

नेपाल सरकार
नेपाल कृषि अनुसन्धान परिषद्
पदपूर्ति समिति

वैज्ञानिक, एस-१ (S-1) पद/तहको खुला 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	Full Mark	Pass Mark	No. Questions (Q) x Mark (M) = Total Marks	Time Allowed
I	Agriculture Research and development Issues	75	30	9 Q x 5 M = 45 (Short Answer) 3 Q x 10 M = 30 (Long Answer)	2.00 Hours
II	Technical Subject	125	50	5 Q x 15 M = 75 (Critical Analysis) 2 Q x 25 M = 50 (Problem Solving)	3.30 Hours

२. द्वितीय चरण(Second Phase): Interview

पूर्णाङ्क: ३०

Subject	Full Marks	System
Interview	30	Oral

द्रष्टव्य:

- 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 Part I को विषयवस्तु सबै उपसमूहको लागि पाठ्यक्रम एउटै भएको कारण एकिकृत परीक्षा सञ्चालन हुनेछ ।
- प्रथम र द्वितीय पत्रको लिखित परीक्षा छुट्टाछुट्टै हुनेछ ।
- प्रथम पत्रको लागि Short Answer का लागि एक वटा र Long Answer का लागि एक वटा उत्तर पुस्तिका हुनेछ ।
- यस पाठ्यक्रम योजना अन्तर्गतका पत्र/विषयका विषयवस्तुमा 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 ।
- प्रथम चरणको लिखित परीक्षाबाट छनौट भएका उम्मेदवारहरूलाई मात्र द्वितीय चरणको अन्तरवार्तामा सम्मिलित गराइने छ ।
- प्रथम चरणको लिखित परीक्षाबाट छनौट भएका उम्मेदवारको प्राप्ताङ्क र द्वितीय चरणको अन्तरवार्तामा प्राप्त गरेको अंक जोडी योग्यताक्रम अनुसार सिफारिस गरिनेछ ।
- यो पाठ्यक्रम तुरुन्त लागू हुने छ ।
- यस भन्दा अगाडि लागू भएको पाठ्यक्रम खारेज गरिएको छ ।

वैज्ञानिक, एस-१, (Scientist, S-1), सबै उपसमूहको खुल्ला प्रतियोगितात्मक
लिखित परीक्षाको लागि पाठ्यक्रम

Paper: I

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

1. Constitution of Nepal: Food, agriculture and natural resources related issues.
2. Current National Agricultural policies and plans: National Agriculture Policy, Agricultural biodiversity policy, Climate change policy, Agriculture Development Strategy (ADS), Long term seed vision and agriculture related issues in development plan and National land use policy.
3. Structure and responsibilities of Nepal Agricultural Research Council (NARC).
4. International Agricultural Research Organizations – CGIAR and IARCS: CIAT, CIMMYT, CIP, ICRISAT, ICARDA, World Fish, ICRAP, IFPRI, IITA, ILRI, Bioversity International, IRRI, IWMI, AVRDC, ICIMOD, IFDC, IFAD, FAO.
5. Agricultural Innovation System: concept, actors, relationship between actors and accountability to stakeholders.
6. Agricultural research project management: Problem & objective tree analysis, logframe development, principles and steps on research project development.
7. Coordination and partnership of Nepal Agricultural Research Council with that of national organizations, international organizations, civil societies, entrepreneurs and agri-business.
8. Use of Information and Communication Technologies (ICTs) in agriculture Research & Development.
9. Agriculture research farm management.
10. Implementation and impact of agricultural research in Nepal.
11. Agriculture statistics: production, productivity, import/export trend of major agricultural commodities.

वैज्ञानिक, एस-१, (Scientist, S-1), एग्रोनोमी उपसमूहको
खुल्ला 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, cowpea, pigeonpea, mungbean, rapeseed, mustard, sunflower, groundnut, sugarcane, jute and cotton with respect to:

- 1.1 Introduction, origin and distribution
- 1.2 Botany, morphology, growth stages and its phenology
- 1.3 Climate and soil
- 1.4 Recommended varieties and their characters.
- 1.5 Cultural practices - land preparation, seed treatment, seed priming, planting methods (spacing), planting/seeding time, seed rate, interculture operation, harvesting, drying, cleaning, transportation and storage
- 1.6 Weed and weed control: important weeds, control measures, recommended herbicides and their use, method and time of application
- 1.7 Manures and fertilizers: recommended doses, method of application and time of application
- 1.8 Water management: requirement, time and frequency of water application, irrigation methods and drainage
- 1.9 Plant protection measures: causal agents, predisposing factors, symptoms, and control measures
- 1.10 Typical cropping calendar and cropping patterns in hills, mid-hills, Terai and inner-Terai of Nepal.
- 1.11 Economics of crop production of major crops and their marketing

2. Climate, Weather and Crops

- 2.1 Climate: temperature, humidity, winds and wind pressure, rainfall, effective rainfall, sunshine hours, soil temperature and their effects on crops
- 2.2 Agro-climatic zones, seasonal weather patterns and crops of Nepal
- 2.3 Effects of droughts, floods, cold, frost, hailstones, and wind on crops and their mitigation measures
- 2.4 Agro-meteorological services to agriculture
- 2.5 Global warming, climate change, greenhouse gases: their impact in different field crops
- 2.6 Agro-climatic normal of field crops

3. Soil and Fertilizers

- 3.1 Soil: definition, soil and sub-soil, importance of top and sub-soils
- 3.2 Texture, structure, bulk density, soil profile, consistency of soil and their importance in agriculture
- 3.3 Soil of Nepal and their classifications

- 3.4 Soil moisture, surface tension, water holding capacity of soil, movement of water in soil, loss of water from soil and amount of water used by different crops
- 3.5 Essential plant nutrients and their sources
- 3.6 Functions of essential elements and their deficiency symptoms
- 3.7 Chemical fertilizer, their composition, chemical formula and transformation from fertilizer to available nutrient forms
- 3.8 Process of absorption of nutrient by plant and loss of plant nutrients from soil
- 3.9 Determination of nutrient requirement of major crops and amount of major nutrient removed by different crops
- 3.10 Soil pH, its measurement, liming materials, reaction of liming materials in soil
- 3.11 Importance of organic matters, soil organic matter, nutrient content of different manures
- 3.12 Recommended doses of nutrients to different crops in Nepal, method and times of application in various crops
- 3.13 Soil organism, function of soil organism, processes of ammonification, nitrification, denitrification, nitrogen fixation and importance of azotobacter, clostridium, algae, phosphobacterium, nitrogen cycle and VAM (Vesicular-arbuscular mycorrhiza) in soil
- 3.14 Green manure: benefit of green manure, influence of green manures in soil, desirable characteristics of green manures, plants suitable for green manure, green manuring and the maintenance of soil fertility, aerobic and anaerobic decomposition and its effect on soil, constraints of green manuring
- 3.15 Strategy to maintain soil fertility in hilly areas of Nepal
- 4. Weeds and Weed Control**
 - 4.1 Classification of weeds, their effects on crop production and pattern of weed distribution in Nepal
 - 4.2 Common weeds of major field crops
 - 4.3 Principles and methods of weed control
 - 4.4 Herbicides: types of herbicides, herbicide formulation, their modes of action, effects of herbicides on plants, herbicides use in Nepal
 - 4.5 Weed control measures in major cereals, legumes, oilseed and industrial crops
 - 4.6 Economic of herbicides use and their adverse effects on environment
 - 4.7 Integrated weed management
- 5. Insects, Diseases and their Control**
 - 5.1 Principles of diseases and insects control
 - 5.2 Sources of disease and insect infestation
 - 5.3 Main diseases of major field crops and their control measures
 - 5.4 Main insects and pests of major field crops and their control measures
 - 5.5 Common fungicides and insecticides used in Nepal
 - 5.6 IPM and use of plant pesticides
 - 5.7 Responses of crop varieties released in Nepal to different diseases and insects
 - 5.8 Environment and chemical control of diseases and insects
- 6. Water Requirement in Crop Production**
 - 6.1 Sources of water and its utilization
 - 6.2 Irrigation status and potential in Nepal

- 6.3 Quality of irrigation water, irrigation methods and techniques of irrigation
- 6.4 Measurement of water used by plants
- 6.5 Losses of water in different operations
- 6.6 Water requirement for a specific crop and a set of cropping pattern
- 6.7 Water use efficiency

7. Land Resources and Tillage

- 7.1 Physiographic distribution and land systems of Nepal
- 7.2 Land capability and utilization and irrigation suitability
- 7.3 Tillage: Objective of tillage, significance of tillage and importance in crop production
- 7.4 Zero tillage, minimum tillage and optimum tillage
- 7.5 Condition of soil suitable for cultivation and tillage practices
- 7.6 Terrace management and cultivation

8. Farming Systems and Outreach Research

- 8.1 Farming System: definition, concept, scope and importance
- 8.2 Components of farming systems and pre-dominant cropping patterns in Nepal
- 8.3 Social, economical and institutional aspects of farming system
- 8.4 On- farms farming system research (FSR), its methodology, characteristics of FSR, diagnostic methods (RRA, PRA, agro-ecosystem, analysis, and conventional survey)
- 8.5 Indexes and indices of cropping and farming systems

9. Crops and Crop Improvement

- 9.1 Definition, importance, history and achievements of plant breeding and improvement
- 9.2 Genetic basis of plant breeding
- 9.3 Genotypes and phenotypes
- 9.4 Mode of reproduction in crop plants
- 9.5 Classification of crops according to pollination
- 9.6 Germplasm collection, evaluation and utilization
- 9.7 Methods of crop improvement in field crops
- 9.8 Method of hybridization in major field crops
- 9.9 Varietal improvement procedure in Nepal
- 9.10 Purity maintenance of crop varieties

10. Seed Technology

- 10.1 Seed formation, development and composition
- 10.2 Physiology of seed
- 10.3 Seed quality and its classes
- 10.4 Principles and practices of seed production
- 10.5 Seed testing principles
- 10.6 Seed certification procedures and seed certification standards in major crop in Nepal
- 10.7 Seed distributing agency and legislation in Nepal

11. Crop Physiology

- 11.1 Growth and development: Definition, stages and differences
- 11.2 Photosynthesis, respiration, photo-periodism, transpiration, absorption and translocation

12. Statistics Methods

- 12.1 Concepts and fundamental parameters of statistics
- 12.2 Estimate and control of error-replication, blocking and randomization
- 12.3 Field plot techniques and data analysis
- 12.4 Complete randomized design, randomized complete block design and Latin square design: randomization, layout and analysis of variance
- 12.5 Lattice design-balanced lattice design and partially balance lattice: Concept and use.
- 12.6 Split plot design and Strip-plot design: Randomization, layout, analysis of variance and interaction of two factor experiments
- 12.7 Split-split plot design and Strip-split-plot design: Three or more factorial design, randomization and analysis of variance
- 12.8 Pair Comparison: least significant different (LSD) and Duncan's Multiple Range Test (DMRT), between-groups comparison, within group comparison, trend comparison and factorial comparison
- 12.9 Regression and correlation: simple linear regression and correlation, multiple-linear regression and correlation; simple and multiple nonlinear regression
- 12.10 Importance and validity of statistics in agriculture
- 12.11 Use of computer statistical packages in agronomy research

13. Others

- 13.1 History of agronomy research and development in Nepal
- 13.2 Area, production and productivity of major crops
- 13.3 Constraints of agronomical research and extension in Nepal
- 13.4 Institutions involved in agronomy research and development in Nepal
- 13.5 Importance of low cost technology in major crop to compete in world market
- 13.6 Concept of decision support tools and their use in agronomic research

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वैज्ञानिक, एस-१, (Scientist, S-1), प्लाण्ट ब्रिडिङ एण्ड जेनेटिक्स उपसमूहको
खुल्ला प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Plant Breeding and Genetics

1. Plant Genetic Resources

- 1.1 Biodiversity and agro-biodiversity
- 1.2 Evolution of major crop species
- 1.3 Centers of origin and centers of diversity
- 1.4 Germplasm collection and exchange
- 1.5 Plant exploration, conservation (*ex situ/in situ*) and management of genetic resources
- 1.6 Evaluation and utilization of plant genetic resources
- 1.7 Status of plant genetic resources in Nepal

2. Genetic Basis of Plant Breeding

- 2.1 Cell division and molecular biology
- 2.2 Genetic models and partitioning of genetic variance
- 2.3 Hybridization and selfing
- 2.4 Modes of reproduction and pollination
- 2.5 Inbreeding depression and heterosis
- 2.6 Mating systems
- 2.7 Heritability
- 2.8 Selection and response to selection
- 2.9 Choice of breeding methods
- 2.10 Genotype x environment interaction
- 2.11 Combining abilities (GCA and SCA)

3. Biometrical Techniques in Plant Breeding

- 3.1 Assessment of variability
- 3.2 Genetic diversity
- 3.3 Correlation coefficient, correlation and path analysis
- 3.4 Diallele crosses analysis
- 3.5 Field plot techniques
- 3.6 Experimental designs
- 3.7 Analysis of variance and co-variance
- 3.8 Chi-square test
- 3.9 Stability analysis
- 3.10 Computer statistical packages and their use in plant breeding

4. Breeding self- pollinated Crops by Introduction, Selection and Hybridization

- 4.1 Characteristics of self-pollinated crops
- 4.2 Crops introduction
- 4.3 History and principles of selection

- 4.4 Mass selection method
- 4.5 Pureline selection method
- 4.6 Objectives of hybridization
 - 4.6.1 Pedigree selection method
 - 4.6.2 Bulk selection method
 - 4.6.3 Backcross selection method
 - 4.6.4 Single seed descent method

5. Breeding Cross-pollinated Crops

- 5.1 Main characteristics of cross-pollinated crops
- 5.2 Concept and theory of population improvement
- 5.3 Mass selection method
- 5.4 Progeny selection methods i.e. half-sib, full-sib, selfed progeny selection
- 5.5 Recurrent selection method:
 - 5.5.1 Simple recurrent selection
 - 5.5.2 Reciprocal recurrent selection
 - 5.5.3 Recurrent selection for combining abilities
- 5.6 Types of varieties and their development
- 5.7 Hybrid varieties development procedures and their seed production methods

6. Special Techniques

- 6.1 Mutation breeding
- 6.2 Polyploidy in plant breeding
- 6.3 Apomixis
- 6.4 Self incompatibility and its application in plant breeding
- 6.5 Male sterility and its application in crop improvement
- 6.6 Wide crossing and distant hybridization in plant breeding
- 6.7 Clonal breeding
- 6.8 Breeding for resistance to biotic stresses i.e. diseases and insects
- 6.9 Breeding for abiotic stresses i.e. drought, mineral heat and cold
- 6.10 Breeding for quality improvement
- 6.11 Ideotype concept in crop improvement

7. Biotechnology

- 7.1 Scope and importance of plant biotechnology in Nepalese context
- 7.2 Plant tissue culture
- 7.3 Genetic engineering
- 7.4 Embryo culture
- 7.5 Anther or pollen culture
- 7.6 Methods of gene transfer
- 7.7 Molecular markers
- 7.8 Utilization of gene of interest and gene transfer
 - 7.8.1 Haploid breeding
 - 7.8.2 Intergeneric and interspecific crosses
 - 7.8.3 Marker assisted selection

- 7.8.4 Overcoming conventional breeding barriers
- 7.8.5 DNA finger printing
- 7.8.6 Characterization of plant genetic resources with biochemical/molecular techniques
- 7.9 Recent advances related to crop improvement:
 - 7.9.1 Transgenic plants (GMO's for crop improvements and quality)
 - 7.9.2 Terminator genes
 - 7.9.3 Genomics
 - 7.9.4 Biopesticide
 - 7.9.5 Biofertilizer

8. Variety Release and Seed Technology

- 8.1 Evaluation
- 8.2 Multiplication trials
- 8.3 Variety release process in Nepal
- 8.4 Status of seed and seed industry in Nepal
- 8.5 Seed Act and regulation
- 8.6 Classes of quality seed
- 8.7 Seed and field standard for quality seed
- 8.8 Seed priming
- 8.9 Seed marketing
- 8.10 Terminator seed

9. Achievements of Plant Breeding in Nepal

- 9.1 Findings from plant breeding
- 9.2 Findings in plant genetic resources
- 9.3 Future vision in plant breeding and genetic resources

10. Others

- 10.1 History of agricultural research in Nepal
- 10.2 Organizations involved for crop improvement in Nepal and their activities
- 10.3 International institutes for crop improvement and their mandated crops
- 10.4 Relationship of national and international research institutes in crop improvement
- 10.5 Intellectual Property Rights (IPRs) in relation to improved varieties and plant genetic resources (Breeder's and Farmer's Rights)
- 10.6 Objectives and activities of plant breeding
- 10.7 Domestication, plant introduction, acclimatization and centers of origin of major crops

