Environmental potential
 - 1.10.20 Other factors
 - 1.26 Training and pruning of the fruit trees
 - 1.11.4 Importance of training and pruning
 - 1.11.5 Different methods of training and pruning
 - 1.11.6 Effects of pruning on plant growth
 - 1.27 Problems of Fruiting
 - 1.28 Mango malformation
 - 1.29 Citrus decline
 - 1.30 Post-harvest technology for minimizing the post-harvest loss.
- 2. Study on Major Fruit Crops like** mango, banana, litchi, guava, papaya, pomegranate, jack fruit aonla, apple, pear, peach, plum, walnut, pecan nut, almond, apricot, cherry, persimmon, avocado, kiwifruit, grapes and citrus fruits on the following aspects:
- 2.12 Introduction, origin and distribution
 - 2.13 Taxonomy, Morphology and growth stages of plants
 - 2.14 Climate and soil requirement
 - 2.15 Cultivars
 - 2.16 Propagation techniques

- 2.17 Planting method
- 2.18 Cultural practices
- 2.19 Weed control practices
- 2.20 Manures and fertilizers management
- 2.21 Pests and diseases control
- 2.22 Harvesting, post-harvest handling and marketing

3. Weed and Weed Control

- 3.1 Classification of weeds and their distributions
- 3.2 Importance of weed control in fruit production
- 3.3 Common weeds of fruit orchard
- 3.4 Methods of weed control in fruit orchard

4. Plant Breeding

- 4.1 Definition and importance of plant breeding
- 4.2 Genotypes and phenotypes
- 4.3 Methods of breeding of fruit crops
- 4.4 Germplasm collection, evaluation and utilization
- 4.5 Methods of hybridization to improve fruit crops
- 4.6 Maintenance of fruit varieties
- 4.7 Application of bio-technology and tissue culture in fruit crop breeding.

C: Other General Topics

1. Growth Regulation

- 1.1 Photosynthesis, respiration and transpiration
- 1.2 Dynamics of growth
 - 1.2.1 Growth of individual plants
 - 1.2.2 Growth of plant community
 - 1.2.3 Differential growth
 - 1.2.4 Polarity and differentiation
- 1.3 Growth regulators
 - 1.3.1 Auxin, Gibberellins, and cytokines
 - 1.3.1.1 Occurrences
 - 1.3.1.2 Distribution
 - 1.3.1.3 Metabolism
 - 1.3.1.4 Degradation
 - 1.3.1.5 Sources and relation to growth
 - 1.3.1.6 Transport
 - 1.3.1.7 Effect
 - 1.3.1.8 Synthetic
 - 1.3.1.9 Mechanism of action
 - 1.3.2 Ethylene
 - 6.3.2.1 Occurrence
 - 6.3.2.2 Movement
 - 6.3.2.3 Structure and activity
 - 6.3.2.4 Regulatory action
 - 6.3.2.5 Mechanism of action
 - 1.3.3 Inhibitors
 - 1.3.3.1 Chemical nature of inhibitors
 - 1.3.3.2 Abscisic acid
 - 1.3.3.3 Phenolic inhibitors

- 1.3.3.3 Other inhibitors
- 1.4 Development
 - 1.4.1 Germination and dormancy of seeds
 - 1.4.2 Juvenility, maturity and senescence
 - 1.4.3 Photoperiodism and flowering
 - 1.4.4 Vernalisation and flowering
 - 1.4.5 Genetic mechanism of flowering
 - 1.4.6 Substance regulating flowering
 - 1.4.7 Fruiting – pollination, fruit set, fruit growth, fruit ripening
- 2. Horticultural Crop Physiology**
 - 2.1 Photosynthesis
 - 2.2 Respiration
 - 2.3 Transpiration and translocation
 - 2.4 Growth and development: cell division, enlargement and differentiation
 - 2.5 Photoperiodism, light intensity and quality
 - 2.6 Stress physiology - temperature stresses, moisture stresses and nutrient stresses
 - 2.7 Physiological disorders in horticultural crops
- 3. Soils and Fertilizers**
 - 3.1 Soil classification
 - 3.2 Soil moisture
 - 3.3 Surface tension
 - 3.4 Water holding capacity
 - 3.5 Water movement in soil
 - 3.6 Essential plant nutrients
 - 3.7 Classification of plant nutrients
 - 3.8 Functions of macro and micro nutrients symptoms and deficiency
 - 3.9 Forms of nutrients utilized by plants
 - 3.10 Chemical fertilizers- composition, classification and their uses
 - 3.11 Process of absorption of nutrients by plant
 - 3.12 Loss of plant nutrients from soil
 - 3.13 Determination of nutrient requirements of the soils
 - 3.14 Response of N.P.K. in major fruit crops
 - 3.15 Soil pH, its measurement, limiting materials available for correcting soil pH, reaction of liming materials when applied in the soils
 - 3.16 Liming and liming materials
 - 3.17 Soil organic matters
 - 3.18 C: N ratio
 - 3.19 Recommended doses of nutrients, time and methods of application
 - 3.20 Soil organism and their functions
 - 3.21 Green manuring
 - 3.22 Farm yard manure and compost
 - 3.23 Compost preparation
- 4. Statistics**
 - 4.1 Mean, median, mode, standard deviation, standard error, frequency, probability, distribution, sampling theory, test of hypothesis, confidence interval
 - 4.2 Estimate of error- replication and randomization

- 4.3 Experimental designs- complete randomized, Randomized complete block, Latin square, lattice, two factorial experiment, split plot and three or more factorial designs
- 4.4 Comparison
- 4.5 Regression and correlation
- 4.6 Importance and validity of statistics in agriculture

5. Others

- 5.1 History, impact and importance of horticultural research and development plans and programs in Nepal.
- 5.2 Production constraints to horticultural crops production in Nepal and possible remedies.
- 5.3 History, objective, role and activities of Nepal Agricultural Research Council (NARC).
- 5.4 Organizational structure of NARC and activities of major institutions under it.
- 5.5 National and international linkages for horticultural research and development
- 5.6 Prospects of horticultural crops production.
- 5.7 Prioritization of horticulture crops for research and development in Nepalese context.
- 5.8 Planning, implantation and monitoring of horticultural research programs for Nepal.
- 5.9 Concept of pocket area development and satellite farming.

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), हर्टिकल्चर उप समूहको खुला तथा आन्तरिक
प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject: Horticulture

A : Vegetable

1. Vegetable Production

Production practices of following vegetables relating to location, altitude, aspect, soil, climate, seed, open pollinated & hybrid cultivar, sowing and transplanting time, spacing, irrigation, drainage, manure, fertilizer micro-nutrients, mulching, harvesting time, inter-cropping, mix-cropping and relay-cropping on production, productivity and quality of fresh vegetables

- 1.21 Potato, sweet potato, yam, colocasia
- 1.22 Tomato, brinjal, hot chilly, sweet pepper okra
- 1.23 Cauliflower, cabbage, Chinese cabbage and broccoli
- 1.24 Bean, pea, cowpea, broad bean and vegetable soybean
- 1.25 Radish, turnip and carrot
- 1.26 Onion and garlic
- 1.27 Cucumber, bottle gourd, sponge gourd, bitter melon, pointed gourd, ridge gourd, snake gourd, pumpkin and squash
- 1.28 Broad leaf mustard, Swiss chard, cress, spinach, fenugreek, coriander and lettuce
- 1.29 Ginger and cardamom
- 1.30 Asparagus, artichoke, drumstick and tree tomato

2. Organic Vegetable Production

- 2.1 Constraints and potentialities of organic vegetable production and marketing
- 2.2 Need of research and development activities on organic vegetable production
- 2.3 Use of non-chemical methods and means for disease management
- 2.4 Use of non-chemical methods and means for insect pest management.
- 2.5 Use of non-chemical methods and means for soil fertility management.
- 2.6 Quality standard of organic vegetables and system of organic certification
- 2.7 Economics of organic vegetable production

3. Off-season Vegetables Production

- 3.15 Present status, constraints and potentiality
- 3.16 Utilization of diverse agro-climatic zones for off-season vegetables production
- 3.17 Suitable crops, varieties and months for off-season production
- 3.18 Protected cultivation:- Green house, lath house, plastic tunnel, hot beds, cold frame
- 3.19 Improved cultural and management technologies and practices for off-season production
- 3.20 Cost and benefits of off-season vegetable production
- 3.21 Marketing strategies for off-season vegetable production

4. Seed Production Technology

- 4.29. Influence of location, aspects, altitude, temperature, light, daylight, spacing irrigation, manures, fertilizers, micro nutrients, hormone, direct seeding, stickling-transplanting, seeding and planting time on seed yield and seed quality
- 4.30. Breeder, nucleus and foundation and improved seed production
- 4.31. Pollination, fertilization, seed development, dormancy and germination
- 4.32. Variety maintenance methods
- 4.33. Seed standard and field standard
- 4.34. Seed testing, certification and field inspection
- 4.35. Seed production methods for open pollinated and hybrid cultivars
- 4.36. Effects of harvesting time, threshing, drying, grading, packing and storage on quality of vegetable seed
- 4.37. Existing vegetable seed production zones and potential areas of the country
- 4.38. Present production, supply, demand, export and import situation of vegetable seed in Nepal
- 4.39. Major problems and weakness of vegetable seed research, vegetable seed production and marketing in Nepal
- 4.40. Disease free seed potato production technology
- 4.41. Economics of vegetable seed production
- 4.42. F1 hybrid tomato and cucumber seed production technology in Nepal

5. Post-harvest Technology of Vegetables

- 5.19. Post harvest physiology- respiration, transpiration and ethylene production
- 5.20. Method of harvesting, cleaning, grading, and packaging
- 5.21. Post harvest handling, transportation and marketing
- 5.22. Harvesting of vegetables for local and distant markets
- 5.23. Causes of deterioration in harvested vegetables
- 5.24. Consumer's acceptability and quality evaluation of vegetables
- 5.25. Processing and preservation of vegetables, potato, ginger and cardamom
- 5.26. Concept of collection centers and market structures
- 5.27. Available post-harvest technologies on major vegetables

6. Modern Technology of Vegetable Production

- 6.21. Tissue culture and bio-technology
- 6.22. Drip and other micro irrigation
- 6.23. Plastic tunnel, plastic house and plastic mulching
- 6.24. Micro-nutrient, multi-nutrient, liquid fertilizers and bio-fertilizers
- 6.25. Latest recommended superior hybrid and superior open pollinated cultivars
- 6.26. Biological methods for disease and pest management
- 6.27. Integrated disease and pest management
- 6.28. Integrated soil and plant nutrient management
- 6.29. Hydroponics pre basic seed potato production technology
- 6.30. Good agriculture practice (GAP) in safe vegetable production

7. Indigenous Technology

- 7.1 Local and wild edible vegetables, species, cultivars and their usefulness
- 7.2 Indigenous practices of vegetable cultivation
- 7.3 Indigenous methods of disease and pest control and preventive measure
- 7.4 Indigenous methods of soil fertility improvement and management
- 7.5 Indigenous methods and management of water conservation and utilization

8. Plant Genetic and Improvement

- 8.1 Genes and their action
- 8.2 Genotypes phenotype and its heritability
- 8.3 Homozygous and heterozygosity
- 8.4 Improvement of variation
- 8.5 Breeding methods: self-pollinated crops, cross pollinated crops
- 8.6 Concept of heterosis and development of hybrid variety
- 8.7 Mutation breeding
- 8.8 Genetic erosion and transformation
- 8.9 Use of transgenic plants

B : Fruit

10. Fundamentals of Fruit Production

- 1.31 Importance and scope of fruit production in Nepal
- 1.32 Opportunity of fruits crops in Nepal
- 1.33 Climate of Nepal
 - 1.33.1 Temperature
 - 1.33.2 Humidity
 - 1.33.3 Pressure
 - 1.33.4 Rainfall
 - 1.33.5 Sunshine hours
 - 1.33.6 Soil temperature
 - 1.33.7 Weather observation
 - 1.33.8 Climatic zones and their features in Nepal
 - 1.33.9 Climate change and its effect on fruit cultivation
- 1.34 Soils of Nepal and their classification
- 1.35 Land resources
 - 1.35.1 Physiographic distribution of Nepal
 - 1.35.2 Land systems, land use and land capability
- 1.36 Factors to be considered during Orchard establishment including site selection, lay out and planting of fruit plants
- 1.37 Nursery management
 - 1.37.1 Propagating structure
 - 1.37.2 Media
 - 1.37.3 Fertilizers
 - 1.37.4 Soil mixtures
 - 1.37.5 Stratification of seeds of different fruits
 - 1.37.6 Nursery bed preparation

- 1.37.7 Planting of grafted plants in the beds
- 1.38 Propagation
 - 1.38.1 Sexual propagation
 - 1.8.1.1 Development of fruits and seeds
 - 1.8.1.2 Production of genetically pure seeds
 - 1.8.1.3 Techniques of seed production and handling
 - 1.8.1.4 Principles of propagation by seeds
 - 1.8.1.5 Techniques of propagation by seeds
 - 1.38.2 Asexual Propagation
 - 1.8.2.1 General aspects of Asexual propagation – importance of asexual propagation, reasons, changes in clones associated with age, production and maintenance of true to type clones, influence of scions in root stocks and influence of root stock on scions
 - 1.8.2.2 Different types of rootstocks
 - 1.8.2.3 Different types of scions and their methods of collection and preservation for later use
 - 1.8.2.4 Cuttings
 - 1.8.2.5 Grafting
 - 1.8.2.6 Budding
 - 1.8.2.7 Layering
 - 1.8.2.8 Propagation by Specialized stems and roots
 - 1.8.2.9 Micro propagation
 - 1.8.2.10 Tissue culture
- 1.39 Cultural practices
- 1.40 Factors for fruit production
 - 1.10.21 Human Resource
 - 1.10.22 Soils
 - 1.10.23 Water
 - 1.10.24 Climate
 - 1.10.25 Wind
 - 1.10.26 Light
 - 1.10.27 Temperature
 - 1.10.28 Frost
 - 1.10.29 Environmental potential
 - 1.10.30 Other factors
- 1.41 Training and pruning of the fruit trees
 - 1.11.7 Importance of training and pruning
 - 1.11.8 Different methods of training and pruning
 - 1.11.9 Effects of pruning on plant growth
- 1.42 Problems of Fruiting
- 1.43 Mango malformation
- 1.44 Citrus decline
- 1.45 Post-harvest technology for minimizing the post-harvest loss.

11. Study on Major Fruit Crops like mango, banana, litchi, guava, papaya, pomegranate, jack fruit aonla, apple, pear, peach, plum, walnut, pecan nut, almond, apricot, cherry, persimmon, avocado, kiwifruit, grapes and citrus fruits on the following aspects:

- 2.23 Introduction, origin and distribution
- 2.24 Taxonomy, Morphology and growth stages of plants
- 2.25 Climate and soil requirement

- 2.26 Cultivars
- 2.27 Propagation techniques
- 2.28 Planting method
- 2.29 Cultural practices
- 2.30 Weed control practices
- 2.31 Manures and fertilizers management
- 2.32 Pests and diseases control
- 2.33 Harvesting, post-harvest handling and marketing

12. Weed and Weed Control

- 3.1 Classification of weeds and their distributions
- 3.2 Importance of weed control in fruit production
- 3.3 Common weeds of fruit orchard
- 3.4 Methods of weed control in fruit orchard

13. Plant Breeding

- 4.1 Definition and importance of plant breeding
- 4.2 Genotypes and phenotypes
- 4.3 Methods of breeding of fruit crops
- 4.4 Germplasm collection, evaluation and utilization
- 4.5 Methods of hybridization to improve fruit crops
- 4.6 Maintenance of fruit varieties
- 4.7 Application of bio-technology and tissue culture in fruit crop breeding.

C : Flower

- 1. Status, importance and opportunity of floriculture in Nepal
- 2. Cultivation practices of major cut flowers in Nepal
- 3. Cutflower and ornamental plants cultivation under protected structure

D: Other General Topics

6. Growth Regulation

- 6.1 Photosynthesis, respiration and transpiration
- 6.2 Dynamics of growth
 - 6.2.1 Growth of individual plants
 - 6.2.2 Growth of plant community
 - 6.2.3 Differential growth
 - 6.2.4 Polarity and differentiation
- 6.3 Growth regulators
 - 6.3.1 Auxin, Gibberellins, and cytokines
 - 1.3.1.1 Occurrences
 - 1.3.1.2 Distribution
 - 1.3.1.3 Metabolism
 - 1.3.1.4 Degradation
 - 1.3.1.5 Sources and relation to growth
 - 1.3.1.6 Transport
 - 1.3.1.7 Effect
 - 1.3.1.8 Synthetic

- 1.3.1.9 Mechanism of action
- 6.3.2 Ethylene
 - 6.3.2.1 Occurrence
 - 6.3.2.2 Movement
 - 6.3.2.3 Structure and activity
 - 6.3.2.4 Regulatory action
 - 6.3.2.5 Mechanism of action
- 6.3.3 Inhibitors
 - 1.3.3.1 Chemical nature of inhibitors
 - 1.3.3.2 Abscisic acid
 - 1.3.3.3 Phenolic inhibitors
 - 1.3.3.3 Other inhibitors
- 6.4 Development
 - 6.4.1 Germination and dormancy of seeds
 - 6.4.2 Juvenility, maturity and senescence
 - 6.4.3 Photoperiodism and flowering
 - 6.4.4 Vernalisation and flowering
 - 6.4.5 Genetic mechanism of flowering
 - 6.4.6 Substance regulating flowering
 - 6.4.7 Fruiting – pollination, fruit set, fruit growth, fruit ripening
- 7. Horticultural Crop Physiology**
 - 7.1 Photosynthesis
 - 7.2 Respiration
 - 7.3 Transpiration and translocation
 - 7.4 Growth and development: cell division, enlargement and differentiation
 - 7.5 Photoperiodism, light intensity and quality
 - 7.6 Stress physiology - temperature stresses, moisture stresses and nutrient stresses
 - 7.7 Physiological disorders in horticultural crops
- 8. Soils and Fertilizers**
 - 8.1 Soil classification
 - 8.2 Soil moisture
 - 8.3 Surface tension
 - 8.4 Water holding capacity
 - 8.5 Water movement in soil
 - 8.6 Essential plant nutrients
 - 8.7 Classification of plant nutrients
 - 8.8 Functions of macro and micro nutrients symptoms and deficiency
 - 8.9 Forms of nutrients utilized by plants
 - 8.10 Chemical fertilizers- composition, classification and their uses
 - 8.11 Process of absorption of nutrients by plant
 - 8.12 Loss of plant nutrients from soil
 - 8.13 Determination of nutrient requirements of the soils
 - 8.14 Response of N.P.K. in major fruit crops
 - 8.15 Soil pH, its measurement, limiting materials available for correcting soil pH, reaction of liming materials when applied in the soils
 - 8.16 Liming and liming materials
 - 8.17 Soil organic matters
 - 8.18 C: N ratio

- 8.19 Recommended doses of nutrients, time and methods of application
 - 8.20 Soil organism and their functions
 - 8.21 Green manuring
 - 8.22 Farm yard manure and compost
 - 8.23 Compost preparation
- 9. Statistics**
- 9.1 Mean, median, mode, standard deviation, standard error, frequency, probability, distribution, sampling theory, test of hypothesis, confidence interval
 - 9.2 Estimate of error- replication and randomization
 - 9.3 Experimental designs- complete randomized, Randomized complete block, Latin square, lattice, two factorial experiment, split plot and three or more factorial designs
 - 9.4 Comparison
 - 9.5 Regression and correlation
 - 9.6 Importance and validity of statistics in agriculture
- 10. Others**
- 10.1 History, impact and importance of horticultural research and development plans and programs in Nepal.
 - 10.2 Production constraints to horticultural crops production in Nepal and possible remedies.
 - 10.3 History, objective, role and activities of Nepal Agricultural Research Council (NARC).
 - 10.4 Organizational structure of NARC and activities of major institutions under it.
 - 10.5 National and international linkages for horticultural research and development
 - 10.6 Prospects of horticultural crops production.
 - 10.7 Prioritization of horticulture crops for research and development in Nepalese context.
 - 10.8 Planning, implantation and monitoring of horticultural research programs for Nepal.
 - 10.9 Concept of pocket area development and satellite farming.

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), लाइभस्टक प्रडक्ट प्रोडक्शन एण्ड म्यानेजमेण्ट
उपसमूहको खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject

Sub-Group: Livestock Product Production and Management

- 1. Cattle (Native, crossbred cows, Yak/Nak, Chauri) and Buffalo (Murrah, Murrah crossbreed and Niliravi)**
 - 1.1 Early Weaning Management
 - 1.2 Breeding and feeding management of heifers
 - 1.3 Embryo transfer and Sexed semen
 - 1.4 Care and Feeding Management and health of pregnant heifers and adult animals.
 - 1.5 Improved Housing Management for calves, heifer, pregnant and milch animals
 - 1.6 Possible means of changing the calving pattern in buffalo
 - 1.7 Use of Livestock production management technology for enhancing the high milk production
 - 1.8 Feeds and Feeding:
 - 1.8.1 Meeting nutrient requirement by low cost feeding for low cost milk production
 - 1.8.2 Feeding management for high yielding dairy animals..
 - 1.9 Low cost feed Formulation
 - 1.10 Milk Production:
 - 1.10.1 Process of lactation
 - 1.10.2 Hormonal influence in lactation
 - 1.10.3 Release of milk from the udder
 - 1.10.4 Establishment of pasteurizing unit for rural dairy cooperatives
 - 1.10.5 Detection of adulterant in milk
 - 1.10.6 Milk collection, processing and marketing
 - 1.10.7 Milk production cooperative in Nepal
- 2. Sheep and Goat**
 - 2.1 Sheep and Goat Production/ Management System in the Mountain, Hills and Terai of Nepal
 - 2.2 Management system: Transhumance system and Sedentary System (Open grazing system and Stall feeding system)
 - 2.3 Sheep Breed:
 - 2.3.1 Exotic Breed for dual purpose: Polwarth, French Merino, Rambouillet
 - 2.3.2 Native breed: Bhyanglung, Baruwal, Kage and Medium/Long tailed sheep
 - 2.4 Goat Breed:
 - 2.4.1 Exotic breed: used for upgrading native breed and research purpose in Nepal. (a) Jamunapari (b) Barberi(c) Boer (d) Sannen