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वैज्ञानिक, एस-१, (Scientist, S-1), एग्रोनोमी, प्लाण्ट ब्रिडिङ एण्ड जेनेटिक्स उपसमूहको
खुल्ला प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject

Sub-Group: Agronomy, Plant Breeding and Genetics

A. Agronomy

14. Crop production

Rice, wheat, maize, finger-millet, barley, buckwheat, amaranths, lentil, soybean, chickpea, cowpea, pigeonpea, mungbean, rapeseed, mustard, sunflower, groundnut, sugarcane, jute and cotton with respect to:

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- 1.18 Manures and fertilizers: recommended doses, method of application and time of application
- 1.19 Water management: requirement, time and frequency of water application, irrigation methods and drainage
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- 1.21 Typical cropping calendar and cropping patterns in hills, mid-hills, Terai and inner-Terai of Nepal
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- 3.1 Soil: definition, soil and sub-soil, importance of top and sub-soils
- 3.2 Texture, structure, bulk density, soil profile, consistency of soil and their importance in agriculture
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- 5.8 Environment and chemical control of diseases and insects

19. Water Requirement in Crop Production

- 6.1 Sources of water and its utilization
- 6.2 Irrigation status and potential in Nepal
- 6.3 Quality of irrigation water, irrigation methods and techniques of irrigation

- 6.4 Measurement of water used by plants
- 6.5 Losses of water in different operations
- 6.6 Water requirement for a specific crop and a set of cropping pattern
- 6.7 Water use efficiency

20. Land Resources and Tillage

- 7.1 Physiographic distribution and land systems of Nepal
- 7.2 Land capability and utilization and irrigation suitability
- 7.3 Tillage: Objective of tillage, significance of tillage and importance in crop production
- 7.4 Zero tillage, minimum tillage and optimum tillage
- 7.5 Condition of soil suitable for cultivation and tillage practices
- 7.6 Terrace management and cultivation

21. Farming Systems and Outreach Research

- 8.1 Farming System: definition, concept, scope and importance
- 8.2 Components of farming systems and pre-dominant cropping patterns in Nepal
- 8.3 Social, economical and institutional aspects of farming system
- 8.4 On-farms farming system research (FSR), its methodology, and characteristics of FSR, diagnostic methods (RRA, PRA, agro-ecosystem, analysis, and conventional survey)
- 8.5 Indexes and indices of cropping and farming systems

22. Crop Physiology

- 9.1 Growth and development: Definition, stages and differences
- 9.2 Photosynthesis, respiration, photo-periodism, transpiration, absorption and translocation

B. Plant Breeding and Genetics

11. Plant Genetic Resources

- 1.8 Biodiversity and agro-biodiversity
- 1.9 Evolution of major crop species
- 1.10 Centers of origin and centers of diversity
- 1.11 Germplasm collection and exchange
- 1.12 Plant exploration, conservation (*ex situ/in situ*) and management of genetic resources
- 1.13 Evaluation and utilization of plant genetic resources
- 1.14 Status of plant genetic resources in Nepal

12. Genetic Basis of Plant Breeding

- 2.12 Cell division and molecular biology
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- 2.19 Selection and response to selection
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- 2.21 Genotype x environment interaction
- 2.22 Combining abilities (GCA and SCA)

13. Biometrical Techniques in Plant Breeding

- 3.11 Assessment of variability
- 3.12 Genetic diversity
- 3.13 Correlation coefficient, correlation and path analysis
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- 3.15 Field plot techniques
- 3.16 Experimental designs
- 3.17 Analysis of variance and co-variance
- 3.18 Regression and correlation
- 3.19 Chi-square test
- 3.20 Stability analysis
- 3.21 Computer statistical packages and their use

14. Breeding self- pollinated Crops by Introduction, Selection and Hybridization

- 4.7 Characteristics of self-pollinated crops
- 4.8 Crops introduction
- 4.9 History and principles of selection
- 4.10 Mass selection method
- 4.11 Pureline selection method
- 4.12 Objectives of hybridization
 - 4.6.5 Pedigree selection method
 - 4.6.6 Bulk selection method
 - 4.6.7 Backcross selection method
 - 4.6.8 Single seed descent method

15. Breeding Cross-pollinated Crops

- 5.8 Main characteristics of cross-pollinated crops
- 5.9 Concept and theory of population improvement
- 5.10 Mass selection method
- 5.11 Progeny selection methods i.e. half-sib, full-sib, selfed progeny selection
- 5.12 Recurrent selection method:
 - 5.5.4 Simple recurrent selection
 - 5.5.5 Reciprocal recurrent selection
 - 5.5.6 Recurrent selection for combining abilities
- 5.13 Types of varieties and their development
- 5.14 Hybrid varieties development procedures and their seed production methods

16. Special Techniques

- 6.12 Mutation breeding
- 6.13 Polyploidy in plant breeding
- 6.14 Apomixis
- 6.15 Self incompatibility and its application in plant breeding

- 6.16 Male sterility and its application in crop improvement
- 6.17 Wide crossing and distant hybridization in plant breeding
- 6.18 Clonal breeding
- 6.19 Breeding for resistance to biotic stresses i.e. diseases and insects
- 6.20 Breeding for abiotic stresses i.e. drought, mineral heat and cold
- 6.21 Breeding for quality improvement
- 6.22 Ideotype concept in crop improvement

17. Biotechnology

- 7.9 Scope and importance of plant biotechnology in Nepalese context
- 7.10 Plant tissue culture
- 7.11 Genetic engineering
- 7.12 Embryo culture
- 7.13 Anther or pollen culture
- 7.14 Methods of gene transfer
- 7.15 Molecular markers
- 7.16 Utilization of gene of interest and gene transfer
 - 7.8.7 Haploid breeding
 - 7.8.8 Intergeneric and interspecific crosses
 - 7.8.9 Marker assisted selection
 - 7.8.10 Overcoming conventional breeding barriers
 - 7.8.11 DNA finger printing
 - 7.8.12 Characterization of plant genetic resources with biochemical/molecular techniques
- 7.9 Recent advances related to crop improvement:
 - 7.9.6 Transgenic plants (GMO's for crop improvements and quality)
 - 7.9.7 Terminator genes
 - 7.9.8 Genomics
 - 7.9.9 Biopesticide
 - 7.9.10 Biofertilizer

18. Variety Release and Seed Technology

- 8.11 Evaluation
- 8.12 Multiplication trials
- 8.13 Variety release process in Nepal
- 8.14 Status of seed and seed industry in Nepal
- 8.15 Seed Act and regulation
- 8.16 Principle and practices of seed production
- 8.17 Classes of quality seed
- 8.18 Seed and field standard for quality seed
- 8.19 Seed testing
- 8.20 Seed priming
- 8.21 Seed marketing
- 8.22 Terminator seed

19. Achievements of Plant Breeding in Nepal

- 9.4 Findings from plant breeding
- 9.5 Findings in plant genetic resources
- 9.6 Future vision in plant breeding and genetic resources

20. Others

- 10.8 History and constraints of agricultural research in Nepal
- 10.9 Area, production and productivity of major crops
- 10.10 Organizations involved for crop improvement in Nepal and their activities
- 10.11 International institutes for crop improvement and their mandated crops
- 10.12 Relationship of national and international research institutes in crop improvement
- 10.13 Intellectual Property Rights (IPRs) in relation to improved varieties and plant genetic resources (Breeders' and Farmers' Rights)
- 10.14 Objectives and activities of plant breeding
- 10.15 Importance of low cost technology in major crop to compete in world market
- 10.16 Concept of decision support tools and their use in agronomic research

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वैज्ञानिक, एस-१, (Scientist, S-1), ओलरिकल्चर उपसमूहको
खुल्ला 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 melon, 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, drumstick and tree tomato

2. Off-season Vegetables Production

- 2.1 Present status, constraints and potentiality
- 2.2 Utilization of diverse agro-climatic zones for off-season vegetables production
- 2.3 Suitable crops, varieties and months for off-season production
- 2.4 Protected cultivation:- Green house, lath house, plastic tunnel, hot beds, cold frame
- 2.5 Improved cultural and management technologies and practices for off-season vegetable production
- 2.6 Cost and benefits of off-season vegetable production

3. Seed Production Technology

- 3.1 Present status of vegetables seed production and marketing in Nepal
- 3.2 High value with low volume vegetables crops and their production zones of the country
- 3.3 Effects of location, aspects, altitude, temperature, light, daylight, spacing irrigation, manures, fertilizers, micro nutrients, hormone, direct seeding, transplanting and planting time on seed yield and seed quality
- 3.4 Pollination, fertilization, seed development, dormancy and germination
- 3.5 Technique of quality control in vegetable seed production
- 3.6 Seed production methods for open pollinated and hybrid cultivars
- 3.7 Existing vegetable seed production zones of Nepal

- 3.8 Major problems and weakness of vegetable seed research, vegetable seed production and marketing in Nepal
- 3.9 Pre-basic, basic improved/certified seed production in potato and ginger
- 3.10 Breeder, nucleus and foundation seed production in vegetable
- 4. Post-harvest Technology of Vegetables**
 - 4.1 Post-harvest physiology- respiration, transpiration and ethylene production
 - 4.2 Method of harvesting, cleaning, grading, and packaging
 - 4.3 Post harvest handling, transportation and marketing
 - 4.4 Consumer's acceptability and quality evaluation of vegetables
 - 4.5 Processing and preservation of vegetables, potato, ginger and cardamom
- 5. Modern Technology of Vegetable Production**
 - 5.1 Application of bio-technology and tissue culture in horticulture
 - 5.2 Use of plant growth regulators in vegetables
 - 5.3 Drip and other micro irrigation
 - 5.4 Micro-nutrient, multi-nutrient, liquid fertilizers and bio-fertilizers
 - 5.5 Latest recommended superior hybrid and superior open pollinated cultivars used by Nepali farmers
 - 5.6 Principles and methods of disease and pest control (with emphasis on integrated disease and pest management, sex lure and pheromone for trapping, biological organism)
 - 5.7 Integrated soil and plant nutrient management
 - 5.8 True potato seed and its role in improving potato production technology
 - 5.9 Disease free seed potato production
 - 5.10 Soil-less vegetable production technology
 - 5.11 Good agriculture practices (GAP) in safe vegetable production
- 6. Indigenous Technology**
 - 6.1 Local and wild edible vegetable, species, cultivars and their usefulness
 - 6.2 Indigenous practices of vegetable cultivation
 - 6.3 Indigenous methods of disease and pest control and preventive measure
 - 6.4 Indigenous methods of soil fertility improvement and management
 - 6.5 Indigenous methods and management of water conservation and utilization
- 7. Plant Genetics and Improvement**
 - 9.1 Genes and their action
 - 9.2 Genotypes phenotype and its heritability
 - 9.3 Homozygous and heterozygosity
 - 9.4 Improvement of variation
 - 9.5 Breeding methods: self pollinated species, cross pollinated species
 - 9.6 Concept of heterosis and development of hybrid variety
 - 9.7 Mutation breeding
 - 9.8 Genetic erosion and transformation
 - 9.9 Use of transgenic plants

8. Vegetable Crop Physiology

- 8.1 Photosynthesis
- 8.2 Respiration
- 8.3 Transpiration and translocation
- 8.4 Growth and development: cell division, enlargement and differentiation
- 8.5 Photoperiodism, light intensity and quality
- 8.6 Stress physiology - temperature stresses, moisture stresses and nutrient stresses
- 8.7 Physiological disorders in vegetable crops

9. Research Methods and Management

- 9.1 Need of research in vegetable commodities
- 9.2 Steps in research project proposal preparation
- 9.3 Design of experiments and its basic characters
- 9.4 Exploratory research
- 9.5 Academic research and adoption research
- 9.6 Multi disciplinary and inter-disciplinary research
- 9.7 Laboratory research
- 9.8 Multi-location research
- 9.9 Outreach research
- 9.10 Farmer's participatory research
- 9.11 Socioeconomics and market research
- 9.12 Collaborative research
- 9.13 Multi-partnership research
- 9.14 Data base preparation
- 9.15 Data analysis, technical report writing and presentation

10. Biological Statistics

- 10.1 Need of biological statistics for research and researcher
- 10.2 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.
- 10.3 Estimate of error: Replication and randomization
- 10.4 Control error: Blocking, proper plot technique and data analysis
- 10.5 Control randomized design: Randomization, layout and analysis of variance
- 10.6 Randomized complete block design: Layout, randomization, analysis of variance
- 10.7 Latin square design: Randomization, layout, analysis of variance and efficiency of row and column- blocking
- 10.8 Incomplete block design: Layout, randomization and analysis of variance
- 10.9 Two or more factorial experiment-randomization, layout, analysis of variance and interaction
- 10.10 Split plot design: Randomization, analysis of variance and interaction of factors.
- 10.11 Comparison: Pair comparison by Least Significant Different (LSD) and Duncan's Multiple Range Test (DMRT)

- 10.12 Regression and correlation: Simple linear regression and correlation, multiple-linear regression and correlation.
- 10.13 Co-variance analysis.
- 10.14 Use of statistical tools in data analysis.

11. Others

- 11.1 History, impact and importance of horticultural research and development plans and programs in Nepal.
- 11.2 Major constraints limiting production of horticultural crops in Nepal.
- 11.3 History, objective, role and activities of Nepal Agricultural Research Council (NARC).
- 11.4 Organizational structure of NARC and activities of major institutions under it.
- 11.5 National and international linkages for horticultural research and development
- 11.6 Prospects of horticultural crops in Nepal.
- 11.7 Classification of horticultural crops.

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नेपाल सरकार
नेपाल कृषि अनुसन्धान परिषद्
पदपूर्ति समिति
वैज्ञानिक, एस-१, (Scientist, S-1), पोमोलोजी उपसमूहको
खुल्ला 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 development 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 Nursery bed preparation
 - 1.7.6 Stratification of seeds of different fruits
 - 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
 - 1.8.2.2 Changes in clones associated with age
 - 1.8.2.3 Production and maintenance of true to type clones
 - 1.8.2.4 Influence of scions in root stocks and influence of root stock on scions
 - 1.8.2.5 Different types of rootstocks
 - 1.8.2.6 Different types of scions and their methods of collection and preservation for latter use

- 1.8.2.7 Different types of vegetative propagation
 - 1.8.2.7.1 Cuttings
 - 1.8.2.7.2 Grafting
 - 1.8.2.7.3 Budding
 - 1.8.2.7.4 Layering
 - 1.8.2.8 Propagation by Specialised 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 storage 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 and deficiency symptoms
- 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
- 4.16 Liming and liming materials
- 4.17 Soil organic matters
- 4.18 C: N ratio
- 4.19 Soil organism and their functions
- 4.20 Green manuring
- 4.21 Farm yard manure and compost
- 4.22 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 Maintenance of fruit varieties
- 5.6 Application of biotechnology and tissue culture in fruit crop breeding

6. Growth Regulation

- 6.1 Photosynthesis, respiration and transpiration
- 6.2 Growth of plants
- 6.3 Polarity and differentiation
- 6.4 Growth regulators
- 6.5 Auxin, Gibberellins, and cytokines
 - 6.5.1 Occurrences
 - 6.5.2 Distribution
 - 6.5.3 Metabolism
 - 6.5.4 Degradation
 - 6.5.5 Sources and relation to growth
 - 6.5.6 Transport
 - 6.5.7 Effect
 - 6.5.8 Synthetic
 - 6.5.9 Mechanism of action
 - 6.5.10 Ethylene
 - 6.5.11 Occurrence
 - 6.5.12 Movement

- 6.5.13 Structure and activity
- 6.5.14 Regulatory action
- 6.5.15 Mechanism of action
- 6.5.16 Inhibitors
- 6.5.17 Chemical nature of inhibitors
- 6.5.18 Absciscic acid
- 6.5.19 Phenolic inhibitors
- 6.5.20 Other inhibitors
- 6.6 Development
 - 6.6.1 Germination and dormancy of seeds
 - 6.6.2 Juvenility, maturity and senescence
 - 6.6.3 Photoperiodism and flowering
 - 6.6.4 Vernalisation and flowering
 - 6.6.5 Genetic mechanism of flowering
 - 6.6.6 Substance regulating flowering
 - 6.6.7 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 and its basic characters
- 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 Nepali condition
- 8.5 Report writing
- 8.6 Leadership
- 8.7 Linkage of research, extension and training
- 8.8 Divisions and Agriculture Research Stations involved in fruit research and development in NARC
- 8.9 Main constraints for agricultural research and development in Nepal

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वरिष्ठ वैज्ञानिक, एस-१, (Scientist, S-1), 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

- 1.1 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 melon, 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. F1 hybrid tomato and cucumber seed production technology in Nepal

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

B : Pomology

1. Fundamentals of Fruit Production

- 1.1 Importance and scope of fruit production in Nepal
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- 1.3 Climate of Nepal
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 - 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, kiwifruit, grapes and citrus fruits on the following aspects:**
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 - 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. 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 Absciscic 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.