- 2.4.2 Native breed: (a) Chyangra (b) Sinahal (c) Hill Goat (d) Terai
- 2.5 Sheep / Goat:
 - 2.5.1 Reproductive behaviour and Breeding systems
 - 2.5.2 Breed Improvement
 - 2.5.3 Objectives of breeding plan
 - 2.5.4 Frequent breeding System in Terai goats, hill goats and Kage sheep
 - 2.5.5 Estrous synchronization, Flushing
- 2.6 Feeds and Feeding:
 - 2.6.1 Nutrient requirement supplied through pasture and forages.
 - 2.6.2 Low cost feed for dairy animals
- 2.7 Disease and Parasites:
 - 2.7.1 Common diseases, Infectious disease, Noninfectious disease
 - 2.7.2 Internal and External parasites
- 2.8 Management:
 - 2.8.1 Management of kids / Lambs
 - 2.8.2 Management of breeding does / ewes
 - 2.8.3 Management of Breeding Bucks / rams
 - 2.8.4 Improved housing management for goats in Hills and Terai
- 3. Meat Production**
 - 3.1 Growth and Carcass Quality
 - 3.2 Body Growth and Development
 - 3.2.1 Anatomical Component of the animal body
 - 3.2.2 Bone and Nervous systems
 - 3.2.3 Essential organs- Heart, Brain, Liver
 - 3.2.4 Bones
 - 3.2.5 Muscle
 - 3.2.6 Fat
 - 3.3 Definition of Carcass, offal (Edible and non-edible), Dressing Percentage
 - 3.4 Estimation of carcass yield
 - 3.5 Factors influencing the pattern of growth and development in meat animals
 - 3.6 Meat quality and yield improvement from male buffalo, sheep and goats by reconditioning
 - 3.7 Constraints to meat production throughout the country
 - 3.8 Disease factors affecting the meat production in male buffalo, sheep and goats
- 4. Wool Production (Sheep and Angora Rabbit)**
 - 4.1 Properties of wool
 - 4.1.1 Strength and elasticity
 - 4.1.2 Effect of moisture
 - 4.1.3 Durability and shrinking
 - 4.1.4 Felting and friction
 - 4.1.5 Crimps
 - 4.2 Growth and development of fleece
 - 4.3 Factors affecting wool and quality
- 5. Swine Production**
 - 5.1 Exotic breed: Yorkshire, Land race, Hampshire

- 5.2 Native breed: Hurraha, Chuache
- 5.3 Care and Management of piglets
- 5.4 Economic weaning of piglets

- 5.5 Management of weaning, gilt, pregnant sows and breeding boar
- 5.6 Environmentally sound, Improved housing management for piglets, pregnant, dry sows and boar
- 5.7 Use of green grass in feeding management of pig production
- 5.8 Scope of disease free zone for pig marketing in Nepal
- 6. Poultry, Ducks, Quail and Turkey Production and Management**
 - 1.1 Intensive poultry, Ducks, Quail and Turkey production system
 - 1.2 Semi-intensive and free range system (Scavenging poultry production)
 - 1.3 Hatching management
 - 1.4 Brooding management
 - 1.5 Grower management
 - 1.6 Breeding management
 - 1.7 Recent advances in commercial broiler / poultry production
 - 1.8 Recent problems and constraints in commercial poultry farming
 - 1.9 Use of probiotic in poultry production
- 7. Livestock Production / Management**
 - 7.1 Types of prevailing buffalo, sheep and goat marketing systems
 - 7.2 Use of draft animal power in sustainable agriculture farming system
 - 7.3 Model village development for high milk production
 - 7.4 Model village development for meat production from Male buffalo, sheep and goat
 - 7.5 Major constraints facing by the commercial livestock industry and small holder dairy farmers.
 - 7.6 Vision of Livestock development in 10th five year plan.
 - 7.7 Constraints of Livestock Technology adoption in the farmer's field
 - 7.8 Importance of Livestock On-Farm Trail for technology transfer
 - 7.9 Major challenges in livestock research and development
- 8. Livestock and poultry research and development in Nepal**
- 9. Livestock and poultry production system in Nepal**
- 10. Prospects and Constraints of Livestock Development in Nepal**
- 11. Research Proposal Preparation**
- 12. Research technology transfer**
- 13. Livestock quarantine system in Nepal**
- 14. Scope and challenge of organic meat production in Nepal**

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), एनिमल ब्रिडिङ एण्ड जेनेटिक्स उपसमूहको
खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject

Sub-Group: Animal Breeding and Genetics

1. Concept of Animal Genetics

- 1.5. Cell biology, cytogenetics and molecular genetics
- 1.6. Genetics of population of random mating and inbreeding, the effects of selections mutation, migration in farm animals and birds
- 1.7. Genetics of quantitative characters in random and non-random mating population of livestock and poultry
- 1.8. Application of quantitative genetics theory in breeding work of domesticated animals and birds
- 1.9. Anatomy and physiology of reproduction system of male and female of farm animals and birds
- 1.10. Environmental factors such as feeding, health care, housing and management affecting production traits in farm animals and birds
- 1.11. Genetic and non-genetic factors affecting production traits in farm animals and birds
- 1.12. Inbreeding and hybridization in farm animal and birds
- 1.13. Artificial insemination of farm animals and birds. Semen collection, freezing, thawing, and insemination technique collection from donors, freezing, storage and transfer to recipients
- 1.14. Evaluation of the production performances of different breeds of farm animals and birds found in Nepal and their genetic improvement
- 1.15. Analysis of measurement of quantitative and discrete data, analysis of variance and covariance of livestock production traits, simple linear regression and correlation of production traits, simple linear regression and correlation of production traits of farm animals and birds
- 1.16. Experimental design of the breeding experiment of farm animal and birds
- 1.17. Expected progeny differences and predicted transmitting ability of sire and dam of farm animals and birds
- 1.18. Animal breeding in the Nepalese social context
- 1.19. Breed society formation and their importance in Nepal
- 1.20. Improvement of reproductive efficiency of farm animals particularly in Nepalese farmer's condition
- 1.21. Genetic principles in animal breeding

2. Population and Quantitative Genetics

- 2.1. Genetic structure of population hardy Weinberg law, sex linkage, linkage, analysis of qualitative characters, estimation of gene frequency
- 2.2. Changes of gene frequency mutation, migration, selection

- 2.3. Changes of gene frequency on small populations
- 2.4. Quantitative variation, gene effect, various repeatability, heritability, genetic correlations, genotypes x environment interaction
- 2.5. Inheritance of qualitative and quantities traits (Reproduction and fertility traits udder development, milking rate, yield and composition of milk, body size and carcass traits, wool production sits quality, production characteristics in poultry, pigs, buffalo goat and cattle

3. Reproduction and Physical basis of Inheritance

- 3.1. Anatomy and physiology of reproductive organs of male and female of farm animals and birds
- 3.2. Physical basis of inheritance: Formation of germ cells spermatogenesis, organs fertilization
- 3.3. Artificial insemination and embryo transfer of farm animal and birds
- 3.4. Cryo-preservation techniques to be use in different farm species
- 3.5. Manipulation of germ cells, collection, evaluation, storage, transfers for different farm animals and birds
- 3.6. Different techniques of pregnancy diagnosis in farm animals
- 3.7. Hormonal regulation in growth and development from fertilization to maturity
- 3.8. Multiple ovulation and embryo transfer
- 3.9. Heat synchronization and its importance in animal breeding
- 3.10. Cloning and sexing of fertile egg and production of homogeneous genotypes
- 3.11. Genetic aspects of reproduction traits
- 3.12. Embryonic and fetal development, hormones in reproduction and artificial control of farm animals

4. Animal Genetic Resource

- 4.1. Phenotypic and genetic characterization of different breeds of farm animal and birds in Nepal
- 4.2. Animal genetic biodiversity
- 4.3. Conservation (ex-situ/in-situ) and management of genetic resources
- 4.4. Breeding system in smaller population size of rare breeds
- 4.5. Genetic and non-genetic factors affecting conservation and maintenance of genetic resources
- 4.6. Issues and constraint associated with conservation of animal genetic resources in Nepal

5. Genetic Improvement of Farm Animals and Birds

- 5.1. Genetic models and partitioning of genetic variances
- 5.2. Additive and dominance relationship
- 5.3. Coefficient of inbreeding and its effect in productivity
- 5.4. Crossbreeding and hybridization and estimation of hybrid vigour and their impact in genetic improvement program in Nepal
- 5.5. Genetic covariance between individuals

- 5.6. Genetic parameters and their estimation and their use in estimating breeding value of breeding animals
 - 5.7. Methods and response to selection
 - 5.8. Construction of selection index
 - 5.9. General linear models for analysis of animal breeding data
 - 5.10. Importance of multivariate regression and correlation analysis in animal breeding
 - 5.11. Sire and dam evaluation based on their breeding values
 - 5.12. Progeny testing and performance testing of farm animals and birds
 - 5.13. Techniques for breed development
 - 5.14. Bio-chemical polymorphism and their use in genetic improvement in Nepal
 - 5.15. Genetic improvement technique for smaller herd size of Nepalese farmers
 - 5.16. Hereditary defects and disease resistance in farm animals
 - 5.17. Farmers participatory group breeding approach in genetic improvement program
 - 5.18. Breeds and breed formation and development of breeding strategy
- 6. Cellular and Molecular Genetics**
- 6.1. Qualitative genetics, genes and their control in expression of economic important traits of farm animals
 - 6.2. Molecular genetics, RNA, DNA transcription, translation and gene regulation
 - 6.3. Developmental genetics and gene multiplication
 - 6.4. Polymorphism and its use in animal breeding
 - 6.5. Bioinformatics
- 7. Biotechnology and Biostatistics**
- 7.1. Role of biotechnology in animal breeding
 - 7.2. Experimental design for animal breeding experiment
 - 7.3. Breed evaluation for production and reproduction traits particularly in the smaller herds' size of farm animals in Nepalese condition
 - 7.4. Different techniques in genetic conservation of farm animals
 - 7.5. Analysis of animal breeding data
- 8. Outreach Animal Breeding**
- 8.1. Social aspects of rural Nepalese life
 - 8.2. Techniques of data collection for animal breeding from farmers' herds or flocks
 - 8.3. Characteristics of different breeds of farm animal and birds
 - 8.4. Animal breeding problems identification in the outreach sites
 - 8.5. Organization of breeding society and its need for each breed of farm animals and birds
 - 8.6. Variation of marketing value of different superior breeding animals
 - 8.7. Reproduction efficiency of farm animals and birds
 - 8.8. A.I. and E.T. in Nepalese context
 - 8.9. Reproductive problems in farm animals
 - 8.10. Progeny testing
 - 8.11. Performance testing

9. Development of Breeding Plans in Nepal

9.1. Cattle and buffalo

- Progeny testing and selection among tested bulls
- Selection of dam of bulls
- Selection of young bulls for testing
- Selection of cows within herds
- Farmers participation cattle/ buffalo breeding program
- Buffalo breeding for milk and meat

9.2. Goat

- Farmers participation goat breeding program for growth rate, fertility, carcass quality
- Cross breeding for meat production

9.3. Pigs

- Selection based on sib and own performance
- Farmers participating organized line breeding/cross breeding

9.4. Sheep

- Selection for carpet wool in Bhyanglung

9.5. Poultry

- Selection for dual purpose poultry
- Selection for meat
- Experimental design factorial experiments one way and two way classification covariance analysis.
- Linear model and multivariate analysis
- Application of modern molecular genetics to animal breeding

10. Others

10.1. Animal breeding strategy in Nepal

10.2. Role of NARC in genetic improvement of livestock and poultry.

10.3. Role of NARC in conservation, utilization and promotion of farm AnGR

10.4. The structure objectives and activities of Nepal Agricultural Research Council and Executive Board.

10.5. Main constraints and issues in animal genetic improvement programme in Nepal.

**

*

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), एनिमल न्यूट्रिशन एण्ड फिडिङ उपसमूहको
खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Animal Nutrition and Feeding

1. Digestion of the Feeds

- 1.1 Digestion in ruminant and non- ruminant animals
- 1.2 Microbial digestion in the ruminants

2. Important Nutrients of the Feeds

- 2.1 Carbohydrates
 - 2.1.1 Classification of carbohydrates
 - 2.1.2 Monosaccharide
 - 2.1.3 Oligosaccharides
 - 2.1.4 Disaccharides
 - 2.1.5 Polysaccharides
 - 2.1.6 Lignin
- 2.2 Lipids
 - 2.2.1 Fats
 - 2.2.2 Glyco lipid
 - 2.2.3 Phospholipids
 - 2.2.4 Waxes
 - 2.2.5 Steroids
- 2.3 Proteins
 - 2.3.1 Amino acid
 - 2.3.2 Structure of protein
 - 2.3.3 Properties of proteins
 - 2.3.4 Classification of proteins
- 2.4 Nucleic Acids
- 2.5 Other nitrogenous compounds
 - 2.5.1 Amines
 - 2.5.2 Amides
 - 2.5.3 Nitrates
 - 2.5.4 Alkaloids
- 2.6 Vitamins
 - 2.6.1 Vitamin A
 - 2.6.2 Vitamin D
 - 2.6.3 Vitamin E
 - 2.6.4 Vitamin K
 - 2.6.5 Vitamin B complex
 - 2.6.6 Vitamin C
- 2.7 Minerals
 - 2.7.1 Major elements
 - 2.7.2 Trace elements

- 2.8 Enzymes
 - 2.8.1 Catalytic action
 - 2.8.2 Nature and mechanism of enzyme action
 - 2.8.3 Factors affecting enzyme activity
- 3. Metabolism of the Nutrients**
 - 3.1 Energy metabolism
 - 3.2 Amino acid synthesis
 - 3.3 Fat synthesis
 - 3.4 Carbohydrates synthesis
- 4. Evaluation of Foods**
 - 4.1 Digestibility
 - 4.2 Partition of energy within the animal
 - 4.3 Systems for expression the energy value of foods
 - 4.4 Protein quality of foods for feeding ruminants (cattle, buffalo, sheep and goats) and non-ruminants (Poultry, pigs and rabbits)
- 5. Feeding Standards**
 - 5.1 Maintenance, growth and production
 - 5.2 Reproduction
 - 5.3 Lactation
 - 5.4 Work
- 6. Voluntary Intake of Food**
 - 6.1 Ruminants
 - 6.2 Non-ruminants
 - 6.3 Prediction of food intake
- 7. Feeds of Livestock**
 - 7.1 Grass, forage crops and fodder trees, silage, hay, straws, root and tuber crops and related by-products, Cereal grains and cereal byproducts
 - 7.2 Role of biotechnology in the feeds of livestock and avian
- 8. Ration Formulation**
 - 8.1 Feed formulation for cattle/buffalo
 - 8.2 Feed formulation for sheep and goats
 - 8.3 Feed formulation for Swine/rabbit
 - 8.4 Feed formulation for Poultry
 - 8.5 Preparation of mixed mineral supplements
 - 8.6 Linear programming of feed mixtures
- 9. Utilizations of Low Quality Feeds and Feed Stuffs**
 - 9.1 Cereals, leguminous and oil seeds straw
 - 9.2 Agro-industrials by products
 - 9.3 Non-conventional feeding resources
- 10. Feedstuffs Control and Legislation**

11. Feed intake and their efficiency in improving productions and productivity

12. Statistics

- 12.1 Organization and description of data
- 12.2 Probability
- 12.3 Introduction to statistical inference
 - 12.3.1 Sampling distributions and estimation
 - 12.3.2 Hypothesis testing
 - 12.3.3 Experimental Design and data analysis
 - 12.3.4 Regression and correlation
 - 12.3.5 Analysis of variance and covariance

13. Other

- 13.1 Livestock population and their distribution in Nepal
- 13.2 Production and productivity of livestock in Nepal and other developing and developed countries
- 13.3 Crop production and its impact in the livestock feeding system
- 13.4 Pasture, forage and agro-forestry productions in Nepal
- 13.5 Status of compound feeds and its ingredients in Nepal
- 13.6 Organic Chemistry
 - 13.6.1 Hydrocarbon
 - 13.6.2 Derivatives of hydrocarbons
- 13.7 Bio-Chemistry
 - 13.7.1 Introduction to Biological system
 - 13.7.2 Biological molecules
- 13.8 General knowledge about NARC

*

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), फिसरिज उप-समूहको
खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Fishery

1. Aquaculture

- 1.1 Scope of Aquaculture
- 1.2 Potentialities and prospects of aquaculture
- 1.3 Aquaculture Techniques in Nepal
 - 1.3.1 Extensive system
 - 1.3.2 Semi Intensive system
 - 1.3.3 Intensive system
 - 1.3.4 Super-Intensive
- 1.4 Types of fish culture in Nepal
 - 1.4.1 Pond fish culture
 - 1.4.2 Raceway culture
 - 1.4.3 Cage fish culture
 - 1.4.4 Enclosure fish culture
 - 1.4.5 Integrated fish Farming
 - 1.4.6 Aquaculture in marginal swamps/ghols
 - 1.4.7 Open water stocking
- 1.5 Biology of major fresh water cultivated fish species – indigenous and exotic
- 1.6 Status of fish culture in Nepal-coverage area, production (production and wild capture) contribution/ consumption
- 1.7 Fish farm design and construction
 - 1.7.1 Planning
 - 1.7.2 Site selection
 - 1.7.3 Topography and layout
 - 1.7.4 Soil quality
 - 1.7.5 Pond construction
 - 1.7.6 Water source
- 1.8 Fish breeding and hatchery management
 - 1.8.1 Hatchery design and construction
 - 1.8.2 Brood fish management
 - 1.8.3 Natural breeding
 - 1.8.4 Semi-artificial breeding
 - 1.8.5 Artificial breeding
- 1.9 Nursing and rearing management
 - 1.9.1 Artificial incubation
 - 1.9.2 Nursing and rearing of hatchling, fry and fingerlings

2. Grow Out Fish

- 2.1 Pond fertilization
- 2.2 Fish harvest

2.3 Fish market

3. Post Harvest Fish Technology

3.1 Preservation by control of temperature

3.2 Preservation techniques based on the control of water activity

3.3 Preservation techniques based on chemical control of microbial activity,

3.4 Processed and preserved fish products, mechanism of heat transfer, freezing, dehydration processes

4. Water quality management in aquaculture

5. Fish nutritional requirement and feed management

5.1 Types of fish feeds

5.2 Natural and artificial feed

5.3 Feed formulation

5.4 Feed preparation and nutrition value

5.5 Feed ingredients and major nutrients

5.6 Essential amino acids, vitamin and minerals

6. Fish health management

6.1 Internal and external fish parasites

6.2 Fungal fish disease

6.3 Bacterial fish diseases

6.4 Non infectious diseases

6.5 Application of prophylactic and therapeutic control measures of fish parasites and diseases

7. Fishing gears technology

7.1 Basic principles of fishing gears,

7.2 Types and selection of fishing gear

7.3 Accessories for fishing gear, maintenance of fishing gear, maintenance and storage of gears and gear materials

8. Live fish transportation

9. Capture fisheries

10. Fish biodiversity and conservation

11. Fish migration

12. Aquatic weeds and their control

13. Fisheries law and application

14. Role and importance of fisheries in aquatic resources management and poverty alleviation
15. Role of fisheries in food security
16. Women participation in fisheries and fish culture activities
17. Importance of cold water fish culture in Nepal-site selection, requirement of criteria, lay out and construction
18. Status and prospect of fish culture in Nepal
19. Fisheries plan (five year and long term prospect plan)
20. Fisheries project planning and management
21. Fisheries law 2017 and amendment 2055
22. Fisheries policies
23. Role of Nepal Agricultural Research Council (NARC)

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), पाश्चर फोरेज एण्ड एग्रो फरेष्ट्री उपसमूहको
खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject

Sub-Group: Pasture, Forage and Agro-forestry

1. Forage Physiology

- 1.1 Cell organization, plant metabolism, nitrogen metabolism, photosynthesis and respiration.
- 1.2 Forage and fodder seed physiology, seed development, seed dormancy, germination and other physiological processes associated with seed production and storage of economically important pasture/ forage and fodder tree seeds

2. Forage Breeding

- 2.1 Principles of breeding
- 2.2 Factors to consider in breeding
- 2.3 Breeding and improvement objectives
- 2.4 Breeding behavior
- 2.5 Genetic and cytogenetic
- 2.6 Breeding methods
- 2.7 Forage and pasture crop evolution.
- 2.8 Application of advances in somatic genetics and tissue culture techniques in pasture improvement.
- 2.9 Advanced nursery and plantation techniques
- 2.10 Advanced forest tree improvement approaches to forest tree improvement, selection, species introduction, seed orchards hybridization, mutation and progeny testing.
- 2.11 Registered and released varieties of fodders in Nepal

3. Forage Agronomy

- 3.1 Plant introduction, evaluation and utilization
- 3.2 Fertilization and liming
- 3.3 Cutting management
- 3.4 Irrigation management
- 3.5 Recycling of nutrients dung and urine spots
- 3.6 Weed control and mowing
- 3.7 Factors affecting crop adaptation, production, utilization and conservation
- 3.8 Principles and practices of fodder / pasture and fodder tree production , utilization and conservation
- 3.9 Seed cycles and common seed classes commonly used in Nepal
- 3.10 Institutions involved and their roles in varietal registration and release of forage and fodder crops in Nepal

- 3.11 Seed testing principles, seed certification procedures, seedcertification standards in major forage crops in Nepal
- 3.12 Cropping systems, crop rotation, inter-cropping, mixed cropping, multiple cropping and mixed farming systems
- 3.13 Marginal land utilization for pasture, forage and fodder trees
- 4 Production Technology**
 - 4.1 Production technology of forage crops
 - 4.2 Production technology of temperate species
 - 4.3 Production technology of fodder trees
 - 4.4 Seed production technology of forage crops, temperate species and tree fodders
 - 4.5 Sapling production technology in fodder trees
 - 4.6 Vegetative propagation of forage and fodder crops and tree fodders
- 5. Grazing and Range Management**
 - 5.1 Grazing practices
 - 5.2 Aspects grazing management
 - 5.3 Efficiency of grazing
 - 5.4 Stocking rate and grazing pressure
 - 5.5 Factors affecting grazing behavior
 - 5.6 Experimentation in grazing management
 - 5.7 Principles of range management, vegetation development and soil conservation, classification of range condition, practices for range management and conservation
 - 5.8 Fodder and feed from trees and shrubs, grassland productivity and carrying capacity, productivity influencing factors
 - 5.9 Burning as a management practice, bush control, provision of water, range reseeding and fertilizing
 - 5.10 Rangeland Policy-2068
- 6. Herbage Quality and Nutritive Value**
 - 6.1 Nutritive value, digestibility, palatability and voluntary intake
 - 6.2 Estimation of intake and digestibility, nutritive value and herbage quality and animal productivity
 - 6.3 Feeding value of grass, legume and its products
 - 6.4 Forage quality i.e. cell wall contents, cell contents, digestibility, total digestible nutrients and metabolizable energy
- 7. Agro-forestry**
 - 7.1 Definition, scope and advantage, classification of agro-forestry systems, silvi-pasture system, agri-silvi-pasture system, productive agroforestry systems, protective agro-forestry systems, multipurpose agro-forestry systems, management of trees in agroforestry systems , Economics of agroforestry systems
 - 7.2 Shifting cultivation; shifting cultivation in Nepal
 - 7.3 Interaction in crops ; effects of trees on agricultural crops, effects of agricultural crops on trees, effects of animal on vegetation, effects of trees on animal