वैज्ञानिक, एस-१, (Scientist, S-1), एग्री एक्सटेन्शन एग्री ईकोनोमिक्स एण्ड मार्केटिङ उपसमूहको
खुल्ला प्रतियोगितात्मक परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject

Sub-Group: Agri Extension Agri Economics and Marketing

1. General Economics

- 1.1 Theory of Consumer Behavior
 - 1.1.1 Utility Functions: Concept and Existence (conditions)
 - 1.1.2 Demand Functions: Ordinary and Compensated
 - 1.1.3 Price and Income Elasticity of Demand
 - 1.1.4 Revealed Preference Theory
- 1.2 Theory of Firm
 - 1.2.1 Production Function
 - 1.2.2 Isoquants
 - 1.2.3 Elasticity of Substitution
 - 1.2.4 Cost Functions
- 1.3 Classification of Markets and their critical appraisal
- 1.4 Price Determination in Different Market conditions
- 1.5 Welfare Economics:
 - 1.5.1 Pareto Optimality - for consumption and production
 - 1.5.2 Public goods: concept and properties

2. Farm Business Analysis

- 2.1 Concept of Farm Management and Production Economics
- 2.2 Farm Planning and Budgeting
- 2.3 Farm Records and Accounts
- 2.4 Major Production Relationships in Agriculture
 - 2.4.1 Factor-product relationship
 - 2.4.2 Factor-factor relationship
 - 2.4.3 Product-product relationship
- 2.5 Technological change: Concept and impact on production function

3. Agricultural Marketing and Trade

- 3.1 Role of Agriculture marketing and trade in agricultural development
- 3.2 Use of new technology in agri-business
- 3.3 Problems and prospects of agricultural marketing in Nepal
- 3.4 Present output marketing system of major cereals, pulses, livestock, fish and horticultural commodities
- 3.5 Present marketing system of major agricultural inputs
- 3.6 Marketing Information System: Present status and importance in Nepal
- 3.7 Development and Management of Agricultural Market Centers in Nepal
- 3.8 Agricultural Marketing institutions at public and private sectors in Nepal
- 3.9 Export and import of major agricultural commodities in Nepal

- 3.10 Concept of Marketing Efficiency
- 3.11 Concept and importance of Agricultural Marketing Research
- 3.12 Regional and global organizations related to trade and marketing (SAFTA, WTO)
- 3.13 Comparative and competitive advantage
 - 3.13.1 Concept
 - 3.13.2 Analytical Techniques (Domestic Resource Cost, Implicit Tariff, Nominal Protection Rate, Effective Protection Rate)
- 4. Agricultural Planning: Linkage and Coordination**
 - 4.1 Concept of agricultural research planning, project, project cycle
 - 4.2 Research Project and Technology Analysis
 - 4.2.1 Financial and Economic Aspects
 - 4.2.2 Project and technology impact analysis
 - 4.3 Environmental economic evaluation of technology
 - 4.4 Participatory Planning, Monitoring and Evaluation
 - 4.5 Market-oriented production planning
 - 4.6 Linkage and coordination at local, province and federal level
 - 4.7 Environmental consideration in agricultural project preparation
- 5. Socio-economic Research**
 - 5.1 Need and Importance
 - 5.2 Project Concept Note and Proposal Writing
 - 5.3 Participatory Research in Technology Generation
 - 5.4 Ex-post and ex-ante evaluations
 - 5.5 Technology adoption decision making and analysis
 - 5.6 Assessing the Impact of New Agricultural Technology in income, employment, social inclusion, Food security, labor and land productivity
 - 5.7 Research investment and return analysis
 - 5.8 Qualitative research methods
- 6. Public Resource Allocation and Organizational Development in Nepal**
 - 6.1 Trend in resource allocation for agricultural development in general and agricultural research in particular
 - 6.2 Role of Foreign Aid in Agricultural Development: Issues and Prospects
 - 6.3 History of agricultural research and development
- 7. Public Policy Analysis**
 - 7.1 Concept of Policy Analysis
 - 7.2 The Process of Policy Making
 - 7.3 Role of Policy analysis in Policy making process
- 8. Statistics/Econometrics**
 - 8.1 Sampling techniques
 - 8.2 Sample size determination
 - 8.3 Desirable properties of estimator

- 8.4 Probability distribution
- 8.5 Hypothesis testing and confidence intervals
- 8.6 Classical Linear Regression Model: Assumptions
- 8.7 Relaxing the assumptions of Classical Model
 - 8.7.1 Multicollinearity
 - 8.7.2 Heteroscedasticity
 - 8.7.3 Autocorrelation
- 8.8 Use of dummy variables in regression analysis
- 8.9 Analytical tools used in technology adoption (probit, logit, tobit)

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Paper: II

Technical Subject
Sub-Group: Agro Meteorology

1. General Information on Agro-meteorology

- 1.1 Agriculture Development Strategy
- 1.2 NARC: Laws, Bylaws, Organization and Vision
- 1.3 Agriculture research and development: History, achievements, constraints and scope
- 1.4 National Policy on Climate Change
- 1.5 Meteorology: Composition of the atmosphere, Weather elements, Precipitation, Temperature, Relative humidity, Wind, Sunshine, Global radiation, Dew
- 1.6 Climatology: Definition and scope of climatology, Climatic classification of Nepal: Thornthwaite and Koppen's classification, Monsoon and annual rainfall, El Nino & La Nina Phenomenon
- 1.7 Agro Meteorology: Agro-Meteorology & its Scope, Interdisciplinary Aspects, Study the Practical, Utility on Agro-Meteorology, Future Thrust of Agro-Meteorology
- 1.8 Area, yield and production trend of following crops/commodities in Nepal: Paddy, wheat, maize, potato, citrus fruits, vegetables, fisheries, Poultry
- 1.9 Climate Change: Definition and scope, Atmospheric composition and its changes, Green house effects and anthropogenic influences, Variation of climate in Nepal, Adaptation and mitigation

2. Solar Radiation

- 2.1 Energy for Physical and Biological Processor occurring on the Earth Radiation received from Sun
- 2.2 Solar Constant and its measurement
- 2.3 Measurement of Radiation Distribution in a Plant Canopy
- 2.4 Efficiency of Solar Radiation and its utilization
- 2.5 Radiation and duration of sunshine
- 2.6 Distribution of solar radiation
- 2.7 Outgoing radiation
- 2.8 Radiation balance in the green house
- 2.9 Radiation utilization by field crops
- 2.10 Radiation utilization during successive stage of crop development
- 2.11 Empirical relationship between Radiation and crop yield
- 2.12 Efficiency of radiation utilization by field crop

3. Temperature and Photosynthesis

- 3.1 General effect of Radiation on plant growth
- 3.2 Respiration and net photosynthesis
- 3.3 Basic process of Photosynthesis
- 3.4 Photosynthesis in relation to temperature

- 3.5 Factor affecting the rate of net photosynthesis
- 3.6 Limiting Temperature for Net Photosynthesis
- 3.7 Photosynthesis in relation to Carbon Dioxide Concentration
- 3.8 Water in relation to Photosynthesis
- 3.9 The effect of water on photosynthesis

4. Physical Properties of Soil

- 4.1 Soil texture its importance for plant growth
- 4.2 Particle and bulk density of soil
- 4.3 Soil structure its importance for plant growth
- 4.4 Improvement of soil texture
- 4.5 Effective soil depth
- 4.6 Soil temperature and crop yield

5. Air Temperature

- 5.1 Sensible Heat Flux and Air Temperature
- 5.2 Heat Transfer from Plant Leaves
- 5.3 High temperature plant injury
- 5.4 Wind profile near the ground

6. Moisture Factor in Plant Growth

- 6.1 Soil Moisture
- 6.2 Absorption of water by Plants
- 6.3 Water flow in plants
- 6.4 Significance of soil temperature
- 6.5 The damage in effect of freezing temperature

7. Drought

- 7.1 Definition of drought
- 7.2 Drought and its Classification
- 7.3 Drought indices
- 7.4 Drought tolerance
- 7.5 Drought effect

8. Water Loss and its Measurement

- 8.1 Evaporation
- 8.2 Measurement of Evaporation by different methods
- 8.3 Transpiration

9. Evaporation Versus Transpiration

- 9.1 Difference between evaporation and transpiration
- 9.2 Evaporation from bare soil
- 9.3 Evapotranspiration
- 9.4 Relation between evapotranspiration and pan evaporation
- 9.5 Meteorological factors determining potential evapotranspiration
- 9.6 Estimation of evapotranspiration by Blaney Criddle method
- 9.7 The effect of plant height on the rate of evapotranspiration

10. Lysimeter

- 10.1 Installation of Lysimeter
- 10.2 Drainage Sysimeter
- 10.3 Weighing Lysimeter

11. Effect of Rainfall on Plant Growth

- 11.1 Weather forecasting for Agriculture
- 11.2 Accurate weather forecasting can reduce crop losses
- 11.3 Time factor in weather forecast
- 11.4 Types of weather forecasting and their application in Agriculture operation and planning
- 11.5 Preparation of weather outlook for the Farmers
- 11.6 Meteorological Basis of disease and insect pest present

12. Water Yield Crop Relationship

- 12.1 Irrigation practice for maximum yield
- 12.2 Relation between actual evapotranspiration and yield

13. Agroclimatological Management

- 13.1 Role of meteorological conditions in the formation crop
- 13.2 Weather and climate role in scheduling of sowing of crop
- 13.3 Role of weather and climate with cereal, vegetable and fruit crops

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Paper: II

Technical Subject
Sub-Group: Plant Pathology

1. Introduction

- 1.1 History of plant pathology
- 1.2 Importance of plant pathology
- 1.3 Various terminologies of plant diseases
- 1.4 Causes of plant diseases
- 1.5 Classification of plant diseases
- 1.6 Symptom and signs produced by different plant pathogens
- 1.7 Plant disease diagnosis

2. Plant Pathogens and other Plant Disease Causing Agents

- 2.1 General characteristics (morphology, nutrition, reproduction), isolation, purification, taxonomy, nomenclature, classification of different fungi, bacteria and mycoplasmas
- 2.2 General characteristics (morphology, nutrition, anatomy), isolation, taxonomy, nomenclature and classification of nematodes
- 2.3 General characteristic (morphology, chemical composition, ultrastructure), isolation, purification, multiplication, transmission, serology, classification, nomenclature or grouping (cryptograms) of virus and viroids
- 2.4 Characteristics of non-infections plant disease-causing agents (Environments, nutrients, pollution, improper agricultural practices)

3. Parasitism and Disease Development

- 3.1 Parasitism and pathogenicity
- 3.2 Pathogenesis
- 3.3 Stages in development of diseases (Disease cycle):
 - 3.3.1 Inoculation
 - 3.3.2 Penetration
 - 3.3.3 Infection
 - 3.3.4 Growth and reproduction (multiplication) of the pathogens
 - 3.3.5 Dissemination (Dispersal) of the pathogens
 - 3.3.6 Pathogen survival (over-wintering/over-summering)

4. Mechanisms of Infection by Plant Pathogens

- 4.1 Mechanical forces by pathogens
- 4.2 Chemicals
- 4.3 Enzymes
- 4.4 Toxins (host specific and nonspecific)
- 4.5 Growth regulators (Auxin, Gibberellins, Cytokinin, Ethylene, Polysaccharides)

- 5. Effects of Plant Pathogens on Host Physiology**
 - 5.1 Effects on tissue integration, growth and reproduction of the host
 - 5.2 Effect on host photosynthesis
 - 5.3 Effect on host respiration
 - 5.4 Effects on translocation of water and nutrients in the host plant
- 6. Defense Mechanisms of Host Plants to Plant Diseases**
 - 6.1 Structural defense
 - 6.2 Biochemical defenses
- 7. Effects of Environment on Plant Disease Development**
 - 7.1 Temperature
 - 7.2 Moisture and relative humidity
 - 7.3 Shade and light
 - 7.4 Soil pH
 - 7.5 Host nutrition
 - 7.6 Other environmental factors
- 8. Genetics and Plant Disease**
 - 8.1 Genetics and variability of fungi and bacteria
 - 8.2 Host-pathogen interactions
 - 8.3 Gene for gene concepts
 - 8.4 Types of host resistance and
 - 8.5 General concepts on breeding for disease resistance
- 9. Plant Disease Epidemiology, Disease Forecasting and Crop Losses**
 - 9.1 Development of plant disease epidemiology
 - 9.2 Elements of plant disease epidemics: host, pathogen, environment
 - 9.3 Infection rates and disease progress curves
 - 9.4 Forecasting of plant diseases and their epidemics
 - 9.5 Simulation models of plant diseases
 - 9.6 Plant disease incidence measurement and crop loss assessment
- 10. Principles and Methods of Plant Disease Control**
 - A. Principles:**
 - 10.A.1 Avoidance of pathogens
 - 10.A.2 Exclusions of inoculum
 - 10.A.3 Eradication of pathogens
 - 10.A.4 Immunization
 - 10.A.5 Protection
 - 10.A.6 Therapy
 - B. Methods**
 - 10.B.1 Regulatory method
 - 10.B.2 Cultural method

- 10.B.3 Biological method
- 10.B.4 Physical method
- 10.B.5 Chemical (Pesticides) method
- 10.B.6 Host resistance and
- 10.B.7 Integrated disease management

11. Pesticides in Plant Disease Control

- 11.1 History, classification and nomenclature of pesticides
- 11.2 Major pesticides and their formulations
- 11.3 Mode of action of pesticides
- 11.4 Evaluation of pesticides in the field and in the laboratory
- 11.5 Application methods of pesticides
- 11.6 Appropriate pesticide application equipment and auxiliary spray materials
- 11.7 Factors affecting the field performance of pesticides
- 11.8 Safe storage and handling of pesticides
- 11.9 Pesticides residue assessment on vegetables and fruits

12. Laboratory Equipment and Chemicals used in Plant Pathology

- 12.1 General and specific equipment and machineries used in plant pathology lab
- 12.2 General and specific glassware used in plant pathological activity
- 12.3 Various media used to grow fungi, bacteria and other plant pathogens
- 12.4 Various chemicals used in cleaning, sterilizing, preserving, fixing, staining etc in plant pathological activity

13. Laboratory and Field Techniques in Plant Pathology

- 13.1 Survey, collection of disease specimens and methods of disease recording
- 13.2 Disease specimen preservation and cataloguing
- 13.3 Dis-infection, sterilization, culturing, maintenance and other lab-techniques in plant pathological studies
- 13.4 General disease diagnosis techniques

14. Economic importance, distribution, disease symptoms, causal agents, disease cycle, predisposing factors and adopted control measures of nationally important diseases of major crop plants caused by

- 14.1 Fungi
- 14.2 Bacteria
- 14.3 Viruses
- 14.4 Nematodes
- 14.5 Environmental factors
- 14.6 Physiological disorder

15. Seed Pathology

- 15.1 General concepts of Seed borne diseases
- 15.2 Significance of seed borne diseases
- 15.3 Seed health testing for fungi, bacteria, viruses and nematodes

16. Storage Fungi and Mycotoxins

- 16.1 Major storage fungi and their effects
- 16.2 Important Mycotoxin fungi
- 16.3 Effects of Mycotoxin in human beings and animals

17. Mushroom

- 17.1 Types of edible mushroom
- 17.2 Spawn production techniques
- 17.3 Cultivation techniques of common edible (Agaricus and Pleurotus) mushrooms

18. Bio-technology in Plant Pathology

- 18.1 Importance of tissue culture techniques in Plant Pathology
- 18.2 Use of molecular techniques in development of resistance varieties
- 18.3 Biotechnological tools for identification and characterization of plant pathogens
- 18.4 Other uses of biotechnology in plant pathology

19. Research Design and Statistical Tools

- 19.1 General knowledge on research designs, statistical tools and analysis of the collected data
- 19.2 Computer software used in analysis of plant pathological data

20. Project Proposal Development for Plant Pathological Researches

- 20.1 Major components needed for the development of a sound project proposal based on NARC project format

21. General Knowledge of Nepal Agricultural Research Council

- 21.1 Its organizations, roles, objectives, importance, major activities and linkages with other agricultural and non-agricultural sectors of the country

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Paper: II

Technical Subject
Sub-Group: Entomology

2. Introduction

- 2.1 History of entomology in Nepal
- 2.2 Definition of an insect
- 2.3 Relatives of insects and their relationships
- 2.4 Generalized external and internal organization patterns of a winged insect
- 2.5 Harmful and beneficial insects: nationally important insect pests of agriculture, pollinators including honey bees, silkworms, lac insects, entomophagus insects

3. External Morphology of Insects

- 3.1 Body wall and exoskeleton
- 3.2 Head, appendages of a head, mouth parts, principal types of mouth parts
- 3.3 Thorax, thoracic segment, legs, and wings
- 3.4 Abdomen, appendages, processes, and external genitalia