- 7.4 Understanding climate smart agriculture and carbon accounting
- 7.5 Value chain of agroforestry products
- 7.6 Policies and institutions involved in agroforestry in Nepal
- 8. Forage Conservation**
 - 9.1 Principles of conservation
 - 9.2 Silage making
 - 9.3 Hay making
 - 9.4 Artificially dried forage
 - 9.5 Conserved forages for animal feeding
- 9. Forage Toxicology**
 - 9.1 Antiquality constraints and disorders
- 10. Forage diseases and their control**
 - 10.1 Diseases of pasture/forage and fodder trees, seed borne, soil borne and air borne diseases
 - 10.2 Genetics of disease resistance in pasture/forage and fodder trees, breeding for disease resistance and utilization of disease resistant genes
 - 10.3 Biological control of pasture/forage and fodder tree pathogens
 - 10.4 Cultural control measures of pasture/forage and fodder tree pathogens
- 11. Forage Insect's Management and their Control**
 - 11.1 Principles of insect- pest control, physical and mechanical control, cultural control, biological control, chemical control and host plant resistance
 - 11.2 Toxicity of insecticides, precaution in the use of insecticides, insecticide-application equipment
 - 11.3 Major pests of pasture/forage and fodder trees and their control measures
- 12. Statistics**
 - 12.1 Experimental designs and data analysis (parametric and non- parametric)
 - 12.2 Central tendency, dispersion
 - 12.3 Sampling and distribution of data
 - 12.4 Regression and correlation
 - 12.5 Data collection and analysis techniques for annual and perennials forages and fodders, rangeland experiments and agroforestry experimentations
 - 12.6 Experimental designs and data analysis for multi-location and multi-year experiments
 - 12.7 Multivariate analysis and principle component
- 13. Survey, Need Identification, Logical Framework, Risk Analysis, Project Concept Note and Proposal Writing**

14. Others

- 14.1 Botany of grasses and legumes
- 14.2 Plant Growth and Development
- 14.3 Types of grassland and its distribution
- 14.4 Seasonal growth curve
- 14.5 Ruminant's digestive , productive and reproductive systems
- 14.6 Feed balanced situation and mitigation strategies to feed deficit in Nepal
- 14.7 Use of System Research Tools (GIS, GPS, IT, remote sensing, climate smart resource management tools, software) in forage, fodder, rangelands and pasturelands and tree fodders research
- 14.8 Role of cooperative and private sector in forage and fodder seed production, processing and marketing

वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), भेटेरिनरी उपसमूहको
खुल्ला तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Veterinary

1. Pharmacology and Toxicology

- 1.1 Development and scope of veterinary pharmacology
- 1.2 Principles of drug activity: pharmacokinetics-absorption, distribution, biotransformation and excretion of drugs
- 1.3 Pharmacodynamics- concept of drug and receptors, dose-response relationship, terms related to drug activity and factors modifying the drug effect and dosage.
- 1.4 Drugs acting on central nervous system
- 1.5 History and theories of general anesthesia; volatile, gaseous, intravenous and dissociative anesthetics, hypnotics and sedatives, tranquilizers, analgesics
- 1.6 Antipyretics, analgesics, and anti-inflammatory agents
- 1.7 Transmitters of CNS, analeptics and other CNS stimulants
- 1.8 Local anesthetics
- 1.9 Neuromuscular blocking agents
- 1.10 Peripheral and central muscle relaxants
- 1.11 Drugs acting on autonomic nervous system-adrenergic antagonists, adrenoceptors blockers, adrenergic neuron blockers, cholinergic antagonist and blockers, ganglionic stimulants and blockers,
- 1.12 Histamine and antihistaminic agents
- 1.13 Prostaglandins, angiotensin and bradykinin
- 1.14 Drugs acting on cardiovascular system
- 1.15 Drugs acting on digestive tract
- 1.16 Drugs acting on respiratory system
- 1.17 Drugs acting on endocrine system- adrenocorticosteroid, sex hormones, insulin and other hypoglycemic agents, thyroid hormones
- 1.18 Drugs acting on skin and mucus membrane
- 1.19 Antibacterial agents- classification, general principles in antibacterial chemotherapy, sulphonamide and their combination; antibiotics; antituberculus agents; miscellaneous agents
- 1.20 Antifungal agents
- 1.21 Anthelmintics and antiprotozoal agents
- 1.22 Antiviral and anticancer agents
- 1.23 Antiseptics and disinfectants
- 1.24 Hormones –hormone stimulating and inhibiting drugs, antagonists, hypoglycaemic agents, prostaglandins, oxytocin, anabolics, growth promoters and corticosteroids
- 1.25 Commonly used herbal drugs used in veterinary medicine
- 1.26 General toxicology: scope, source of poisoning, mode of action of poisons, factors modifying toxicity and line of treatment of poisoned cases

- 1.27 Toxicity caused by metals and non-metals: arsenic, lead, zinc, mercury, copper, selenium, phosphorus, nitrates, nitrite, common salt and fluorosis
- 1.28 Plant toxicity due to various poisonous plants
- 1.29 Toxicity caused by commonly used drugs, mycotoxins, bacterial toxins and others
- 1.30 Toxicity caused by agrochemicals, insecticides, herbicides and rodenticides
- 1.31 Venoms, bites and stings
- 1.32 Environmental toxicity- toxicity caused by air, water, food additives and preservatives

2. Veterinary Parasitology

- 2.1 Development of veterinary parasitology and its importance
- 2.2 Parasites of veterinary importance and their classification
- 2.3 Parasites, parasitism, commensalism and symbiosis
- 2.4 Host -parasite relationship and specificity between parasites and hosts and development of parasites in the host system
- 2.5 Nomenclature and classification of parasites and characteristics of various phyla of parasites.
- 2.6 General morphological characteristics of different types of helminths, arthropods and protozoa
- 2.7 Tissue reactions of parasites in the hosts and development of immunity/resistance to parasite infection/infestation
- 2.8 Natural and acquired immunity, parasitic immunity
- 2.9 Life cycle and mode of transmission of different types of helminths, arthropods and protozoan parasites infecting farm animals, pets and poultry.
- 2.10 Anthelmintics Drugs
- 2.11 Important morphological features, life cycles, mode of transmission, pathogenesis, diagnosis, chemo and immunoprophylaxis and general control measures of intestinal flukes and liver flukes, amphistomes, visceral and nasal schistosomes.
- 2.12 Important morphological features, life cycles, mode of transmission, pathogenesis, diagnosis, chemo and immunoprophylaxis and general control measures of tapeworms of farm animals, pets and birds and development of bladderworm with emphasis on metacestodes of zoonotic importance
- 2.13 Important morphological features, life cycles, mode of transmission, pathogenesis, diagnosis, chemo and immunoprophylaxis and general control measures of nematode parasites of farm animals, pets and birds
- 2.14 Important morphological features, life cycles, mode of transmission, pathogenesis, diagnosis, chemo and immunoprophylaxis and general control measures of arthropod parasites of farm animals, pets and birds
- 2.15 Important morphological features, life cycles, mode of transmission, pathogenesis, diagnosis, chemo and immunoprophylaxis and general control measures of protozoan parasites of farm animals, pets and birds
- 2.16 The epidemiology of parasitic diseases and recent approaches for the control of parasitic diseases
- 2.17 Mechanism of resistance development against antiparasitic agents and detection of resistance

- 2.18 Recent approaches on the control of parasitic diseases of farm animals
- 2.19 Investigation of parasitic diseases

3. Pathology

- 3.1 History and scope of pathology
- 3.2 Causes of disease and the factors associated with diseases of farm animals, pets and birds
- 3.3 Developmental disturbances, anomalies and monsters
- 3.4 Disturbances of circulation- embolism, thrombosis, haemorrhage, edema, shock
- 3.5 Disturbances of cell metabolism- gout, amyloid infiltration, mucoid degeneration
- 3.6 Disturbances of pigment metabolism and icterus
- 3.7 Necrosis, gangrene and PM changes
- 3.8 Disturbances of growth- atrophy, aplasia, hyperplasia, hypertrophy, metaplasia
- 3.9 Inflammation- causes, signs, effects, classification
- 3.10 Healing and fever
- 3.11 Uroliths, choleliths, enteroliths
- 3.12 Hypersensitivity and autoimmunity
- 3.13 Pathology of cardiovascular system- functional disturbances and malformation of heart, arteries and veins, lymph node, vessels and spleen, blood, bone marrow; anemia
- 3.14 Pathology of respiratory system- functional disturbances and malformation of nasal cavity, larynx, bronchi, lungs and pleura
- 3.15 Pathology of digestive system- functional disturbances and malformation of organs of digestion
- 3.16 Pathology of urogenital system- functional disturbances and malformation of organs of urinary and genital system of male and female animals
- 3.17 Pathology of nervous system and sensory organs- functional disturbances and malformation of meninges, brain and spinal cord and sense organs
- 3.18 Pathology of endocrine system- functional disturbances and malformation of endocrine glands
- 3.19 Neoplasm- classification, cause and pathology of different types of tumour, difference between benign and malignant tumour
- 3.20 Pathology of the diseases caused by viruses in farm livestock, pets and poultry
- 3.21 Pathology of the diseases caused by bacteria in farm livestock, pets and poultry
- 3.22 Pathology of the diseases caused by fungus, parasites and protozoa in farm livestock, pets and poultry
- 3.23 Pathology of the diseases caused by nutritional deficiency and metabolic diseases in farm livestock, pets and poultry
- 3.24 Pathology of the common diseases found in wild/zoo animals and laboratory animals

4. Veterinary Medicine, Ethics and Jurisprudence

- 4.1 History and scope of medicine, concept of animal disease, health and disease concept, etiological agents, infection and immunity
- 4.2 Clinical examination and diagnosis of diseases in the sick animals

- 4.3 General and systemic states, hyperthermia, hypothermia, fever, toxæmia, septicaemia, shock and dehydration
- 4.4 Definition, etiology, clinical symptoms, pathogenesis, clinical pathology, diagnosis, treatment, prevention and control of the diseases of digestive, respiratory, cardiovascular and lymphatic, urogenital, nervous, sense organs, skin, musculoskeletal systems of cattle, buffaloes, horses, pigs, sheep, goats and pet animals
- 4.5 Diseases of new born animals
- 4.6 Definition, etiology, clinical symptoms, pathogenesis, clinical biochemistry, clinical pathology, diagnosis, treatment, prevention and control of metabolic diseases (like: milk fever, ketosis, lactation tetany, downer cow syndrome, hypomagnesaemia) and nutritional deficiency diseases in domestic animals, pets and poultry
- 4.7 Incidence, etiology, epidemiology, transmission, clinical symptoms, pathogenesis, clinical biochemistry, clinical pathology, diagnosis, treatment, prevention and control of diseases caused by bacteria, viruses, chlamydia, rickettsia, protozoa, parasites and fungi indomestic animals, pets and poultry
- 4.8 Definition, etiology, clinical symptoms, pathogenesis, clinical biochemistry, clinical pathology, diagnosis, treatment, prevention and control of diseases caused by physical and chemical agents
- 4.9 Diseases caused by allergy
- 4.10 Diseases caused by undesirable inherited characters and unknown etiologies
- 4.11 Vaccines and vaccination and recent development in vaccine production
- 4.12 Legal duties of veterinarians, forensic and state medicine, laws, common offences against animals and laws related to those offences, legal points and examination of live and dead animals in criminal cases, mischief, killing, maiming and poisoning, cruelty to animals and bestiality.