4. Internal Anatomy and Physiology of Insects

- 4.1 Digestive system: alimentary canal, digestion and absorption
- 4.2 Respiratory system: tracheae, tracheoles and respiration
- 4.3 Circulatory system: blood and its circulation
- 4.4 Excretion system: malpighian tubules and rectum; regulation of dissolved salts and water
- 4.5 Nervous system: central, visceral and peripheral nervous systems
- 4.6 Reproductive system: male reproductive system, female reproductive system, types of reproduction and metamorphosis of insects
- 4.7 Muscular system: cephalic, thoracic, abdominal and flight muscles, metabolism and degeneration of muscles
- 4.8 Endocrine system: neurosecretory cells, hormones and pheromones
- 4.9 Sense organs and perceptions
- 4.10 Sound-and light-producing organs

5. Insect Ecology

- 5.1 Weather and climate: temperature, humidity, water, wind and light
- 5.2 Food: organic remains, plant material, animal material
- 5.3 Animal and plant community: competition, predation and parasitism
- 5.4 Habitat: Terrestrial habitats, fresh water habitats and marine habitats
- 5.5 Symbiotic associations
- 5.6 Insect populations
- 5.7 Ecological methods
- 5.8 Life table

6. Insect Toxicology

- 6.1 Synthetic chemical insecticides, acaricides and molluscicides, their classifications by hazard (WHO classification)
- 6.2 Classification of insecticides based on mode of entry, mode of action and chemical nature
- 6.3 Botanical insecticides
- 6.4 Type of insecticide formulation
- 6.5 Commonly used insecticides in Nepal
- 6.6 Metabolite/s formation and degradation of insecticide in plants and animals
- 6.7 Mode of action of organophosphates and carbamates in target organism
- 6.8 Insecticide residues: maximum residue limit (MRL) and average daily intake (ADI)
- 6.9 Median lethal dose (LD 50) of insecticides
- 6.10 Bioassay of insecticide in laboratory
- 6.11 Methods of diluting insecticide to a recommendation level
- 6.12 Equipments for handling insecticides
- 6.13 Repercussion of insecticide misuse and overuse
- 6.14 Proper storage and disposal of insecticides
- 6.15 Precautions in handling insecticides

7. Principles of Insect Control

- 7.1 Cultural methods: use of resistant varieties, crop rotation, crop refuse
- 7.2 Destruction, tillage of soil, variation of time of planting or harvesting, pruning or thinning, fertilization, sanitation, water management, planting of trap crops
- 7.3 Mechanical methods: hand destruction, exclusion by screen, barriers
- 7.4 Physical methods: heat, cold, humidity, energy and sound
- 7.5 Biological methods: conservation of natural enemies, importation of exotic natural enemies of insect pests and augmentations of natural enemies, propagation and dissemination of specific bacterial, virus, fungus, and protozoan diseases
- 7.6 Chemical methods: attractants, repellents, insecticides, sterilants and growth inhibitors
- 7.7 Genetic methods: propagation and release of sterile or genetically incompatible pests
- 7.8 Regulatory methods: plant quarantine, eradication and suppression programs
- 7.9 Integrated pest management (IPM)
- 7.10 Regulatory provisions of plant protection in Nepal

8. Biological Control

- 8.1 Scope, history and concepts
- 8.2 Biological characteristics of entomophagous insects
- 8.3 Foreign exploration for beneficial organisms and quarantine handling
- 8.4 Mass rearing of parasitoids, predators and their host insects
- 8.5 Methods of colonization, inoculation, augmentation, recovery of entomophagous insects and their evaluation with respect to efficacy to suppress target pest insect/s
- 8.6 Conservation of natural enemies of pest insects
- 8.7 Biological control of insect as a component of IPM
- 8.8 Microbial pathogens against pest insects
- 8.9 Biological control of weeds by insects

9. Insect Taxonomy

- 9.1 Importance of taxonomy
 - 9.2 Systematics and identification of insects belonging to different Orders
 - 9.3 Species and subspecies of insects
 - 9.4 Curating
 - 9.5 Data recording
 - 9.6 Practice of classification: use of literature, use of names, zoological nomenclature and descriptive taxonomic process
 - 9.7 Publication of data
 - 9.8 Methods of collection, preservation and dispatching insect specimens to specialist
- 10. Statistics in Entomological Research**
- 10.1 Descriptive statistics
 - 10.2 Chi-square test
 - 10.3 Student t-test
 - 10.4 Mortality correction
 - 10.5 Transformation of data: square root transformation, logarithmic transformation and angular (arc sine) transformation.
 - 10.6 Analysis of variance
 - 10.7 Mean separation: LSD and Duncan's Multiple Range Test

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Paper: II

Technical Subject
Sub-Group: Agri-Engineering

1. Soil and Water Engineering

- 1.1 Soil-water-plant relationship, Evapotranspiration and consumptive use, estimation of crop water requirement and irrigation requirement, climatic and plant factors affecting irrigation requirement
- 1.2 Survey, design and development of
 - 1.2.1 Irrigation and drainage related structures
 - 1.2.2 Construction of groundwater wells/tube-wells
 - 1.2.3 Irrigation pump selection and installation
 - 1.2.4 Mechanics of water erosion, forms of erosion and land degradation and their assessment and control
 - 1.2.5 Hill torrents and gully control
 - 1.2.6 Land development, grading, shaping and layout
- 1.3 Concept and practices of water resources conservation and management
- 1.4 Measurement & analysis of precipitation & run off
- 1.5 Various water harvesting techniques and relevant water management practices
- 1.6 Irrigation and drainage methods and design consideration-Check basin, border, furrow, sprinkler and drip; Surface and sub-surface drainage
- 1.7 Irrigation efficiencies

2. Farm power and Machinery

- 2.1 Source of farm power and their state of uses in agriculture in Nepal. Importance of promoting renewable energy options in agriculture and rural development Development, selection, use and management of farm equipments and machines
 - 2.1.1 Tillage equipments and machines
 - 2.1.2 Seeding and planting machinery and equipment
 - 2.1.3 Intercultural equipments
 - 2.1.4 Plant protection equipments
 - 2.1.5 Threshing and harvesting machines
 - 2.1.6 Design criteria
 - 2.1.7 Assessment of field performance of agricultural machines
 - 2.1.8 Testing of agricultural machines in laboratory and field environment
 - 2.1.9 Need of modification
- 2.2 Testing, data analysis and evaluation of machinery and equipment
- 2.3 Cost analysis
- 2.4 Organization of farm machinery repair shop and its management
- 2.5 Selection of appropriate tools, implements and machinery for cereals, cash crops, vegetables, fruits and animal production

3. Farm structures

- 3.1 Farmstead planning
- 3.2 Survey, design/estimate and cost estimation of
 - 3.2.1 Farm structures such as residential quarters, office buildings, grains and feed storage structures, green/screen houses, ware houses, threshing floor, animal sheds
 - 3.2.2 Planning, design and development of systems and structures for plant and animal production in controlled environment - green house, screen house, mist house, heating and cooling system in animal shelter
 - 3.2.3 Ancillary facilities such as electric supply, drinking water supply and sewerage fencing, farm roads and walkways and culvert
- 3.3 Material properties and choices of materials for the development of farm structures
- 3.4 Rate analysis of different construction item
- 3.5 Inventory management and computation of depreciation farm structure and services.

4. Post Harvest Engineering

- 4.1 Unit operations in processing of agricultural produces
- 4.2 Assessment of post-harvest losses and methods to minimize
 - 4.2.1 Harvesting and threshing losses
 - 4.2.2 Transportation losses
 - 4.2.3 Storage losses
- 4.3 Properties of air vapor moistures, psychometric chart and EMC models
- 4.4 Theory of aerobic and anaerobic grain storage Theory of grain drying and drying methods
- 4.5 Design of grain dryer and its performances
- 4.6 Design of grain silos
- 4.7 Principle of milling
- 4.8 Heat transfer methods and simple exchanger
- 4.9 Improved methods of processing and preservation of various agricultural produces

5. Statistics

- 5.1 Data management and Measures of central tendency, dispersion and variability in experimental data
- 5.2 Field experimental design and their selection for field experiments
- 5.3 Sampling theory and plan
- 5.4 Conclusion validity and control of exogenous variables
- 5.5 Hypothesis testing
- 5.6 Regression and correlation analysis - Simple linear, multiple- nonlinear regression models

6. Other

- 6.1 Research methodology
 - 6.1.1 Collection of issues and researchable problems pertinent to agricultural mechanization, land and labor productivity and value chain development
 - 6.1.2 Research prioritization based on needs and the focus and priorities of NARC and GoN.
 - 6.1.3 Development of research projects, project concept note and proposal
 - 6.1.4 Design of field experiments, conducting inquiries and analysis and synthesizing findings/results and their dissemination

- 6.2 Computer added data analysis using statistical packages
- 6.3 Basic socio-economy studies, field research methodology and qualitative analysis
- 6.4 Nepal Agriculture Research Council- establishment, organizational structure and functions
- 6.5 Context, problems, prospects and opportunities of Nepal's agricultural system and emerging concerns- climate change, knowledge and technology gaps, migration, feminization, value chain

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वैज्ञानिक, एस-१, (Scientist, S-1), वायोस्ट्याटिस्टिक्स उपसमूहको
खुल्ला प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Biostatistics

Paper II: Technical Subject
(For Sub Faculty - Biostatistics)

1. General Information on Agriculture Statistics

- 1.1 Agricultural statistics and trend analysis
- 1.2 National agriculture sample census 2011
- 1.3 Statistics and biometrics
- 1.4 Role of biometrics in agriculture innovation system
- 1.5 Basic concepts of statistics
- 1.6 Observations/ variables
- 1.7 Population and sample
- 1.8 Statistical system in Nepal and databases
- 1.9 Computer software

2. Statistics

- 2.1 Descriptive statistics
 - 2.1.1 Frequency distribution
 - 2.1.2 Measures of central tendency
 - 2.1.3 Measures of variation and dispersion
- 2.2 Probability and distribution
 - 2.2.1 Binomial distribution
 - 2.2.2 Normal distribution
 - 2.2.3 Poisson distribution
 - 2.2.4 Chi-square distribution
 - 2.2.5 Student's t distribution
 - 2.2.6 Estimation and inference
- 2.3 Sampling
 - 2.3.1 Sampling design
 - 2.3.2 Sampling fundamental
- 2.4 Testing of hypothesis
 - 2.4.1 Hypothesis
 - 2.4.2 Hypothesis testing
 - 2.4.3 Test of hypothesis
 - 2.4.4 Important parametric test
 - 2.4.5 Limitation

2.5 Analysis of categorical data

2.5.1 Contingency tables

2.5.2 Chi-square distribution

2.6 Non-parametric test

2.6.1 Chi-square test

2.6.2 Sign test

2.6.3 Wilcoxon's signed rank test

2.6.4 Rank correlation

2.6.5 Kolmogorov Smirnov one and two sample test

2.6.6 Wilcoxon Mann Whitney two sample test

2.6.7 Kruskal Wallis k-sample test

2.6.8 Friedman's test for two-way classification

2.7 Correlation

2.7.1 Simple linear correlation

2.7.2 Multiple linear correlation

2.7.3 Partial correlation

2.7.4 Test of hypothesis

2.8 Regression

2.8.1 Simple linear regression

2.8.2 Multiple linear regression

2.8.3 Non-linear regression (simple and multiple)

2.8.4 Test of hypothesis

2.8.5 Application of dummy variable

2.8.6 Searching for the best regression

2.8.7 Assumption and problem data

2.8.8 Use and misuse of correlation and regression analyses

2.9 Experimental design

2.9.1 Basic concepts of statistical models and use of samples

2.9.2 Concepts of experimental design, factorial experiments, confounded factorials

2.9.3 Principles and techniques of planning, establishing and executing field and greenhouse experiments

2.9.4 Completely randomized design

2.9.5 Randomized complete block design

2.9.6 Latin square design

2.9.7 Lattice design

2.9.8 Factorial experiments

2.9.9 Split-plot design

2.9.10 Strip plot design

2.9.11 Split-split plot design

2.9.12 Fractional factorial design

2.9.13 Confounded factorials

- 2.9.14 Change-over design
- 2.9.15 Incomplete block designs
- 2.9.16 Perennial crop experiment
- 2.9.17 Lab experiment
- 2.9.18 Livestock and fishery experiment
- 2.9.19 Experiment in farmers' fields
- 2.9.20 Assumption and data transformation
- 2.9.21 Missing values
- 2.10 Multi-observation data
 - 2.10.1 Combining data from a series of years and/or locations
 - 2.10.2 Rotation experiments
 - 2.10.3 Repeated measures data
- 2.11 Covariance
 - 2.11.1 Uses
 - 2.11.2 Model and assumption
 - 2.11.3 Computation
- 2.12 Means comparisons
 - 2.12.1 Pair comparison
 - 2.12.2 Group comparison
- 2.13 Multivariate analysis
 - 2.13.1 An introduction to use of multivariate statistical methods
 - 2.13.2 Applications of maximum likelihood estimation
 - 2.13.3 Multivariate linear regression models
 - 2.13.4 Cluster analysis
 - 2.13.5 Discriminant analysis
 - 2.13.6 Principal components analysis
 - 2.13.7 Canonical correlation analysis
- 2.14 Special application of statistics
 - 2.14.1 Bioinformatics and biotechnology
 - 2.14.2 Statistics in genetics and plant breeding
 - 2.14.3 Statistics in livestock and fishery breeding and their performance evaluation
 - 2.14.4 Statistics in social science
 - 2.14.5 Statistics in fruit crop breeding and their performance evaluation
 - 2.14.6 Crop, livestock and fishery modeling
- 2.15 Biometrical software (SAS, SPSS, R, GIS, MSTATC, MINITAB, GenStat, MS Excel)
- 2.16 Research Materials, Methods, Methodology and Design

2.17 Experimental plot/ unit technique

2.17.1 Size, shape and orientation of plots

2.17.2 Border and competition effects

2.17.3 Soil heterogeneity

2.17.4 Estimation of size of experiments for specified accuracy

2.17.5 Sub-sampling plots and yields for laboratory analysis

2.18 Interpretation and report writing

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वैज्ञानिक, एस-१, (Scientist, S-1), वायोटेक्नोलोजी उपसमूहको खुल्ला
प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Biotechnology

1. Tissue Culture

- 1.1 History
- 1.2 Basic steps and requirements of tissue culture
- 1.3 Micropropagation
- 1.4 Somatic embryogenesis
- 1.5 Virus and pathogen elimination
- 1.6 Haploid production by anther and ovary culture
- 1.7 Embryo rescue
- 1.8 Ploidy manipulation
- 1.9 Germplasm conservation, storage and transportation (invitro, exsitu conservation and cryopreservation)
- 1.10 Production of secondary metabolites by cultured cells
- 1.11 Callus culture
- 1.12 Suspension culture
- 1.13 Variability and instability in tissue culture (Somaclonal variation)

2. Molecular Biology

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

3. Cell Biology

- 3.1 Isolation, culture and plant regeneration from protoplast
- 3.2 Protoplast fusion
- 3.3 Gene transfer into plant cells (Agrobacterium mediated, direct gene transfer)

4. Methodologies and Techniques

- 4.1 PCR techniques (Conventional PCR, qRT-PCR, RAPD, Microsatellite, AFLP)
- 4.2 RFLP
- 4.3 Agarose gel, starch gel and SDS-PAGE electrophoresis, Western blotting
- 4.4 DNA sequencing

- 4.5 Preparation of media, buffer and reagents for tissue culture and DNA analysis
- 4.6 DNA and isozyme extraction, isozyme staining
- 4.7 Genetic analysis using computer software (MSTAT, GenSTAT, NTSys)
- 4.8 GMO testing
- 4.9 Bioinformatics: Publicly available databases for protein and nucleic acid sequences, primer designing, comparative genomic studies, transcriptomics, proteomics etc.
- 4.10 Molecular data analysis and diversity estimation, BLAST and interpretation of results, multiple sequence alignment
- 4.11 Protein purification, characterization, quantification
- 4.12 Laboratory Bio-safety issues, bio-safety levels, National and International laws of bio-safety regulations
- 4.13 Gene bank: Importance, management

5. Ethical and Socioeconomic prospective of biotechnology, Intellectual property right

6. Statistics

- 6.1 Definition and importance of statistics
- 6.2 Experimental design
- 6.3 Central tendency and measures of dispersion as tools for measuring quantitative inheritance/traits
- 6.4 Analysis of Variance (ANOVA)
- 6.5 Analysis of Covariance (ANCOVA)
- 6.6 Regression and Correlation analysis
- 6.7 Introduction to relevant statistical packages for analyzing breeding data
- 6.8 Least Squares Analysis
- 6.9 Mixed Model Methodology
- 6.10 Best Linear Unbiased Prediction (BLUP)

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वैज्ञानिक, एस-१, (Scientist, S-1), फूड टेक्नोलोजी उपसमूहको
खुल्ला प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Food Technology

11. Food Technology

- 1.1 Basic principles of food preservation and their mode of development in the 21st century
- 1.2 Various kinds of food packaging materials and their role
- 1.3 Processing of foods-cereals, legumes, and oilseeds, fruits and vegetables, tea, coffee and spices, confectionery, and bakery products, meat, and meat products, milk and milk products, eggs and poultry products, fishery products, sugar and chocolates and fermented products
- 1.4 Food additives in food processing and preservation
- 1.5 Predication of shelf life of food-stuffs, role of packaging materials in shelf life of food and their marketing
- 1.6 Enzyme kinetics and role of enzymes in food processing
- 1.7 Cold storage, MAP, cellar stores for extending shelf life of fruits and vegetables
- 1.8 Role of refrigeration and freezing in storage of perishable food commodities
- 1.9 Emerging food technologies: minimal processing technology, high pressure, pulse electric field, hurdle technology, nano-technology

2. Food Engineering

- 2.1 Unit operation in food processing
- 2.2 Material and energy balance
- 2.3 Steam generation and utilization, boiler operation and its maintenance
- 2.4 Time, temperature, pressure in food processing
- 2.5 Triple point of water
- 2.6 Super critical fluid extraction and its uses in food industry
- 2.7 Concentration, filtration and extraction
- 2.8 Food rheology
- 2.9 Extrusion and texturization
- 2.10 Dehydration of food, various kinds of dryers; such as cabinet, tunnel, drum, spray, and evaporators
- 2.11 Fermenter and its design

3. Food Chemistry

- 3.1 Food chemistry and its development
- 3.2 Proximate composition of foods and their determination
- 3.3 Chemistry of carbohydrates-monosaccharide, disaccharides, and polysaccharides, caramelization, Maillard reaction, and browning reaction in food
- 3.4 Lipids and fatty acids, identification of common edible oils such as mustard/rapeseed oil, olive oil, peanut oil, soybean oil, sunflower oil and others

- 3.5 Changes of cooking oils and formation of toxic and polar compounds and their implications in food safety and quality
- 3.6 Proteins, amino acids and their quality evaluation
- 3.7 Basic concept of standardization, use of food additives and their limits. Acceptable Daily Intake (ADI) and Maximum Residue Limit (MRL)
- 3.8 Residues of pesticides, antibiotics, drugs and growth hormones in food and feed
- 3.9 Antioxidants, emulsifying and stabilizing agents, flavoring substances, chelating agents, surface-active agents, humectants, and anticaking agents
- 3.10 Concept of supplementation, enrichment and functional foods
4. **Food Microbiology**
 - 4.1 Microorganisms and their role in food processing, preservation and product preparation
 - 4.2 Microbiology and cytology of bacteria, yeasts, and molds
 - 4.3 Basic principles of serology and immunology
 - 4.4 Microbial kinetics and Growth theory of microbes
 - 4.5 Environmental food microbiology- air, water, and soil
 - 4.6 Microbiology of meat and meat products, milk and milk products, fruits and vegetables
 - 4.7 Food poisoning, food intoxication, microbial food poisoning, emerging issues of microbial food poisoning, food borne infection and intoxication
 - 4.8 Natural toxins in foods, compounds and toxins formation during processing and preparation of foods
 - 4.9 GMOs, issues, advantages and disadvantages of GMO
 - 4.10 Food pathogens and indicator organisms; *E. coli*, *Salmonella*, *Listeria monocytogens*, *Staphylococcus aureus*, *Clostridium botulinum*, and *Clostridium perfringens*
 - 4.11 Useful microorganisms in food and food products
 - 4.12 Mycotoxin related food safety issues in Nepal
 - 4.13 Principles and methods of new food product development, product-process-packaging interaction
 - 4.14 Prebiotics, probiotics products and their uses
5. **Human Nutrition**
 - 5.1 Status of malnutrition and micronutrients deficiency in Nepal
 - 5.2 Double burden of malnutrition, nutrition and development
 - 5.3 Interface between agriculture, food, health and nutrition
 - 5.4 Food-based dietary guidelines and its formulation
 - 5.5 Food pyramid, food composition tables
 - 5.6 Growth monitoring
 - 5.7 Diets and their role in management of cardiovascular diseases
 - 5.8 Strategy for the improvement of nutritional status
 - 5.9 Life cycle approach of nutrition, nutritional requirements for infants, pregnant, lactating mother and elderly
 - 5.10 Food fortification and enrichment
 - 5.11 Balanced diets
 - 5.12 Food security and food balance sheet
 - 5.13 Protein quality evaluation, chemical score, BV, NPU

- 5.14 Methods of nutritional assessment
 - 5.15 Macro and micro-nutrients
 - 5.16 Metabolism of carbohydrates, lipid, and protein and their interrelatedness
 - 5.17 Concept of national and international policy on nutrition, Multi-Sectoral Nutrition Plan of Nepal
 - 5.18 Relationship between food safety and nutrition
 - 5.19 Anti-nutritional factors in foods
 - 5.20 Different methods of nutrient analysis
 - 5.21 Food supplement, concept of nutraceuticals and nutrigenomics
 - 5.22 Food and nutrition in relation to lifestyle, food habits and food taboos
6. **Quality Control**
- 6.1 Basic elements of food quality control, concept of food safety, food quality and quality assurance
 - 6.2 Salient features of the current Food Act and Food Regulations
 - 6.3 Salient features of the Feed Act and Feed regulations
 - 6.4 Critical views of the existing food legislation to comply with WTO requirement, TBT and SPS measures
 - 6.5 Concept of food chain approach and preventive measures of food safety and quality
 - 6.6 Hygienic design and food plant sanitation
 - 6.7 Good Agriculture Practices (GAP) and Nepal GAP. Good Manufacturing Practices (GMP). Good Hygienic Practices (GHP), and Good Animal Husbandry and Good Veterinary Practices (GVP)
 - 6.8 Status of food safety and quality control in Nepali context.
 - 6.9 Risk analysis and concept of risk based inspection and quality control
 - 6.10 Codex alimentarius, harmonization of National Standard with codex standards
 - 6.11 Basic principles of food analysis, Instrumental methods of food analysis and their importance in identifying and detecting new emerging hazards and contaminants
 - 6.12 Principles and use of GLC, HPLC, AAS in food analysis
 - 6.13 Food inspection and sampling techniques, sampling tools
 - 6.14 Food plant sanitation and hygiene
 - 6.15 Issues of major food adulterants in Nepali food market
 - 6.16 Current plans, policy and strategy for enhancing food safety situation in Nepal, current National Food Safety Policy
 - 6.17 Laboratory Quality Assurance, Laboratory Accreditation and its importance, Proficiency Testing, Basic approach and need to develop a new analytical methodology
7. **Research Methods and Statistics**
- 7.1 Introduction to research methodology : logical argument, research contexts, research ethics, formulating research questions, research approaches, utilization of research approaches, case research designs
 - 7.2 Problem identification and hypothesis setting
 - 7.3 Sampling and sample design
 - 7.4 Data collection, processing and analysis

- 7.5 Hypothesis testing, Chi-square test, variance and covariance and multivariate analysis techniques
- 7.6 Measure of central tendencies : mean, mode and median
- 7.7 Correlation and regression analysis
- 7.8 Index numbers, time series analysis
- 7.9 Probability, theoretical distributions
- 7.10 Interpolation and extrapolation,
- 7.11 Statistical quality control

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वैज्ञानिक, एस-१, (Scientist, S-1), लाइब्रेरी साइन्स उपसमूहको
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Paper: II

Technical Subject
Sub-Group: Library Science

Section - A

1. Library and Society

- 1.1 History of Agricultural System in Nepal, NARC structure and Law
- 1.2 Role of Communication, Publication and Documentation Division of NARC
- 1.3 Types of libraries: their aims, objectives and functions
- 1.4 Law of library science
- 1.5 ISBN and ISSN system in Nepal

2. Library and Information Management

- 2.1 Management
 - 2.1.1 Library Management: Definition, Nature, Purpose, Characteristics and Functions
 - 2.1.2 Management Skills: Technical, Human Resources
 - 2.1.3 Scientific Management: Functions and Principles
- 2.2 Planning
 - 2.2.1 Library Buildings: Design and Preliminary Considerations
 - 2.2.2 Space Management: Areas & Sub-areas
- 2.3 Financial Management
 - 2.3.1 Library Statistics
 - 2.3.2 Annual Reports
- 2.4 Library Committees: Need, Purposes, Functions, Roles & types

3. Library and Information System and Services in Nepal

- 3.1 Nepal National Library
- 3.2 Nepal Library Association

4. Information Sources, Services and Information Literacy

- 4.1 Primary, secondary and tertiary information sources
- 4.2 Non-book materials and electronic sources

Section - B

1. Library House-keeping Operations

- 4.1 Collection Development: Book Plan, Book Policies & Programmes
- 4.2 Acquisition Section, Book Selection, Ordering Procedure, Accessioning
- 4.3 Maintenance: Relationship with other Sections, Stacking, Shelving, Binding, Stock-taking
Preservation and Conservation, IFLAPAC
- 4.4 Circulation Control: Functions, Routines, Registration of Borrowers, Circulation Systems,
Inter-library Loan

2. Library Cataloguing and Indexing

- 2.1 Need, purpose and function of a library catalogue
- 2.2 Physical forms(External form)
- 2.3 Types of catalogue: Internal forms
- 2.4 Data elements in different types of entries
- 2.5 Subject cataloguing & Indexing problems and models (techniques only) specially chain
procedure, PRCIS and POPSI

3. Information Processing and Retrieval Technique (Library Classification)

- 3.1 Definition, Need, Purpose and Function
- 3.2 Agro-Voc thesaurus and its use
- 3.3 Introduction to Major Schemes of Classification: DDC, CC, UDC

4. Library Automation

- 6.1 Definition, need, purpose and functions of NARC library automation
- 6.2 Library Management Software e.g. CDS/ISIS or WINISIS
- 6.3 Designing Bibliographic Databases
- 6.4 Library Housekeeping Systems
- 6.5 OPAC
- 6.6 MARC, OCLC

5. Information and Communication Technology

- 5.1 Introduction to computers
- 5.2 Online databases
- 5.3 Webpage design
- 5.4 Need and purpose of ICT in NARC Library
- 5.5 Information Technology (IT) policy of Nepal
- 5.6 Multipurpose Community Telecentres
- 5.7 Free and Open Source Software (FOSS)
- 5.8 Internet and email
- 5.9 Information Network
- 5.10 CD-ROM Databases

6. E-Libraries

- 6.1 Need, Importance and justification of e- libraries
- 6.2 Different Component needed to establish e-libraries

- 6.3 State of e-libraries in Nepal
- 6.4 Free e-resources
 - 6.4.1 AGORA
 - 6.4.2 HINARI
 - 6.4.3 OARE
 - 6.4.4 DOAJ

7. Bibliography and Documentation

- 7.1 Bibliography: Need, Types, Function, Bibliographic control
- 7.2 Abstracting techniques and types of abstracts, Importance
- 7.3 Documentation: Definition, scope, functions and types
- 7.4 Documentation services: CAS, SDI, Current contents

8. Role of library and Information Centers in Education and Research

- 8.1 Research and Librarianship
 - 8.1.1 Role of Librarianship in Research
- 8.2 Research and Librarianship
 - 8.2.1 Definition, Need, Purpose
 - 8.2.2 Role of Librarianship in Research
 - 8.2.3 Areas of Research in Librarianship

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वैज्ञानिक, एस-१, (Scientist, S-1), स्वायत्त साइन्स उपसमूहको
खुल्ला प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Soil Science

1. Soil Fertility and Plant Nutrient Management

- 1.1 Concept of soil productivity and fertility
- 1.2 Essential plant nutrients and their classification
- 1.3 Nutrients availability and plant growth influences by soil pH, clay particles, organic matter, Cation exchange capacity, soil depth, surface slope, texture, structure, evaluation of soil fertility by missing element techniques, field experiment, soil and plant analysis
- 1.4 Nutrients availability, plant uptake, plant response, deficiency symptoms of crops and indicator plants
- 1.5 Different forms of nutrients taken up by plants and loss of nutrients from soil, importance of balance fertilizer, application methods and appropriate time
- 1.6 Diagnostic technique and fertilizer recommendation
- 1.7 Fertilizer use efficiency and factor affecting plant growth
- 1.8 Concept and prospect of "Integrated Plant Nutrients System (IPNS)"
- 1.9 Indigenous soil fertility management systems in Nepal

2. Manure and Fertilizers

- 2.1 Sources and types of manures, commercial fertilizers and their uses
- 2.2 Method of FYM and compost preparation, application methods of FYM and compost
- 2.3 The nutrients composition of manure
- 2.4 Chemical fertilizers and its importance
- 2.5 Type of fertilizers, nutrients content and fertilizer handling and storage
- 2.6 Crop response of fertilizer and fertilizer recommendation for major crops of Nepal
- 2.7 Vermi-compost preparation and application

3. Soil Microbiology/Biology

- 3.1 General classification of soil organisms, role of bacteria, fungi, algae, actinomycetes, protozoa and virus
- 3.2 Optimum condition for essential microbial activity in soil, encouraging beneficial microorganisms, composting and crop residue management
- 3.3 C.N. ratio-its importance in decomposition and relationship between high C. N. ratio and low C.N. ratio
- 3.4 Role of biogas in rural development and soil productivity
- 3.5 Bio-fertilizers- nitrogen fixers, Azolla, phosphate-solublizing microbes, Vesicular Arbuscular Mycorrhizes (VAM), plant growth promoting Rhizobacteria (PGPR) and sulfur solublizing microbes.
- 3.6 Strain selection, collection, evaluation, propagation, inoculants preparation and response to inoculation
- 3.7 Significance of inoculants in agriculture

- 3.8 Importance of "biological nitrogen fixation" (BNF) in agriculture and use of nitrogen fixing plants
- 3.9 Green manure- benefit of green manure, influence of leguminous green manure, desirable characteristics of green manure, plant suitable for green manure, green manuring and the maintenance of soil fertility, aerobic and anaerobic decomposition and its effect on soil, constraints of green manuring
- 3.10 Use of indigenous plant materials as nutrient source for crop production in different parts of Nepal

4. Soil Chemistry

- 4.1 Kind of exchangeable ion and exchange capacity
- 4.2 Mineralization and immobilization of nitrogen, nitrification, amonification, denitrification and nitrogen losses from the soil system and the nitrogen cycle
- 4.3 The phosphorus cycle and transformation, managing soil phosphorus
- 4.4 The potassium cycle, soil potassium, different forms of potassium
- 4.5 Role of sulfur, calcium, magnesium, sources and requirement in crop production
- 4.6 The sulfur cycle, soil sulfur, some characteristic of soil sulfur and amendments
- 4.7 General concept of micronutrients (Boron, Copper, Iron, Manganese, Molybdenum, Zinc, Chloride) role, sources, availability, functions, deficiency symptoms and application
- 4.8 Micronutrients that are low availability in Nepalese soils.
- 4.9 Soil pH- definition, role of soil pH on nutrients availability, soil pH correction, and reaction of liming material when applied in soil

5. Soil and Plant Analysis:

- 5.1 Soil Analysis
 - 5.1.1 Soil sampling techniques- soil profile sampling, soil sampling of establish experimental plots, sampling from fields
 - 5.1.2 Soil samples preparation and properly handling of soil samples in the laboratory
- 5.2 Soil test correlation and interpretation and soil test critical limitation for various nutrients
 - 5.2.1 Fertilizer recommendation on the basis of soil test

6. Plant Analysis

- 6.1 Importance of plant analysis
- 6.2 Plant samples collection and preparation
- 6.3 Plant analysis for various nutrients
- 6.4 Plant analysis as a diagnostic tool

7. Soil Physics

- 7.1 Particles density, bulk density, porosity, particles size and chemical natures
- 7.2 Soil texture classification and behavior of different soil textures
- 7.3 Soil structure- definition, types and classes of soil structure, organic matter effect and agriculture significance
- 7.4 The dynamic properties of soils- consistency, plasticity, shear strength, compaction and resistance to penetration of soil
- 7.5 Soil color and aeration and mottles

- 7.6 Thermal regime of soils- thermal properties of soil
- 7.7 Soil water-the field water balance, water movement, infiltration, percolation and permeability
- 7.8 Importance of soil drainage in agriculture

8. Soil Physical Measurement

- 8.1 Determination of soil texture by field method
- 8.2 Hydraulic conductivity measurement in situ
- 8.3 Bulk density- Core method
- 8.4 Infiltration measurement
- 8.5 Soil aggregate analysis