5. Veterinary Microbiology and Immunology

- 5.1 General description and classification of infectious organisms
- 5.2 Morphology, isolation, growth, colonial, biochemical and antigenic characteristics, pathogenicity, and the disease caused in farm animals, pets and poultry by *Staphylococcus*, *Streptococcus*, *Moraxella*, *Brucella*, *Enterobacteriaceae*, *Pseudomonas*, *Leptospira*, *Vibrio*, *Aeromonas*, *Pasteurella*, *Yersinia*, *Actinobacillus*, *Actinomyces*, *Corynebacterium*, *Mycobacterium*, *Bacillus*, *Clostridium*, *Listeria*, *Erysipelothrix*, *Nocardia*, *Bacteroides*, *Haemophilus*, *Bordetella*, and *Spirochaetes*
- 5.3 Morphology, isolation, growth, colonial, biochemical and antigenic characteristics, pathogenicity, and the disease caused in farm animals, pets and poultry by *rickettsia* and *chlamydia*
- 5.4 Morphology, isolation, growth, colonial, biochemical and antigenic characteristics, pathogenicity, and the disease caused in farm animals, pets and poultry by *Mycoplasma* and *Acholeplasma*
- 5.5 Morphology, isolation, growth, colonial, biochemical and antigenic characteristics, pathogenicity, and the disease caused in farm animals, pets and poultry by fungus

(*Candida*, *Mycetomal*, *Sporotrichum*, *Aspergillus*, *Cryptococcus*, *Histoplasma*, *Rhinosporidium* and others)

- 5.6 Diseases caused by mycotoxins
- 5.7 Viruses and their classification, DNA and RNA viruses and their importance in veterinary medicine
- 5.8 Cultivation of viruses in developing chicken embryos, primary cell cultures and cell lines and animals
- 5.9 Replication of RNA and DNA viruses and regulation of virus multiplication
- 5.10 Viral genetics and interactions with references to mutation, genetic recombination
- 5.11 General characteristics of various families of DNA and RNA viruses causing diseases in livestock and poultry with reference to virus antigens, cultivation, pathogenesis, epidemiology, diagnosis and immunity of Pox virus, Iridovirus, Herpes virus, Adenovirus, Papovavirus, Orthomyxovirus, Paramyxovirus, Arbovirus, Rhabdovirus, Coronavirus, Togavirus, Picornavirus, Birnavirus, Parvovirus and Retrovirus
- 5.12 Concept of virulence, pathogenicity, infection and immunity
- 5.13 Principles of immunity and immune mechanisms
- 5.14 Cellular and humoral immunity and mechanisms involved in it
- 5.15 Immune responses their development and specificity
- 5.16 Hypersensitivity and allergy
- 5.17 Immunodiagnostic tests used in veterinary diagnostics
- 5.18 Development of resistance against therapeutic agents in the microorganism and its mechanism

6. Veterinary Gynaecology and Obstetrics

- 6.1 Development and description of genitalia of male and female farm animals and pets
- 6.2 Growth, puberty, sexual maturity in relation to reproduction in male and female farm animals and pets
- 6.3 Role of hormones in various phases of reproduction in male and female farm animals and pets
- 6.4 Sexual behaviour of male and female animals and factors affecting the sex libido of animals
- 6.5 Symptoms of oestrus and oestrus cycle in domestic animals and factors affecting oestrus cycle, detection of oestrus and stages of oestrus, oestrus synchronisation, ovulation and transport of ovum and sperms
- 6.6 Fertilization, development of foetus, foetal membrane and placenta, gestation period, stages of gestation
- 6.7 Manipulation of oestrus, ovulation, in-vitro fertilization and embryo transfer
- 6.8 Maintenance of pregnancy and pregnancy diagnosis by different methods, differential diagnosis of pregnancy
- 6.9 Diseases and accidents during pregnancy, causes of premature birth, early embryonic death, abortion-causes, treatment and control, intrauterine death, mummification, metritis and pyometra

- 6.10 Fertility, infertility and sterility- functional infertility, anoestrus, ovarian hypoplasia, cystic ovary, repeat breeding, Infectious infertility: specific and non specific infection affecting genital organs of male and female animals
 - 6.11 Infertility of farm animals in Nepal and the approaches to alleviate it
 - 6.12 Sexual health control and herd reproductive health programme
 - 6.13 Male infertility and its forms, -factors affecting male infertility, diseases of sex organs and accessory sex glands of male animals
 - 6.14 Parturition in domestic animals, causes and stages of parturition, expulsion and retention of placenta
 - 6.15 Intrauterine presentation of foetus, dystocia, its causes and management, caesarian section
 - 6.16 Parturition hygiene, care and management of newborn and dam, udder health care
 - 6.17 Post partum diseases and complications- prolapse, vaginitis, cervicitis, metritis, pyometra, post partum paraplegia, milk fever
 - 6.18 Clinical use of hormones and prostaglandins in reproduction management in farm animals
 - 6.19 Artificial insemination- introduction, history, development, advantage and limitation of AI, methods of semen collection and processing in different farm animals, techniques of AI, factors affecting quality and quantity of semen, semen abnormalities and tests for evaluation of semen quality, semen metabolism, biochemistry of semen of farm animals
 - 6.20 Problems associated with artificial insemination in Nepalese farm animals
- 7. Veterinary Epidemiology**
- 7.1 Definition, aims, objectives and applications of epidemiology and preventive medicine
 - 7.2 Ecological concept of epidemiology
 - 7.3 Disease process and its spread, pattern of disease distribution in the community,
 - 7.4 Multi-factorial causation of diseases, agent, host and environmental strategies of epidemiology
 - 7.5 Types of epidemiological studies-case control, cohort studies
 - 7.6 Investigation of epidemic
 - 7.7 Molecular Epidemiology and Bioinformatics
 - 7.8 Prevention control and eradication of diseases
 - 7.9 Categorization of communicable diseases
 - 7.10 Regulations regarding handling, import and export of biomaterials
- 8. Physiology**
- 8.1 Structure of different types of muscles, mechanism of contraction and effect of different stimuli on contraction
 - 8.2 Chemical composition and physiological properties of muscle
 - 8.3 Rigor mortis, fatigue and chemical changes associated with muscular contraction
 - 8.4 General function of blood, blood cells, plasma and serum
 - 8.5 Blood cells, their functions and their role in body functions
 - 8.6 Physiology and hemodynamics of blood circulation

- 8.7 Blood pressure and the factors influencing it, venous pressure and arterial pulse
 - 8.8 Neural and chemical control of blood vessels and vasomotor reflexes
 - 8.9 Shock and its mechanism and classification; fluid and electrolyte balance
 - 8.10 Mechanism of respiration, chemistry of respiration, composition of inspired and expired air, blood gases and law of solubility of gases, transport of blood gases and exchange of gases in lungs and tissues
 - 8.11 Regulation of respiration, chemical regulation of respiratory centre
 - 8.12 Respiratory reflexes, role of respiration in acid base mechanism
 - 8.13 Respiration in birds
 - 8.14 Physiology of digestion- ingestion, mastication, movement of stomach, intestine, rumination and defecation and other digestive processes
 - 8.15 Thirst, hunger, vomition and eructation reflexes
 - 8.16 Composition, regulation and functions of saliva, pancreatic juice, bile, intestinal juice
 - 8.17 Digestion in ruminant stomach- microbial activities in the stomach and intestines, absorption of foodstuffs, place of absorption, mechanism of absorption of carbohydrate, proteins, fats and water
 - 8.18 Digestion in chickens
 - 8.19 Physiology of excretion- mechanism of urine formation, micturition, physical characteristics and composition of urine in health and diseases, role of kidneys in acid, base and electrolyte balance, excretion of urine in birds
 - 8.20 Maintenance of body temperature, thermoregulation against cooling and heating
 - 8.21 Physiology of reproduction- sex organs and their functions in male and female animals, sex hormones and their physiological role in reproductive functions of male and female animals, oestrus, ovulation, fertilization and development of fetus, and parturition.
 - 8.22 Physiology of egg laying in birds
 - 8.23 Hormones and their general functions, mechanism of secretion, storage, transport, action, and regulation of secretion and recent approaches on the use of hormones in veterinary practices.
 - 8.24 Chemical nature, secretion, functions and regulation of secretion of hormones from hypothalamus, pituitary, thyroid, pancreas, adrenal and male and female reproductive organs
 - 8.25 Physiology of nervous system- degeneration and regeneration of nerve fibres, nature of nerve impulse and its propagation, cutaneous receptor organs, peripheral nerves, spinal cord and reflex action, autonomic nervous system
 - 8.26 Sensory organs and their function and mechanism of vision, hearing, taste and olfaction
 - 8.27 Examination of proper functioning of different organs of excretion and reproduction
- 9. Biochemistry/ Biotechnology**
- 9.1 Scope and importance of biochemistry, biochemistry of cell and cell organelles
 - 9.2 Physical biochemistry-concentration of solutions, diffusion, osmotic pressure, dissociation of acids, pH, buffer system

- 9.3 Biochemistry of carbohydrates, lipids, proteins
- 9.4 Enzymes-definition, properties, composition, specific enzyme action, enzymes and coenzymes involved in oxidation and reduction
- 9.5 Metabolism in ruminants and non ruminants-Carbohydrate metabolism-glycolysis, TCA cycle; fat metabolism-beta oxidation of fatty acid, ketone body formation; protein metabolism-deamination and transamination, urea cycle, protein synthesis nucleic acid metabolism-DNA synthesis; energy metabolism in domestic animals; mineral metabolism; vitamins - structure and metabolic role
- 9.6 Biochemistry of blood- plasma proteins and functions, changes in disease, inherited deficiency of plasma protein fractions
- 9.7 Haemoglobin chemistry- coagulation and haemolysis of blood, lymph, tissue fluid and other body fluids
- 9.8 Biochemistry of hormones- structure and metabolic role
- 9.9 Biochemical process in health and disease conditions- biochemistry of respiration, renal function, stress and shock and detoxification
- 9.10 Immunochemistry- nature of antigens and antibody, structure of antibodies
- 9.11 Diagnostic biochemistry- blood sugar, ketone bodies, blood urea nitrogen and uric acid, enzymes
- 9.12 Basic principles of biosynthesis of proteins and nucleic acids, genome, genesequencing, DNA, RNA, PCR, hybridoms and monoclonal antibodies, DNA probe, in-vitro fertilization and embryo transfer and cloning
- 9.13 Recent approaches on the use of biotechnology tools in veterinary practices

10. Genetics and Principles of Animal Breeding

- 10.1 Study of animal cell, chromosome number of different species of livestock and poultry,
- 10.2 Cell division and behaviour of chromosomes during mitosis and meiosis
- 10.3 Mendelian principles, dihybrid and polyhybridisation
- 10.4 Gene interaction, epistasis, multiple alleles
- 10.5 Linkages and crossing over
- 10.6 Sex controlled inheritance and sex determination
- 10.7 Modified Mendelian inheritance-lethal and sublethal characters, mutation, chromosomal aberration, cytoplasmic inheritance
- 10.8 Quantitative inheritance- Genetic constitution of population, gene frequency, genotype frequency, Hardy Weinberg's law, selection and effect of selection, migration, mutation and population size on gene frequency
- 10.9 Values and means-population mean, average effect, breeding value, genetic, phenotypic and environmental variance, heritability
- 10.10 Breeds and their classification and basis of classification, Important native and exotic breeds of farm animals, pets and poultry, concept of environment and genotype
- 10.11 Heritability, repeatability, genetic and phenotypic correlation of different traits of economic value

- 10.12 Selection and methods of selection, basis of selection, response to selection and its measures, selection differential, sire index, selection index, recurrent and reciprocal selection
- 10.13 Breeding methods-different mating systems, inbreeding and its measure, effect and application of inbreeding with its merits and demerits, inbreeding coefficient and coefficient of relationship, line breeding; open nucleus breeding, out breeding (cross breeding)
- 10.14 Heterosis- causes, measurement and application in animal breeding, outcrossing, topcrossing, grading up, criss crossing, rotational crossing, incrossing, back crossing, species and species hybridization
- 10.15 Breeding behaviour, Importance of recording of breeding performance