9. Soil Genesis, Classification and Mapping

- 9.1 Concept of soils, Definition
- 9.2 Weathering and soil formation
 - 9.2.1 Rocks and minerals (Parent materials)
 - 9.2.2 Soil forming minerals
 - 9.2.3 Weathering and soil forming processes
 - 9.2.4 Factors of soil formation
 - 9.2.5 Soil profile and soil horizons development
 - 9.2.6 Diagnose horizons for classification-epipedons, subsurface diagnostic horizons, diagnostic organic materials and diagnostic soil characteristic
- 9.3 General concept and importance of soil classification USDA system
- 9.4 Soil taxonomy-USDA systems
- 9.5 World Reference Base (WRB) soil classification system

10. Soil Survey

- 10.1 Importance and purpose of soil survey
- 10.2 Type and methods of soil survey
- 10.3 Identification of soil profile and description
- 10.4 Base maps and soil mapping
- 10.5 Types of soil maps and their important

11. Soil and Water Conservation

- 11.1 General concept and principal
- 11.2 Type of soil erosion
- 11.3 Mechanics of wind erosion and controlling measures
- 11.4 Land capability classification to prevent soil erosion
- 11.5 Terracing, strip-cropping, cover crops
- 11.6 Soil depleting, conserving and building crops
- 11.7 Conservation irrigation and farm drainage management
- 11.8 Methods of soil erosion assessment

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

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वैज्ञानिक, एस-१, (Scientist, S-1), स्वायत्त साइन्स (जि.आई.एस. एण्ड कार्टोग्राफी) उपसमूहको
खुल्ला प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject

Sub-Group: Soil Science (GIS and Cartography)

14. Geographical Information Systems

- 1.1 Introduction
- 1.2 Components of GIS
- 1.3 Functional components
- 1.4 GIS as decision making tool
- 1.5 Applications of GIS in agriculture sector
- 1.6 Spatial and attribute data

15. Database Concepts and Design

- 2.1 Data and Information
- 2.2 Database Management System (DBMS) and its types
- 2.3 Importance of DBMS
- 2.4 Database Design
- 2.5 Spatial Data Model
- 2.6 Raster and Vector data structures (models)
- 2.7 Advantages & Disadvantages of Raster and Vector data structures
- 2.8 Consistency in Geo-database
- 2.9 Metadata, Data Dictionary

16. Data Input, Verification, Storage, Output

- 3.1 Data sources (Primary and Secondary)
- 3.2 Geo-referencing and Map Projection system
- 3.3 Horizontal and vertical datum (local and global datum)
- 3.4 Coordinate System (Geographic and projected) & coordinate transformation
- 3.5 Map digitizing (Process)
- 3.6 Error detection and correction (Topology Test and correction)
- 3.7 Data quality components
- 3.8 Data Storage
- 3.9 Data Dissemination (Analogue to web)
- 3.10 Spatial Data Infrastructure (SDI) and its importance

17. Digital Elevation Models

- 4.1 DEM Definition
- 4.2 TIN, DTM, DSM, DLM, DCM
- 4.3 Source of Data for DEM generation
- 4.4 Importance of DEM & application area
- 4.5 Free available DEMS

18. Spatial Analysis

- 5.1 Classification, retrieval and measurement function (Spatial and attribute queries)
- 5.2 Overlay function (Vector and Raster overlay)
- 5.3 Neighborhood function (buffering, flow etc)
- 5.4 Network function

19. Remote Sensing

- 6.1 Introduction
- 6.2 Energy Sources and Radiation principles
- 6.3 Sensors and Platforms
- 6.4 Application of remote sensing
- 6.5 Satellite system for capturing Remote Sensing Images (Landsat, Spot, NOAA, IRS, GOES and Sentinel)
- 6.6 Microwave Remote Sensing
- 6.7 Digital Image Processing (Radiometric and Geometric Correction)
- 6.8 Image Interpretation and Classification (Supervised, unsupervised and object base)

20. Cartography

- 7.1 Definition and scope of cartography
- 7.2 Cartography and GIS
- 7.3 Map: Definition, Scale and Types (Base map and thematic map)
- 7.4 Map Elements
- 7.5 Map Design and Layout
- 7.6 Visual variables
- 7.7 Generalization
- 7.8 Map visualization

21. Global Navigation Satellite System (GNSS)

- 8.1 Introduction and Types of GNSS
- 8.2 Characteristics of GNSS Satellite
- 8.3 GNSS Segments (Space, Ground & user)
- 8.4 Application areas of GNSS
- 8.5 Accuracy of positioning system using GNSS

22. Overview of Current GIS& Remote Sensing Software Packages

- 9.1 Introduction
- 9.2 Various types of GIS and Remote Sensing Software Package
 - 9.2.1 Commercial Packages: ArcGIS, ERDAS Imagine
 - 9.2.2 Open Source Packages: QGIS, GRASS GIS

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वैज्ञानिक, एस-१, (Scientist, S-1), लाइभस्टक प्रडक्ट प्रोडक्शन उपसमूहको
खुल्ला प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject

Sub-Group: Livestock Product Production and Management

1. Cattle (Native, exotic, crossbred, Yak/Nak, Chauri) and Buffalo (Native, Murrah, Murrah Crossbred, Niliravi)

- 1.1 Care and Management of calves to breeding age
- 1.2 Breeding and feeding management of heifers
- 1.3 Management of AI and ET in cattle
- 1.4 Care and feeding, Management and health of pregnant heifers and adult animals
- 1.5 Management of Steaming Up in advanced pregnant animals
- 1.6 Improved Housing Management for calves, heifer and pregnant animals and milking animals
- 1.7 Management of Crossbred bulls (Cattle / Buffalo) production for breeding purpose
- 1.8 Sexed semen
- 1.9 Feeds and Feeding
 - 1.9.1 Nutrient requirement
 - 1.9.2 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 Definition of milk and composition
 - 1.10.5 Preparation of Khuwa, Paneer, Yoghurt, Chhurpi and Ghee, Cheese with low cost
 - 1.10.6 Equipment Management

2. Sheep and Goat

- 2.1 Sheep and Goat Production/ Management System in the mountain , Hills and Terai in Nepal
- 2.2 Management system: Transhumance system and Sedentary System
- 2.3 Sheep Breed:
 - 2.3.1 Exotic Breed for dual purpose: Polwarth, French Merino, Rambouillet and Romnymarsh
 - 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 goat
- 2.5 Sheep / Goat
 - 2.5.1 Reproductive behavior and Breeding systems
 - 2.5.2 Breed Improvement
 - 2.5.3 Mating Systems

- 2.5.4 Artificial Insemination
- 2.5.5 Reproduction in Doe
- 2.5.6 Fertility in doe
- 2.5.7 Objectives of breeding plan
- 2.6 Feeds and Feeding
 - 2.6.1 Nutrient requirement
 - 2.6.2 Formulation of Ration
- 2.7 Disease and Parasites
 - 2.7.1 Infectious and Noninfectious disease
 - 2.7.2 Internal and External parasites
 - 2.7.3 Prevention and control of diseases
- 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
 - 3.1.1 Body Growth and Development
 - 3.1.2 Anatomical Component of the animal body.
 - 3.1.3 Bone and Nervous systems
 - 3.1.4 Essential organs- Heart, Brain, Liver
 - 3.1.5 Bones
 - 3.1.6 Muscle
 - 3.1.7 Fat
- 3.2 Definition of Carcass, offal (Edible and non edible), Dressing Percentage
- 3.3 Factors influencing the pattern of growth and development of meat animals
- 3.4 Slaughter house and hygienic meat production

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: Hurrah, Chuache
- 5.3 Care and Management of piglets
- 5.4 Management of weaning, gilt, pregnant sows and breeding boar
- 5.5 Environmentally sound, Improved housing management for piglets, pregnant, dry sows and boar

6. Poultry, Ducks, Quail and Turkey Production and Management

- 6.1 Intensive poultry, Ducks, Quail and Turkey production system
- 6.2 Semi-intensive and free range system (Scavenging poultry production)
- 6.3 Hatching management
- 6.4 Brooding management
- 6.5 Grower management
- 6.6 Layers management for efficient egg production
- 6.7 Breeding management
- 6.8 Culling, Selection of laying hens
- 6.9 Replacement of old laying poultry flock with new pullet

7. Angora rabbit (wool and meat) production / management

8. Livestock marketing in Nepal

9. Research Methodology

- 9.1 Competitive research proposal preparation
- 9.2 Research programme planning and budgeting
- 9.3 Experimental Design, Data collection and sampling (Parametric and non-parametric data)
- 9.4 Data Analysis

10. History of Livestock (Cattle, Buffalo, Sheep, Goats, Swine and poultry) Development in Nepal

11. Livestock (Cattle, Buffalo, Sheep, Goats, Swine and poultry) Production System in Nepal

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वैज्ञानिक, एस-१, (Scientist, S-1), एनिमल ब्रिडिङ एण्ड जेनेटिक्स उपसमूहको
खुल्ला प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Paper II: Technical Subject
Sub-Group: Animal Breeding and Genetics

1. Principles of Genetics and Population Genetics

- 1.1. Definition, importance and history of genetics
- 1.2. Study of animal cell
- 1.3. Chromosomes, types of chromosomes and number of chromosomes in different animals
- 1.4. Cell division
- 1.5. Mendelian principles
- 1.6. Dihybrid and polyhybridization
- 1.7. Genetic constitution of population-frequencies of genes and genotypes, Hardy-Weinberg equilibrium
- 1.8. Gene interaction, epistasis and multiple alleles
- 1.9. Linkage and crossing over
- 1.10. Sex controlled inheritance and sex determination
- 1.11. Mutation and chromosomal aberrations
- 1.12. Cytoplasmic inheritance
- 1.13. Quantitative inheritance
- 1.14. Heredity and environment
- 1.15. Genetic forces changing gene frequencies-selection, migration, mutation and population size
- 1.16. Coefficient of inbreeding and genetic relationship
- 1.17. Values and means; breeding values
- 1.18. Variances-genetic and environmental
- 1.19. Resemblance-genetic and phenotypic

2. Principles of Animal Breeding

- 5.1 Definition, importance, achievements and history of Animal Breeding
- 5.2 Application of genetic principles in Animal Breeding
- 5.3 Gene and genotypic frequencies
- 5.4 Qualitative and quantitative inheritance
- 5.5 Heredity and environment
- 5.6 Principles of mating systems
- 5.7 Basis and methods of selection; Selection differential, Selection intensity, Generation interval
- 5.8 Breeding values; measure of genetic and phenotypic relationship
- 5.9 Progeny testing
- 5.10 Hybrid vigour/heterosis and estimation of heterosis
- 5.11 Genetic gain/Response to selection
- 5.12 Heritability
- 5.13 Repeatability

- 5.14 Correlations-Genetic, phenotypic and environmental
- 5.15 Dissemination methods
- 5.16 Concept of genetic resistance for disease and parasites

3. Molecular Genetics

- 3.1 Definition, importance and history of Molecular Genetics
- 3.2 Application of Molecular genetics
- 3.3 Structure of DNA, Replication of DNA
- 3.4 Transcription and Translation
- 3.5 Plasmids
- 3.6 Isolation of DNA
- 3.7 Electrophoresis
- 3.8 Polymerase Chain Reaction (PCR)
- 3.9 DNA Finger Printing
- 3.10 Transgenic animals
- 3.11 Biological or genetic basis of disease resistance
- 3.12 Polymorphism
- 3.13 Bioinformatics

4. Biotechnology

- 4.1 Definition, scope and importance of Biotechnology
- 4.2 Application of Biotechnology tools in Animal Improvement
- 4.3 Artificial Insemination techniques
- 4.4 Collection, processing, evaluation and storage of fresh and frozen semen
- 4.5 Pregnancy Diagnosis
- 4.6 Embryo collection, embryo transfer technology in livestock development
- 4.7 Sexed semen production technology
- 4.8 In vitro fertilization
- 4.9 Animal cloning
- 4.10 MOET
- 4.11 Reproductive disorders and their corrective measures
- 4.12 Reproductive systems of domestic animals
- 4.13 Reproduction parameters in domestic animals
- 4.14 Hormones of reproduction and their functions; Estrous cycle, ovulation, fertilization and parturition
- 4.15 Induction and Heat synchronization

5. Reproduction and Physiology

- 6.1 Reproductive systems of domestic animals
- 6.2 Reproduction parameters in domestic animals
- 6.3 The estrous cycle
- 6.4 Hormones involved in reproduction
- 6.5 Heat synchronization
- 6.6 Pregnancy and calving
- 6.7 Reproductive efficiency

6. Domestic Animal Genetic Resources

- 6.1 Identification of indigenous breeds of domestic animals
- 6.2 Characterization of indigenous breeds of domestic animals
- 6.3 Status of indigenous breeds in relation to conservation
- 6.4 Positive attributes of indigenous breeds
- 6.5 Methods of conservation-in situ and ex situ
- 6.6 Available introduced breeds
- 6.7 Animal Genetic Resources Management and Utilization: Policy and Strategy
- 6.8 Current breeding programmes in Nepal
- 6.9 Breeding Plan for livestock and poultry

7. Statistics

- 6.11 Definition and importance of statistics
- 6.12 Experimental design
- 6.13 Central tendency and measures of dispersion as tools for measuring quantitative inheritance/traits
- 6.14 Analysis of Variance (ANOVA)
- 6.15 Analysis of Covariance (ANCOVA)
- 6.16 Regression and Correlation analysis
- 6.17 Introduction to relevant statistical packages for analyzing breeding data
- 6.18 Least Squares Analysis
- 6.19 Mixed Model Methodology
- 6.20 Best Linear Unbiased Prediction (BLUP)

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वैज्ञानिक, एस-१, (Scientist, S-1), एनिमल न्यूट्रिशन एण्ड फिडिङ उपसमूहको
खुल्ला प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Paper II: Technical Subject
Sub-Group: Animal Nutrition and Feeding

- 1. Feedstuffs**
 - 1.1 Terms and definitions
 - 1.2 Proximate and detergent analysis of feeds
 - 1.3 Energy value of feeds
 - 1.4 Protein values of feeds
 - 1.5 Measuring the intake and utilization of energy and nutrients of feeds
- 2. Nutritional Requirements of Animals**
 - 2.1 Energy requirements of animals
 - 2.2 Protein requirements of animals
 - 2.3 Minerals, vitamins and additives requirements for animals
 - 2.4 Feeding Standards
- 3. The Nutritional Characteristics of Some Common Feeds**
 - 3.1 Classification of feedstuffs
 - 3.2 Basal feeds
 - 3.3 Protein supplements
 - 3.4 Vitamin and mineral supplements and additives
 - 3.5 Forages and roughages
- 4. Ration Formulation**
 - 4.1 Feed formulation for cattle and Buffalo
 - 4.2 Feed formulation for swine and rabbit
 - 4.3 Feed formulation for poultry
 - 4.4 Feed formulation for sheep and goats
 - 4.5 Preparation of mixed mineral supplements
 - 4.6 Linear programming of feed mixtures
- 5. Winter, summer and perennial fodder cultivation status of Nepal**
- 6. Digestive system of ruminant and non-ruminant animals and factors affecting on digestibility of nutrients**
- 7. Statistics**
 - 7.1 Organization and description of data
 - 7.2 Probability
 - 7.3 Introduction to statistical inference
 - 7.4 Sampling distributions and estimation
 - 7.5 Hypothesis testing

- 7.6 Analysis of variance
- 7.7 Regression and correlation analysis

8. Classification of Feed Stuffs

9. Animal feed processing for improving the quality of feed stuffs

10. Others

- 10.1 Production and Productivity of cattle, buffalo, sheep, goat, pig and poultry in Nepal
- 10.2 Existing cattle, buffalo, sheep, goat, pig and poultry feeding system in the country
- 10.3 Pasture, Forage and Agro forestry production in Nepal
- 10.4 Organic Chemistry
- 10.5 Hydrocarbon
- 10.6 Derivatives of hydrocarbon
- 10.7 Bio-Chemistry
- 10.8 General knowledge about NARC

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वैज्ञानिक, एस-१, (Scientist, S-1), पाश्चर / फरेज एण्ड एग्रो फरेष्ट्री उपसमूहको
खुल्ला प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Pasture /Forage and Agro-forestry

1. Forage Physiology

- 4.1 Cell organization, plant metabolism, nitrogen metabolism, photosynthesis and respiration
- 4.2 Crop seed physiology, seed development, seed dormancy, germination, vigor 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

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 Cropping systems, crop rotation, inter-cropping, mixed cropping, multiple cropping and mixed farming systems
- 3.9 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 in rangelands and pasturelands
- 4.3 Production technology of fodder trees

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 Fodder and feed from trees and shrubs, grassland productivity, livestock units and carrying capacity, productivity influencing factors
- 5.7 Burning as a management practice, bush control, provision of water, range reseeding and fertilizing
- 6. Herbage Quality and Nutritive Value**
 - 7.1 Nutritive value, digestibility, palatability and voluntary intake
 - 7.2 Estimation of intake and digestibility, nutritive value and herbage quality and animal productivity
 - 7.3 Feeding value of grass, legume and its products
 - 7.4 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 agro-forestry systems, protective agro-forestry systems, multipurpose agro-forestry systems, management of trees in agro-forestry systems, Economics of agro-forestry systems
 - 7.2 Restoring landscapes and science of restoration
 - 7.3 Shifting cultivation; shifting cultivation in Nepal
- 8. Forage Conservation**
 - 8.1 Principles of conservation
 - 8.2 Silage making
 - 8.3 Hay making
- 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 Management and their Control**
 - 11.1 Survey and surveillance of forage insect pests
 - 11.2 Principles of insect- pest control, physical and mechanical control, cultural control, biological control, chemical control and host plant resistance
 - 11.3 Toxicity of insecticides, precaution in the use of insecticides, insecticide-application equipment
 - 11.4 Major pests of pasture/forage and fodder trees and their control measures
- 12. Understanding the climate smart agriculture, selection of fodder species for low methane production from the ruminants, carbon sequestrations from the forage and tree fodders**

13. Statistics

- 13.1 Experimental designs and data analysis (parametric and non- parametric).
- 13.2 Regression and correlation
- 13.3 ANOVA & ANOCOOVA
- 13.4 Central tendency, dispersion
- 13.5 Sampling and distribution of data

14. Other

- 1.1 Botany of grasses and legumes
- 1.2 Plant Growth and Development
- 1.3 Types of grassland and its distribution
- 1.4 Seasonal growth curve
- 1.5 Ruminant's digestive, productive and reproductive systems
- 1.6 Feed balance situation in Nepal

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नेपाल सरकार
नेपाल कृषि अनुसन्धान परिषद्
पदपूर्ति समिति
वैज्ञानिक, एस-१, (Scientist, S-1), फिसरीज उपसमूहको
खुल्ला प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Fishery

1. Inland Fisheries

- 1.1 Introduction, types of inland fisheries resources, lake fisheries, river fisheries & reservoir fisheries
- 1.2 Natural fish stocks; catch statistics; MSY and e-flows
- 1.3 River dam, impacts; mitigation strategies and Community based management
- 1.4 Natural (Inland) water management for aquaculture
- 1.5 Potential fisheries hotspot and recreational fisheries
- 1.6 Conservation policy and programmes for endangered species

2. Aquaculture Production System

A: Aquaculture Techniques

- 2.1 Ecosystem approach to aquaculture; Ecological Aquaculture systems
- 2.2 The two-way interactions of aquaculture and the environment
- 2.3 Social, Economic and Institutional Aspects
- 2.4 Semi-intensive
- 2.5 Intensive aquaculture system
 - 2.5.1 Mechanization of fish farm operations
 - 2.5.1.1 Artificial Feeding in Intensive Fish Culture
 - 2.5.1.2 Mechanized Feeding in Aquaculture
 - 2.5.1.3 Mechanized Harvesting in Fish Culture
 - 2.5.1.4 Aeration and Oxygenation in Aquaculture
 - 2.5.2 Intensive aquaculture design and management
 - 2.5.3 Efficiency and limitation of intensive culture system
 - 2.5.4 Effluent treatment in intensive aquaculture

B: Aquaculture Practices

- 2.6 Pond fish culture
- 2.7 Raceway culture
- 2.8 Cage fish culture
- 2.9 Enclosure fish culture
- 2.10 Integrated fish Farming
 - 2.10.1 Poultry birds (chicken and ducks)-fish system
 - 2.10.2 Horticulture (vegetables and fruits)-fish system
 - 2.10.3 Grass-fish system
 - 2.10.4 Livestock (Piggery)-fish system
 - 2.10.5 Rice-fish culture
 - 2.10.6 Fish-fish culture (Cage-pond integration, Carp-SIS)
 - 2.10.7 Aquaponics
 - 2.10.8 Managing sub-systems in an integrated farming

- 2.10.9 Interlinking an integrated fish farming system and nutrient recycling
- 2.11 Biofloc based fish farming

C Pond Construction and Management

- 2.12 Site selection and management
- 2.13 Fish Farm design and construction
- 2.14 Types of pond, nursing and rearing pond, production pond, and brood fishpond
- 2.15 Hatchery construction

3. Endocrinology

- 3.1 Endocrine systems related to reproduction and growth
- 3.2 Anatomy, physiology, bio-chemistry and regulation of endocrine gland
- 3.3 Hormone application

4. Application of Chemicals

- 4.1 Chemicals and drugs used in aquaculture for improving water quality
- 4.2 Prevention and control of diseases
- 4.3 Effects of chemicals and drugs on pond ecosystem

5. Fish Genetic Resource Management

- 5.1 Genetic improvement of fish: selective breeding and mating design breeding plan
- 5.2 Ways of fish genetic resources loss; inbreeding and its consequences
- 5.3 Hybridization
- 5.4 Polyploidy inclusion
- 5.5 Gynogenesis and androgenesis
- 5.6 Application of molecular genetic techniques in aquaculture
- 5.7 Fish genetic resources management

6. Water Quality Management in Aquaculture

- 6.1 Importance of water quality in aquaculture
- 6.2 Physical, chemical and biological parameters of water quality
- 6.3 Review of analytical methods and sampling techniques
 - 6.3.1 Analytical methods of Physical parameters
 - 6.3.1.1 Temperature, Thermal stratification and de-stratification, Water color, Transparency, Turbidity, Solids
 - 6.3.2 Analytical methods of Chemical parameters
 - 6.3.2.1 Dissolved Oxygen, pH, Alkalinity, Hardness,
 - 6.3.2.2 Nutrients (Different forms of N and P)
 - 6.3.3 Analytical methods of Biological parameters
 - 6.3.3.1 Planktons, Primary productivity, Chlorophyll-a, Benthos, Detritus
 - 6.3.4 Analytical methods of Bottom soil
 - 6.3.4.1 Soil texture
 - 6.3.4.2 Lime requirement
 - 6.3.4.3 Relationship of pond bottom soil and water quality and its effect
- 6.4 Prevention and control of water quality problems by water quality management

7. Fish Nutrition

- 7.1 Digestive and excretory system of fish
- 7.2 Nutritional requirements of cultivable fish and shellfish
- 7.3 Feed formulation and evaluation
- 7.4 Non- conventional feed ingredients
- 7.5 Essential and nonessential amino acids
- 7.6 Vitamins and Essential minerals
- 7.7 Feed additives
- 7.8 Feed production and quality control
- 7.9 Anti-nutritional factors
- 7.10 Nutritional deficiency sign and symptoms
- 7.11 Candidate species of phytoplankton and zoo-plankton as live food organisms of freshwater species
- 7.12 Biology and culture requirements of important live food organisms

8. Physiology and Ecology of Fish

- 8.1 Physiology system and osmo-regulation of fish
- 8.2 Function of organ system and their relation
- 8.3 Environmental factors effect to fish living
- 8.4 Ecology of fish fresh water fish
- 8.5 Factors affect survival and migration
- 8.6 Environmental factors that correlated to distribution of fish

9. Fish Pathology

- 9.1 General fish disease and their control
- 9.2 Types of general fish diseases (Bacterial, Fungal and Protozoan)
- 9.3 Characteristics of fish pathology
- 9.4 Source of pathogens
- 9.5 Environmental affect upon outbreak of fish disease
- 9.6 Noninfectious fish diseases (Gas bubble disease, and Hepatoma)
- 9.7 Fish predators and their control measures
- 9.8 Common drugs, chemicals and their application in aquaculture
- 9.9 Good Aquaculture Practices

10. Ornamental Fish Production and Management

- 10.1 Aquarium construction and fabrication of ornamental fish rearing facilities.
- 10.2 Ornamental important fishes, ornamental aquatic plants and its value addition
- 10.3 Aquarium fish breeding, disease and feeding management

11. Post-Harvest Technology and Marketing

- 11.1 Fish processing and preservation methods
- 11.2 Fish packing methods and value addition
- 11.3 Fisheries byproducts
- 11.4 Fish marketing, socioeconomic and agro business in Nepal

12. Biostatistics

- 12.1 Measures of central tendency- Mean, Median, Mode
- 12.2 Measures of dispersion- quartile deviation, range, variance, mean and standard variation.
- 12.3 Probability: normal distribution, standard sampling error and test of hypothesis, estimate of error
- 12.4 T-test, F-Test and Chi-square test.
- 12.5 Regression and correlation: simple linear regression and correction; multiple linear regression and correction
- 12.6 Analysis of variance (ANOVA)

13. Other

- 13.1 Nepal Agricultural Research Council (Establishment, Objective, Role and Activities)
- 13.2 Role of Fisheries Research Division, Centers and units under NARC
- 13.3 Present Aquaculture status in Nepal
- 13.4 Constrains for fisheries research and fish production in Nepal

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वैज्ञानिक, एस-१, (Scientist, S-1), भेटीनरी उपसमूहको
खुल्ला प्रतियोगितात्मक लिखित परीक्षाको लागि पाठ्यक्रम

Paper: II

Technical Subject
Sub-Group: Veterinary

1. Anatomy, Histology and Embryology

- 1.1 Anatomical description of the organs of the following systems of: cattle, buffalo, horses, sheep, goats, dogs, cats, pigs and poultry
 - 1.1.1. Skeletal system
 - 1.1.2. Articulatary system and muscular system
 - 1.1.3. Digestive system
 - 1.1.4. Respiratory system
 - 1.1.5. Urogenital system
 - 1.1.6. Cardiovascular system
 - 1.1.7. Genital system (male and female)
 - 1.1.8. Nervous system
 - 1.1.9. Sense organs and common integuments
- 1.2 Introduction to histology and histological techniques
- 1.3 Cytology, cell structure, cell division and study of basic tissues of the body
- 1.4 Systemic histology - Histology of the organs of digestive, respiratory, urinary, reproductive, nervous, cardiovascular systems, sense organs, endocrine organs, lymphoid organs of domestic animals and birds.
- 1.5 General Embryology - Introduction, gametogenesis, fertilization, development of foetus and foetal membranes in mammals and birds, Placentation and placenta in mammals
- 1.6 Systemic Embryology- Development of organs of digestive, respiratory, urogenital, cardiovascular, nervous and locomotory systems and organs of special sense and endocrines. Stage wise study of embryo/foetus of chick, cattle/buffalo, sheep, goats, pigs, cats, dogs and horses

2. Physiology

- 2.1 Structure of different types of muscles, mechanism of contraction and effect of different stimuli on contraction
- 2.2 Chemical composition and physiological properties of muscle
- 2.3 Rigor mortis, fatigue and chemical changes associated with muscular contraction
- 2.4 General function of blood, blood cells, plasma and serum
- 2.5 Blood cells, their functions and their role in body functions
- 2.6 Physiology and hemodynamics of blood circulation
- 2.7 Blood pressure and the factors influencing it, venous pressure and arterial pulse
- 2.8 Neural and chemical control of blood vessels and vasomotor reflexes
- 2.9 Shock and its mechanism and classification; fluid and electrolyte balance
- 2.10 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

- 2.11 Regulation of respiration, chemical regulation of respiratory centre
- 2.12 Respiratory reflexes, role of respiration in acid base mechanism
- 2.13 Respiration in birds
- 2.14 Physiology of digestion- ingestion, mastication, movement of stomach, intestine, rumination and defecation and other digestive processes
- 2.15 Thirst, hunger, vomition and eructation reflexes
- 2.16 Composition, regulation and functions of saliva, pancreatic juice, bile, intestinal juice.
- 2.17 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
- 2.18 Digestion in chickens
- 2.19 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
- 2.20 Maintenance of body temperature, thermoregulation against cooling and heating
- 2.21 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.
- 2.22 Physiology of egg laying in birds
- 2.23 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
- 2.24 Chemical nature, secretion, functions and regulation of secretion of hormones from hypothalamus, pituitary, thyroid, pancreas, adrenal and male and female reproductive organs
- 2.25 Physiology of nervous system- degeneration and regeneration of nerve fibers, nature of nerve impulse and its propagation, cutaneous receptor organs, peripheral nerves, spinal cord and reflex action, autonomic nervous system
- 2.26 Sensory organs and their function and mechanism of vision, hearing, taste and olfaction
- 2.27 Examination of proper functioning of different organs of excretion and reproduction

3. Biochemistry/Biotechnology

- 3.1 Scope and importance of biochemistry, biochemistry of cell and cell organelles
- 3.2 Physical biochemistry-concentration of solutions, diffusion, osmotic pressure, dissociation of acids, pH, buffer system
- 3.3 Biochemistry of carbohydrates, lipids, proteins
- 3.4 Enzymes-definition, properties, composition, specific enzyme action, enzymes and coenzymes involved in oxidation and reduction
- 3.5 Metabolism in ruminants and nonruminants-Carbohydrate metabolism-glycolysis, TCA cycle; fat metabolism-beta oxidation of fatty acid, ketone body formation; protein metabolism-deamination and transamination, urea synthesis, protein synthesis; nucleic acid metabolism-DNA synthesis; energy metabolism in domestic animals; mineral metabolism; vitamins - structure and metabolic role
- 3.6 Biochemistry of blood- plasma proteins and functions, changes in disease, inherited deficiency of plasma protein fractions

- 3.7 Haemoglobin chemistry- coagulation and haemolysis of blood, lymph, tissue fluid and other body fluids
- 3.8 Biochemistry of hormones- structure and metabolic role
- 3.9 Biochemical process in health and disease conditions- biochemistry of respiration, renal function, stress and shock and detoxification
- 3.10 Immunochemistry- nature of antigens and antibody, structure of antibodies
- 3.11 Diagnostic biochemistry- blood sugar, ketone bodies, blood urea nitrogen and uric acid, enzymes
- 3.12 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
- 3.13 Recent approaches on the use of biotechnology tools in veterinary practices

4. Veterinary Microbiology and Immunology

- 4.1 General description and classification of infectious organisms
- 4.2 Morphology, isolation, growth, colonial, biochemical and antigenic characteristics, pathogenicity, and the disease caused in farm animals, pets and poultry by Staphylococcus, Streptococcus, Morexella, Brucella, Enterobacteriaceae, Pseudomonas, Leptospira, Vibrio, Aeromonas, Pasteurella, Yersinia, Actinobacillus, Actinomyces, Corynebacterium, Mycobacterium, Bacillus, Clostridium, Listeria, Erysepelothrix, Nocardia, Bacteroides, Haemophilus, Bordetella, and Spirochaetes
- 4.3 Morphology, isolation, growth, colonial, biochemical and antigenic characteristics, pathogenicity, and the disease caused in farm animals, pets and poultry by rickettsia, and chlamydia
- 4.4 Morphology, isolation, growth, colonial, biochemical and antigenic characteristics, pathogenicity, and the disease caused in farm animals, pets and poultry by Mycoplasma and Acholeplasma.
- 4.5 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, Rhinosporedium, and others)
- 4.6 Diseases caused by mycotoxins
- 4.7 Viruses and their classification, DNA and RNA viruses and their importance in veterinary medicine
- 4.8 Cultivation of viruses in developing chicken embryos, primary cell cultures and cell lines and animals
- 4.9 Replication of RNA and DNA viruses and regulation of virus multiplication
- 4.10 Viral genetics and interactions with references to mutation, genetic recombination
- 4.11 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
- 4.12 Concept of virulence, pathogenicity, infection and immunity
- 4.13 Principles of immunity and immune mechanisms
- 4.14 Cellular and humoral immunity and mechanisms involved in it

- 4.15 Immune responses their development and specificity
- 4.16 Hypersensitivity and allergy
- 4.17 Immunodiagnostic tests used in veterinary diagnostics
- 4.18 Development of resistance against therapeutic agents in the microorganism and its mechanism

5. **Veterinary Parasitology**

- 5.1 Development of veterinary parasitology and its importance
- 5.2 Parasites of veterinary importance and their classification
- 5.3 Parasites, parasitism, commensalism and symbiosis
- 5.4 Host -parasite relationship and specificity between parasites and hosts and development of parasites in the host system
- 5.5 Nomenclature and classification of parasites and characteristics of various phyla of parasites.
- 5.6 General morphological characteristics of different types of helminths, arthropods and protozoa
- 5.7 Tissue reactions of parasites in the hosts and development of immunity/resistance to parasite infection/infestation
- 5.8 Natural and acquired immunity, parasitic immunity
- 5.9 Life cycle and mode of transmission of different types of helminths, arthropods and protozoan parasites infecting farm animals, pets and poultry
- 5.10 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
- 5.11 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
- 5.12 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
- 5.13 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
- 5.14 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
- 5.15 The epidemiology of parasitic diseases and recent approaches for the control of parasitic diseases
- 5.16 Mechanism of resistance development against antiparasitic agents and detection of resistance.
- 5.17 Recent approaches on the control of parasitic diseases of farm animals

6. **Veterinary Pathology**

- 6.1 History and scope of pathology
- 6.2 Causes of disease and the factors associated with diseases of farm animals, pets and birds