11. Public Health and Meat Hygiene

- 11.1 Organization, layout and management of slaughterhouses,
- 11.2 Pre-slaughter care of animals, handling and transport of meat animals, ante-mortem examination
- 11.3 Techniques of humane slaughtering
- 11.4 Different techniques of slaughtering and dressing
- 11.5 Chilling, ageing and evaluation of dressed carcasses and carcass yield
- 11.6 Utilization of slaughterhouse by products
- 11.7 Disposal of condemned parts and animals suffering from notifiable diseases
- 11.8 Examination of carcasses of different livestock species for meat borne diseases
- 11.9 Development of meat industry-structure, composition, nutritive value post mortem changes and eating quality of meat tissues
- 11.10 Principles of various preservation techniques
- 11.11 Standard and quality control measures adopted for meat and meat products
- 11.12 Fraudulent substitution of meat and its recognition
- 11.13 Chemical composition and nutritive value of meat obtained from farm livestock and poultry
- 11.14 Zoonotic diseases and their diagnosis, treatment and control
- 11.15 Role of veterinarian for the control of zoonotic diseases
- 11.16 Drug residue in animal food and Antimicrobial Resistance

12. Statistics

- 12.1 Probability, frequency, mean, median, mode, standard deviation, standard error, normal distribution, sampling theory, test of hypothesis, confidence intervals
- 12.2 Students t test, Chi-square test, F test
- 12.3 Estimate of error- replication and randomization
- 12.4 Complete randomized design-randomization, layout and analysis of variance
- 12.5 Randomized complete block design-layout, randomization, analysis of variance
- 12.6 Two factorial experiment- randomization, layout and analysis of variance, interaction
- 12.7 Comparison - pair comparison by least significant difference, group comparison between group comparison, within group comparison
- 12.8 Regression and correlation - simple linear and nonlinear, multiple linear and nonlinear; correlation
- 12.9 Importance and use of Statistics in bio-sciences research

13. Special area

- 13.1 Transboundry Animal Diseases
- 13.2 OIE, WTO, SPS, TRIPS, ADS
- 13.3 Epidemiological status of Livestock diseases in Nepal
- 13.4 Role of Biotechnology in animal disease investigation
- 13.5 Quarantine system in Nepal
- 13.6 Epidemiological reporting system of Nepal
- 13.7 The present contribution and future potential of livestock for national agricultural development
- 13.8 Role of livestock/veterinary research for overall livestock development
- 13.9 Main constraints of livestock/veterinary research in Nepal and the ways to alleviate constraints
- 13.10 Development of research proposal and writing of technical report
- 13.11 Design of experiments and their effective implementation
- 13.12 Monitoring and supervision of experimental studies
- 13.13 Programme planning and budgeting
- 13.14 Development of research programmes on national priorities

14. Research Management

- 14.1 Development of research proposal and writing of technical report
- 14.2 Design of experiments and their effective implementation
- 14.3 Monitoring and supervision of experimental studies
- 14.4 Programme planning and budgeting
- 14.5 Development of research programmes on national priorities

15. Others

- 15.1 History of Veterinary Science in Nepal
- 15.2 The structure, objectives and activities of Nepal Agricultural Research Council and Executive Board
- 15.3 Animal Health and Livestock Services Act, 2055 and regulation

नेपाल सरकार
नेपाल कृषि अनुसन्धान परिषद्
पदपूर्ति समिति

- 15.4 Slaughter house and meat inspection Act, 2055 and regulation
- 15.5 Nepal Veterinary Council Act, 2055 and regulation 2057
- 15.6 Feed Act 2033 and regulation
- 15.7 National and International Ethics in Research
- 15.8 Laws regulating animal diseases including the laws regulated by OIE
- 15.9 Sanitary and phytosanitary measures (SPS) and International Standards in research

NARC पदपूर्ति समिति

नेपाल सरकार
नेपाल कृषि अनुसन्धान परिषद्
पदपूर्ति समिति
वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), वायोस्ट्र्याटिस्टिक्स उप-समूहको खुल्ला तथा
आन्तरिक प्रतियोगितात्मक
लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

**Technical Subject
Sub-Group: Biostatistics**

1. Biostatistics in Nepalese agriculture

- 1.1 Use and application of biostatistics in Nepalese agriculture
- 1.2 Statistical system and agricultural database in Nepal
- 1.3 Agricultural statistics and trend
- 1.4 Biostatistics and information technology
- 1.5 National agriculture sample census
- 1.6 Computer software and apps in Nepalese agriculture

2. General biostatistics

- 2.1 Basic concepts
- 2.2 Observations/ variables, population and sample
- 2.3 Experimental plot and unit
 - 2.3.1 Size, shape and orientation
 - 2.3.2 Border and competition effects
 - 2.3.3 Soil and environmental heterogeneity
 - 2.3.4 Estimation of size of experiments for specified accuracy
 - 2.3.5 Sub-sampling plots and yields for laboratory analysis
- 2.4 Descriptive statistics
 - 2.4.1 Frequency distribution
 - 2.4.2 Measures of central tendency
 - 2.4.3 Measures of variation and dispersion
- 2.5 Probability and distribution
 - 2.5.1 Binomial distribution
 - 2.5.2 Normal distribution
 - 2.5.3 Poisson distribution
 - 2.5.4 Chi-square distribution
 - 2.5.5 Student's t distribution
 - 2.5.6 Estimation and inference
- 2.6 Sampling
 - 2.6.1 Sampling design
 - 2.6.2 Sampling fundamental
- 2.7 Research materials, methods, methodology and design
- 2.8 Data validation, graphics and exploratory data analysis

3. Testing of hypothesis

- 3.1 Hypothesis and research question
- 3.2 Hypothesis testing
- 3.3 Critical region, one and two tailed test
- 3.4 Test statistics
- 3.5 Important parametric test
- 3.6 Limitation

4. Correlation and regressions

- 4.1 Simple linear correlation and regression
- 4.2 Multiple linear correlation and regression
- 4.3 Partial correlation
- 4.4 Non-linear regression (simple and multiple)
- 4.5 Application of dummy variable
- 4.6 Searching for the best regression
- 4.7 Test of hypothesis
- 4.8 Assumption and problem data
- 4.9 Use and misuse of correlation and regression analysis

5. Analysis of categorical and survey data

- 5.1 Contingency tables
- 5.2 Chi-square distribution
- 5.3 Uses of chi-square
- 5.4 Survey data analysis

6. Non-parametric test

- 6.1 Chi-square test
- 6.2 Sign test and Wilcoxon's signed rank test
- 6.3 Rank correlation
- 6.4 Kolmogorov Smirnov one and two sample test
- 6.5 Wilcoxon Mann Whitney two sample test
- 6.6 Kruskal Wallis k-sample test
- 6.7 Friedman's test for two-way classification

7. Experimental design

- 7.1 Basic concepts of statistical models and use of samples
- 7.2 Concepts of experimental design, factorial experiments, confounded factorials
- 7.3 Principles and techniques of planning, establishing and executing field (on-farm, on-station), lab and greenhouse experiments
- 7.4 Completely randomized and randomized complete block design
- 7.5 Latin square and lattice design
- 7.6 Factorial experiments
- 7.7 Split-plot and strip plot design
- 7.8 Split-split plot design
- 7.9 Fractional factorial design

- 7.10 Confounded factorials
 - 7.11 Change-over design
 - 7.12 Incomplete block designs
 - 7.13 Perennial crop experiment
 - 7.14 Lab experiment
 - 7.15 Livestock and fishery experiment
 - 7.16 Experiment in farmers' fields
 - 7.17 Assumption and data transformation
 - 7.18 Missing values
- 8. Analysis of multiobservation data and multiexperiments**
- 8.1 Data from plot sampling
 - 8.2 Measurement over time and location
 - 8.3 Combining analysis (from multi-years and multi-locations experiments)
 - 8.4 Rotation and long term experiments
 - 8.5 Repeated measures data
- 9. Covariance**
- 9.1 Uses
 - 9.2 Model and assumption
 - 9.3 Computation and interpretation
- 10. Treatment comparisons**
- 10.1 Pair comparison
 - 10.2 Group comparison
- 11. Multivariate analysis**
- 11.1 Scope of multivariate analysis
 - 11.2 Applications of maximum likelihood estimation
 - 11.3 Multivariate linear regression models
 - 11.4 Cluster analysis
 - 11.5 Discriminant analysis
 - 11.6 Principal components analysis
 - 11.7 Canonical correlation analysis
- 12. Special application of statistics**
- 12.1 Statistics in bioinformatics and biotechnology
 - 12.2 Statistical genomics and agrobiodiversity measurement
 - 12.3 Statistics in genetics, plant breeding and agronomy
 - 12.4 Statistics in livestock and fishery
 - 12.5 Statistics in social science
 - 12.6 Statistics in entomology, pathology and food science
 - 12.7 Crop, livestock and fishery modeling
- 13. Biometrical software and application**

- 13.1 Software: R, SPSS, SAS, GIS, MSTATC, MINITAB, GenStat, MS Excel)
- 13.2 Online survey tool and software
- 13.3 E-field book
- 13.4 Database software

14. Interpretation, use and misues, report writing and presentation

Referecnes

- Clayton KN. 1984. An introduction to statistics for psychology and education. Charles E. Merrill Publishing Company, London.
- Cockran WG and GM Cox. 1992. Experimental designs. 2nd ed. Wiley, New York.
- Draper NR and H Smith. 1966. Applied regression analysis. Wiley New York.
- Gomez KA and AA Gomez. 1984. Statistical procedures for agricultural research. 2nd ed. John Wiley and Sons, New York.
- Heeringa SG, BT West and PA Berglund. 2017. Applied Survey Data Analysis. 2nd edition. Chapman & Hall/CRC. New York
- Jarvis DI et al. A training guide for in-situ conservation on-farm. Version I. IPGRI, Rome, Italy.
- Johnson RA and DW Wichern. 1996. Applied multivariate statistical analysis. Prentice Hall of India, New Delhi.
- Joshi BK, MP Upadhyay, HP Bimb, D Gauchan and BK Baniya. 2005. Data analysis methods adopted under in-situ global project in Nepal. Nepal Agric. Res. J. 6:99-109.
- Joshi BK, S Gyawali and DS Poudyal. 2002. Regression analyses and multiple comparison procedures: Uses and misuses. JIST. 12:69-81.
- Kempton RA and PN Fox (eds). 1997. Statistical methods for plant variety evaluation. Chapman and Hall, UK.
- Lauckner FB and WJ Fielding. 1999. Biometrics notes for agricultural research in the Caribbean. 2nd ed. CARDI, Trinidad.
- Liu BH. 1998. Statistical genomics. CRC Press. New York.
- MoALD. 2022. Statistical information on Nepalese agriculture. MoALD, Kathmandu.
- Pamela MM and BK Thompson 1981. Presentation of experimental results. Can. J. Plant Sci. 61:799-802.
- Rangaswamy R. 1995. A text book of agricultural statistics. New Age International Limited, New Delhi.
- Snedecor, G.W. and Cockran, W.G., Statistical methods. The Iowa State Univ. USA, 1980.
- Steel RGD and JW Torrie 1960. Principles and procedures of statistics with special reference to the biological science. McGraw Hill Book Company, INC. New York.

नेपाल सरकार
नेपाल कृषि अनुसन्धान परिषद्
पदपूर्ति समिति
वरिष्ठ वैज्ञानिक, एस-३, (Senior Scientist, S-3), वायोटेक्नोलोजी उप-समूहको खुल्ला
प्रतियोगितात्मक
लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Biotechnology

1. Biotechnology

- 1.1 Conventional and modern biotechnology, agricultural biotechnology
- 1.2 History
- 1.3 Application and landmarks
- 1.4 Biotechnology lab and institutes in Nepal
- 1.5 Status of biotechnology in Nepal
- 1.6 Conservation biotechnology (DNA and tissue bank, DNA bar code, DNA finger print)
- 1.7 Nepal policy on agricultural biotechnology

2. Cell Biology

- 3.1 Cell types, structures and functions
- 3.2 Cell metabolism and cell cycle
- 3.3 Cell study techniques including cytometry
- 3.4 Isolation, culture and regeneration from protoplast
- 3.5 Protoplast fusion

3. Molecular Biology

- 2.1 Introduction, DNA, RNA and Protein
- 2.2 Omics technology
- 2.3 Organization of plant genes, repetitive DNA
- 2.4 Restriction enzymes
- 2.5 Functional genes (Encoding RNA molecules, Proteins)
- 2.6 Gene isolation and identification (cDNA, Genomic Library, Transposons)
- 2.7 Cloning strategy (Plasmid, Cosmid, Bacteriophage Ti Plasmid)
- 2.8 Regulation of gene expression
- 2.9 DNA methylation
- 2.10 Mutagenesis
- 2.11 Antisense RNA
- 2.12 MicroRNA (miRNA) and siRNA: Concept and application

4. Tissue Culture

- 1.8 History
- 1.9 Basic steps and requirements of tissue culture
- 1.10 Micropropagation
- 1.11 Somatic embryogenesis and hybridization
- 1.12 Virus and pathogen elimination
- 1.13 Haploid production by anther and ovary culture

- 1.14 Embryo rescue
- 1.15 Ploidy manipulation
- 1.16 Germplasm conservation, storage and transportation (in-vitro, ex-situ conservation and cryopreservation)
- 1.17 Callus culture
- 1.18 Suspension culture
- 1.19 Variability and instability in tissue culture (Somaclonal variation)

5. Molecular breeding and genetic engineering

- 5.1 Quant-qualitative traits, Types of molecular markers, MAS, Marker assisted resistance breeding, Metablomic assisted breeding, Mapping population, QTL and gene tagging, DNA fingerprinting, Genetic diversity analysis, Population and quantitative genetics
- 5.2 Transformation (genetic engineering): Overview, Steps in transgenic technology, Gene transfer methods, Gene silencing, Chloroplast and mitochondria engineering, Pros and Cons of GMOs, Risk assessment of GMOs

6. Molecular farming

- 6.1 Plant as a bioreactor for production of secondary metabolites (pigments, perfumes, flavors, insecticides, anticancer agents, vaccines, antibodies)
- 6.2 Future prospects

7. Bioinformatics

- 7.1 Introduction, Databases, Application of bioinformatics in molecular biology, taxonomy and biodiversity
- 7.2 Database: Data types, data structures, searching, sorting, Query and response, designing a database, genomic, proteomic, and metabolic pathways databases, publicly available databases for protein and nucleic acid sequences (GenBank, EMBL, DDBJ, Swiss Prot, PIR, Hovergen, TAIR, PlasmDB, etc)
- 7.3 Analysis of genetic sequences: General concepts of sequence analysis, identification of functional sequences, sequence alignment, homology searching including BLAST, ENTREZ, and PubMed, Gene expression informatics, Gene finding
- 7.4 Proteomics data analysis: Basic issues and concepts, protein sequences and alignment, protein structure prediction
- 7.5 Molecular modeling

8. Methodologies and Techniques

- 4.1 Preparation of media, buffer and reagents for tissue culture and DNA analysis
- 4.2 Cell isolation, protoplast isolation, ex-plant preparation
- 4.3 Creating genetic variation
- 4.4 Protein purification, characterization, quantification
- 4.5 DNA and isozyme extraction, isozyme staining
- 4.6 PCR techniques (Conventional PCR, qRT-PCR, RAPD, Microsatellite, AFLP) and RFLP
- 4.7 DNA sequencing

- 4.8 Agarose gel, starch gel and SDS-PAGE electrophoresis, Western blotting
- 4.9 Genetic analysis using computer software
- 4.10 Molecular data analysis and diversity estimation, BLAST and interpretation of results, multiple sequence alignment
- 4.11 Bioinformatics: Publicly available databases for protein and nucleic acid sequences, primer designing, comparative genomic studies, transcriptomics, proteomics etc.
- 4.12 GMO testing
- 4.13 Laboratory bio-safety issues, bio-safety levels, National and International laws of bio-safety regulations
- 4.14 Genebank and GenBank: Importance, management

9. Statistics and Statistical Genomics

- 6.1 Definition and importance of statistics, experimental design
- 6.2 Central tendency and measures of dispersion as tools for measuring quantitative inheritance/traits
- 6.3 Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA)
- 6.4 Regression and correlation analysis
- 6.5 Least Squares Analysis and Mixed Model Methodology
- 6.6 Best Linear Unbiased Prediction (BLUP)
- 6.7 Multivariate analysis
- 6.8 Analysis of molecular variance, genetic diversity parameters
- 6.9 Population and quantitative genetics
- 6.10 Genetic and physical mapping, linkage map and mapping populations
- 6.11 QTL mapping and QTL by environment interaction
- 6.12 Resampling and simulation in genomics
- 6.13 Software and database (biotech related)

10. Ethical and socioeconomic prospective of biotechnology, Intellectual property right

11. Application of biotechnology in plant breeding (crops, forage crops), animal breeding (livestock, aquatic animal), pathology (agro-microorganisms), entomology (agro-insects), food, environment

References

- Baxevanis A and FBF Ouellette. 2001. Bioinformatics: A practical guide to the analysis of genes and proteins. John Wiley.
- Bhojwani SS and MK Razdan. 1996. Plant tissue culture: Theory and practice. A revised edition. Elsevier, Amsterdam.
- Bourne PE and H Weissig. 2003. Structural Bioinformatics. Wiley.
- Campbell MA and LJ Heyer. 2006. Discovering genomics, proteomics & bioinformatics. CHLS Press.
- Collard BCY, MZZ Jahufer, JB Brouwer and ECK Pang. 2005. An introduction to markers, quantitative trait loci (QTL) mapping and marker-assisted selection for crop improvement: The basic concepts. Euphytica 142:169–196

- De la RG, J Gonzalez-Cabrera, R Vazquez-Padron and C Ayra-Pardo. 1998. *Agrobacterium tumefaciens*: A natural tool for plant transformation. *Electronic J. Plant Biotechnology* 1(3).
- De Vienne D. 2003. *Molecular Markers in Plant Genetics and Biotechnology*. Science Publishers, Inc, USA.
- Eamens A, MB Wang, NA Smith and PM Waterhouse. 2008. RNA Silencing in Plants: Yesterday, Today, and Tomorrow. *Plant Physiology* 147:456–468.
- Evans EA et al. 1990. *Hand book of plant cell culture: Crop species*. McMillan Publishing Company, New York.
- Glick BR and JJ Pasternak. 2010. *Molecular biotechnology: Principles and application of recombinant DNA*. ASM Press, Washington DC.
- Gupta PK. 2004. *Elements of Biotechnology*. Rastogi Publications, India.
- Higgins D and W Taylor. 2000. *Bioinformatics: Sequences, structure and databanks. A practical approach*. Oxford University Press.
- Joshi BK, B Pandey and RC Adhikari. 2019. Progress and Prospects of Agricultural Biotechnology and Biosafety in Nepal: Present Status, Challenges and Way Forward. In: *Agricultural Biotechnology and Biosafety in South Asia: Progress and Prospects* (PR Pandey, B Bajaj and A Islam, eds). SAARC Agriculture Centre, ILSI Research Foundation, South Asia Biosafety Program, Bangladesh; pp.59-75.
- Joshi BK, D Gauchan, J Bajracharya, P Shrestha, MP Upadhyay and HP Bimb. 2013. Genetic diversity and population structure of pigeon pea. *Journal of Nepal Biotechnology Association* 3(1):26-34.
- Joshi BK, HP Bimb and MP Upadhyay. 2009. Status and prospects of agricultural biotechnology for crop improvement and management in Biotechnology Unit-NARC. In: *Proceedings of the National Seminar on Present Status and Future Prospects of Biotechnology in Nepal, 14-15 March 2007, Khumaltar*. NAST and MOEST, Kathmandu; pp.21-36.
- Joshi BK. 2017. Biotechnology for conservation and utilization of agricultural plant genetic resources in Nepal. *Journal of Nepal Agri. Research Council* 3:49-59. DOI: <http://dx.doi.org/10.3126/jnarc.v3i1.17276>.
- Joshi SP, PK Ranjekar and VS Gupta. Molecular markers in plant genome analysis. Available at <http://www.ias.ac.in/currsci/jul25/articles15.htm> 1/28/07
- Karp A, PG Issar and DS Ingram. 1998. *Molecular tools for screening biodiversity*. Chapman and Hall, London.
- Karp A, S Kresovich, KV Bhat, WG Ayad and T Hodgkin. 1997. *Molecular tools in plant genetic resources conservation: A guide to the technologies*. IPGRI Technical Bulletin No 2. IPGRI, Rome.
- Kole C and AG Abbott. 2008, 2010. *Principles and practices of plant genomics: Molecular breeding (Vol 1-3)*. Science Publishers.
- Liu BH. 1998. *Statistical Genomics: Linkage, Mapping and QTL Analysis*. CRC Press, New York.
- Lycett GW and D Grierson (eds). 1990. *Genetic engineering of crop plants*. Butterworths, London.
- Mount DW. 2004. *Bioinformatics: Sequence and genome analysis*. CSHL Press.
- NAST and MoEST. 2008. *National state of the art report on biotechnology for Nepal*. NAST and MoEST, Kathmandu.
- Natesh S, VL Chopra and S Ramachandran, eds. 1987. *Biotechnology in agriculture*. Oxford and IBH.

- Paterson AH. 1996. Genome mapping in Plants. R.G. Landes Company.
- Pevsner J. 2003. Bioinformatics and functional genomics. Wiley-Liss.
- Phillips RL and IK Vasil (eds). 1994. DNA based markers in plants. Kluwar Academic Publishers, Netherlands.
- Powell W, M Morgante, C Andre, M Hanafey, J Vogel, S Tingey and A Rafalski. 1996. The comparison of RFLP, RAPD, AFLP and SSR markers for germplasm analysis. Mol. Breed. 2:225-238.
- Purohit SS.2010. Agricultural biotechnology. 3rd ed. Agrobios, India.
- Singh B, SK Gautam, MS Chauhan, and SK Singh. 2015. Text book of animal biotechnology. TERI, New Delhi.
- Singh BD. 1998. Biotechnology. Kalyani Publishers, India.
- Singh RP and PK Jaiswal. Plant genetic engineering series. SCI Tech Publishing LLC, USA.
- Spooner D, R van Treuren and MC de Vicente. 2005. Molecular markers for genebank management. IPGRI Technical Bulletin No. 10. International Plant Genetic Resources Institute, Rome, Italy.
- Turner PC, AG McLennan, AD Bates and MRH White. 2007. Instant Notes in Molecular Biology. Routledge.
- VasillK and TA Thorpe. 1994. Plant cell and tissue culture. Kluwer Academic Publishers.
- Wang A and S Ma. 2012. Molecular farming: Recent advances and future prospects. Springer.
- Warburton M and J Crossa. 2000. Data analysis manual for fingerprinting and genetic diversity studies. CIMMYT, Mexico.
- Xu Y. 2010. Molecular plant breeding. CABI