- 6.3 Developmental disturbances, anomalies and monsters
 - 6.4 Disturbances of circulation- embolism, thrombosis, haemorrhage, edema, shock
 - 6.5 Disturbances of cell metabolism- gout, amyloid infiltration, mucoid degeneration
 - 6.6 Disturbances of pigment metabolism and icterus
 - 6.7 Necrosis, gangrene and PM changes
 - 6.8 Disturbances of growth- atrophy, aplasia, hyperplasia, hypertrophy, metaplasia
 - 6.9 Inflammation- causes, signs, effects, classification,
 - 6.10 Healing and fever
 - 6.11 Uroliths, choleliths, enteroliths
 - 6.12 Hypersensitivity and autoimmunity
 - 6.13 Pathology of cardiovascular system- functional disturbances and malformation of heart, arteries and veins, lymph node, vessels and spleen, blood, bone marrow; anemia
 - 6.14 Pathology of respiratory system- functional disturbances and malformation of nasal cavity, larynx, bronchi, lungs and pleura
 - 6.15 Pathology of digestive system- functional disturbances and malformation of organs of digestion
 - 6.16 Pathology of urogenital system- functional disturbances and malformation of organs of urinary and genital system of male and female animals
 - 6.17 Pathology of nervous system and sensory organs- functional disturbances and malformation of meninges, brain and spinal cord and sense organs
 - 6.18 Pathology of endocrine system- functional disturbances and malformation of endocrine glands
 - 6.19 Neoplasm- classification, cause and pathology of different types of tumor, difference between benign and malignant tumor
 - 6.20 Pathology of the diseases caused by viruses in farm livestock, pets and poultry
 - 6.21 Pathology of the diseases caused by bacteria in farm livestock, pets and poultry
 - 6.22 Pathology of the diseases caused by fungus, parasites and protozoa in farm livestock, pets and poultry
 - 6.23 Pathology of the diseases caused by nutritional deficiency and metabolic diseases in farm livestock, pets and poultry
 - 6.24 Pathology of the common diseases found in wild/zoo animals and laboratory animals.
- 7. Veterinary Pharmacology and Toxicology**
- 7.1 Development and scope of veterinary pharmacology
 - 7.2 Principles of drug activity: pharmacokinetics –absorption, distribution, biotransformation and excretion of drugs
 - 7.3 Pharmacodynamics- concept of drug and receptors, dose-response relationship, terms related to drug activity and factors modifying the drug effect and dosage.
 - 7.4 Drugs acting on central nervous system
 - 7.5 History and theories of general anaesthesia; volatile, gaseous, intravenous and dissociative anaesthetics, hypnotics and sedatives, tranquilizers, analgesics
 - 7.6 Antipyretics, analgesics, and anti inflammatory agents
 - 7.7 Transmitters of CNS, analeptics and other CNS stimulants
 - 7.8 Local anaesthetics
 - 7.9 Neuromuscular blocking agents

- 7.10 Peripheral and central muscle relaxants
- 7.11 Drugs acting on autonomic nervous system-adrenergic antagonists, adrenoceptors blockers, adrenergic neuron blockers, cholinergic antagonist and blockers, ganglionic stimulants and blockers,
- 7.12 Histamine and antihistaminic agents
- 7.13 Prostaglandins, angiotensin and bradykinin
- 7.14 Drugs acting on cardiovascular system
- 7.15 Drugs acting on digestive tract
- 7.16 Drugs acting on respiratory system
- 7.17 Drugs acting on endocrine system- adrenocorticosteroid, sex hormones, insulin and other hypoglycaemic agents, thyroid hormones
- 7.18 Drugs acting on skin and mucus membrane
- 7.19 Antibacterial agents- classification, general principles in antibacterial chemotherapy, sulphonamide and their combination; antibiotics; antituberculous agents; miscellaneous agents
- 7.20 Antifungal agents
- 7.21 Anthelmintics and antiprotozoal agents;
- 7.22 Antiviral and anticancer agents
- 7.23 Antiseptics and disinfectants
- 7.24 Hormones –hormone stimulating and inhibiting drugs, antagonists, hypoglycaemic agents, prostaglandins, oxytocin, anabolics, growth promoters and corticosteroids
- 7.25 Commonly used herbal drugs used in veterinary medicine
- 7.26 General toxicology: scope, source of poisoning, mode of action of poisons, factors modifying toxicity and line of treatment of poisoned cases
- 7.27 Toxicity caused by metals and non metals-arsenic, lead, mercury, copper, selenium, phosphorus, nitrates, nitrite, common salt and fluorosis
- 7.28 Plant toxicity due to various poisonous plants
- 7.29 Toxicity caused by commonly used drugs, mycotoxins, bacterial toxins and others
- 7.30 Toxicity caused by agrochemicals, insecticides, herbicides and rodenticides
- 7.31 Venoms, bites and stings
- 7.32 Environmental toxicity- toxicity caused by air, water, food additives and preservatives

8. Public Health and Meat Hygiene

- 8.1 Organisation, layout and management of slaughterhouses,
- 8.2 Pre-slaughter care of animals, handling and transport of meat animals, ante-mortem examination
- 8.3 Techniques of humane slaughtering
- 8.4 Different techniques of slaughtering and dressing
- 8.5 Chilling, ageing and evaluation of dressed carcasses and carcass yield
- 8.6 Utilisation of slaughterhouse by products
- 8.7 Disposal of condemned parts and animals suffering from notifiable diseases
- 8.8 Examination of carcasses of different livestock species for meat borne diseases
- 8.9 Development of meat industry-structure, composition, nutritive value post mortem changes and eating quality of meat tissues
- 8.10 Principles of various preservation techniques
- 8.11 Standard and quality control measures adopted for meat and meat products

- 8.12 Fraudulent substitution of meat and its recognition
- 8.13 Chemical composition and nutritive value of meat obtained from farm livestock and poultry
- 8.14 Zoonotic diseases and their diagnosis, treatment and control
- 8.15 Role of veterinarian for the control of zoonotic diseases
- 8.16 Drug residue in animal food and antimicrobial resistance

9. Veterinary Surgery

- 9.1 Methods of restraints, surgical techniques sutures and suturing
- 9.2 Preoperative care of animals
- 9.3 Use of general and local anesthesia in farm animals, horses, dogs and cats
- 9.4 Wound repair and management of wounds
- 9.5 Surgical management of abscesses, gangrene and fistulae
- 9.6 Management of fractures and dislocation
- 9.7 Surgical management of injuries and affections of head and neck- otitis media, entropion, ectropion, nictitating membrane, hydrophthalmus, corneal injuries and opacities, paralysis of facial nerve, nasal polyp, empyema of sinuses, cleft palate, teeth abnormalities, horn injuries, poll evil, guttural pouches, tracheotomy, oesophagotomy
- 9.8 Surgical management of injuries and affections of shoulder and limbs: sit fast, hematoma, collar gall, fistulus withers, brachiocephalic abscesses, capped elbow, amputation of limbs, arthritis, hygroma of carpus, splints, synovitis, tendinitis, wind gall, grease heel, thrush, laminitis, sand crack, corns, canker
- 9.9 Operative treatment of navicular bursa
- 9.10 Surgical management of injuries and affections of thoracic and abdominal cavities – laparotomy, rumenotomy, intestinal obstruction, colic, cesarean section, hysterectomy, hernias
- 9.11 Surgical management of injuries and affections teats and mammary gland- trauma, wounds and injuries, milk fistulas, imperforate teats, contracted sphincter, spider teats, amputation of teats and extirpation of udder
- 9.12 Surgical management of injuries and affections of male and female genital tracts- orchitis, castration, vasectomy, cryptorchid, prolapse of vagina, cervix, uterus, bladder and prepuce, spaying, phimosis and paraphimosis, urethrotomy and removal of urethral calculi
- 9.13 Amputation of tail, surgical management of atresia ani
- 9.14 Post-operative care of animals

10. Veterinary Gynecology and Obstetrics

- 10.1 Development and description of genitalia of male and female farm animals and pets
- 10.2 Growth, puberty, sexual maturity in relation to reproduction in male and female farm animals and pets
- 10.3 Role of hormones in various phases of reproduction in male and female farm animals and pets
- 10.4 Sexual behavior of male and female animals and factors affecting the sex libido of animals

- 10.5 Symptoms of oestrus and oestrus cycle in domestic animals and factors affecting oestrus cycle, detection of oestrus and stages of oestrus, oestrussynchronization, ovulation and transport of ovum and sperms
 - 10.6 Fertilization, development of foetus, foetal membrane and placenta, gestation period, stages of gestation
 - 10.7 Manipulation of oestrus, ovulation, in-vitro fertilization and embryo transfer
 - 10.8 Maintenance of pregnancy and pregnancy diagnosis by different methods, differential diagnosis of pregnancy
 - 10.9 Diseases and accidents during pregnancy, causes of premature birth, early embryonic death, abortion-causes, treatment and control, intrauterine death, mummification, metritis and pyometra
 - 10.10 Fertility, infertility and sterility- functional infertility, anoestrus, ovarian hypoplasia, cystic ovary, repeat breeding, Infectious infertility- specific and non infectious infections affecting genital organs of male and female animals
 - 10.11 Infertility of farm animals in Nepal and the approaches to alleviate it
 - 10.12 Sexual health control and herd reproductive health programme
 - 10.13 Male infertility and its forms, -factors affecting male infertility, diseases of sex organs and accessory sex glands of male animals
 - 10.14 Parturition in domestic animals, causes and stages of parturition, expulsion and retention of placenta
 - 10.15 Intrauterine presentation of foetus, dystokia, its causes and management, caesarian section
 - 10.16 Parturition hygiene, care and management of newborn and dam, udder health care,
 - 10.17 Post partum diseases and complications- prolapse, vaginitis, cervicitis, metritis, pyometra, post partum paraplegia, milk fever
 - 10.18 Clinical use of hormones and prostaglandins in reproduction management in farm animals
 - 10.19 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
 - 10.20 Problems associated with artificial insemination in Nepalese farm animals
- 11. Veterinary Medicine, Ethics and Jurisprudence**
- 11.1 History and scope of medicine, concept of animal disease, health and disease concept, etiological agents, infection and immunity
 - 11.2 Clinical examination and diagnosis of diseases in the sick animals
 - 11.3 General and systemic states, hyperthermia, hypothermia, fever, toxæmia, septicaemia, shock and dehydration
 - 11.4 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.
 - 11.5 Diseases of new born animals

- 11.6 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
 - 11.7 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 in domestic animals, pets and poultry
 - 11.8 Definition, etiology, clinical symptoms, pathogenesis, clinical biochemistry, clinical pathology, diagnosis, treatment, prevention and control of diseases caused by physical and chemical agents
 - 11.9 Diseases caused by allergy
 - 11.10 Diseases caused by undesirable inherited characters and unknown etiologies
 - 11.11 Vaccines and vaccination and recent development in vaccine production
 - 11.12 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
- 12. Veterinary Epidemiology**
- 12.1 Definition, aims, objectives and applications of epidemiology and preventive medicine
 - 12.2 Ecological concept of epidemiology
 - 12.3 Disease process and its spread, pattern of disease distribution in the community,
 - 12.4 Multifactorial causation of diseases, agent, host and environmental strategies of epidemiology
 - 12.5 Types of epidemiological studies-case control, cohort studies
 - 12.6 Investigation of epidemic
 - 12.7 Prevention control and eradication of diseases
 - 12.8 Laws regulating animal diseases including the laws regulated by international organisation (OIE)
 - 12.9 Categorization of communicable diseases
 - 12.10 Regulations regarding handling, import and export of biomaterials
- 13. Genetics and Principles of Animal Breeding**
- 13.1 Study of animal cell, chromosome number of different species of livestock and poultry,
 - 13.2 Cell division and behaviour of chromosomes during mitosis and meiosis
 - 13.3 Mendelian principles, dihybrid and polyhybridisation
 - 13.4 Gene interaction, epistasis, multiple alleles
 - 13.5 Linkages and crossing over
 - 13.6 Sex controlled inheritance and sex determination
 - 13.7 Modified Mendelian inheritance-lethal and sublethal characters, mutation, chromosomal aberration, cytoplasmic inheritance
 - 13.8 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

- 13.9 Values and means-population mean, average effect, breeding value, genetic, phenotypic and environmental variance, heritability
 - 13.10 Breeds and their classification and basis of classification, Important native and exotic breeds of farm animals, pets and poultry, concept of environment and genotype
 - 13.11 Heritability, repeatability, genetic and phenotypic correlation of different traits of economic value
 - 13.12 Selection and methods of selection, basis of selection, response to selection and its measures, selection differential, sire index, selection index, recurrent and reciprocal selection
 - 13.13 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)
 - 13.14 Heterosis- causes, measurement and application in animal breeding, outcrossing topcrossing, grading up, criss crossing, rotational crossing, incrossing, species hybridization
 - 13.15 Breeding behavior, Importance of recording of breeding performance
- 14. Animal Nutrition**
- 14.1 Importance of nutrition and nutrients in animal health and production, composition of animal body and plants, biochemical basis of animals, plants and soil.
 - 14.2 Nutrients in the feed, their digestion and metabolism in ruminants, non-ruminants, pets and birds
 - 14.3 Role, requirements and deficiency symptoms of nutrients (water, carbohydrate, proteins, lipids, vitamins and minerals) in farm animals, dogs, cats and horses.
 - 14.4 Feed additives in the ration of animals and poultry
 - 14.5 Antibiotics and other hormonal compounds and growth promoters in the animal feed, their use and abuses
 - 14.6 Measures of feed energy and their application
 - 14.7 Chemical composition and nutritive value of various feeds and fodders
 - 14.8 Use of agro-industrial by-products and agricultural waste as animal feed
 - 14.9 Utilization of unconventional feeds and recent approaches on the use of NPN in ruminant feed
 - 14.10 Economics and efficiency of feed conversion to animal products
 - 14.11 Feeding of young animals and animals with different stages of production in farm animals, pets and poultry
 - 14.12 Formulation of feeds for farm animals, pets and poultry
 - 14.13 Importance of colostrum suckling and composition of different milk formulae
- 15. Livestock Production, Management and Economics**
- 15.1 Introduction to animal husbandry, body conformation and identification of common breeds of cattle, buffaloes, sheep, goats, horses, pigs, poultry and pets
 - 15.2 Common vices of animals, their prevention and care
 - 15.3 Factors affecting health of livestock and care and management of sick animals
 - 15.4 Disinfection, isolation, quarantine and segregation of sick and healthy animals
 - 15.5 Dentition and age determination of animals

- 15.6 Care and management of young, pregnant, dry and lactating animals
- 15.7 Care and management of animals during transport via different means
- 15.8 Medication, vaccination and other preventive approaches
- 15.9 Feeding management of farm livestock, pets and poultry
- 15.10 Watering management of farm livestock, pets and poultry
- 15.11 Housing management of farm livestock, pets and poultry during different stages of production, ventilation, light, flooring, drainage
- 15.12 Proper disposal of animal waste from the animal houses, general principles of sewage disposal and purification, compost making, drainage, storage and disposal of solid and liquid manure
- 15.13 Effect of environment on health and production of animals and methods to counter
- 15.14 Importance of grasses and fodder in livestock production and agronomical practices for production of leguminous and non-leguminous grasses
- 15.15 Role of tree fodder and crop by-products for livestock feeding in Nepal
- 15.16 Feeding and management of cattle and buffaloes, economic traits, their selection and management
- 15.17 Economics of dairy farming and development plans for commercial dairy farming
- 15.18 Importance of sheep and goat rearing for meat and wool production
- 15.19 Selection of sheep and goats for wool and meat production
- 15.20 Feeding and management of sheep and goats for wool and meat production
- 15.21 System of sheep and goat management in the country and their importance
- 15.22 Economics of sheep and goat rearing under different system of management and development of plans for commercial production
- 15.23 Poultry production: importance, system of management and management of birds under different systems
- 15.24 Selection and culling of birds under commercial management
- 15.25 Selection, handling and incubation of hatching eggs
- 15.26 Management of birds for broiler and egg production
- 15.27 Economics in poultry production, preparation of projects for commercial poultry production
- 15.28 Production management of swine and equines
- 15.29 Care and management of laboratory and pet animals
- 15.30 Care and management of wild and zoo animals
- 15.31 Composition and nutritive value of milk and milk products produced from milk of cattle, buffaloes, yak and goats
- 15.32 Principles of hygienic milk production and precautions required for it
- 15.33 Principle involved in pasteurization, homogenisation and dehydration
- 15.34 Preparation of various concentrated and dehydrated milk products and meat products
- 15.35 Legal and national standards required for milk and milk products
- 15.36 Utilisation and role of milk and milk by-products in human nutrition in Nepal

16. Statistics

- 16.1 Probability, frequency, mean, median, mode, standard deviation, standard error, normal distribution, sampling theory, test of hypothesis, confidence intervals
- 16.2 Students t test, Chi-square test, F test
- 16.3 Estimate of error- replication and randomization

- 16.4 Complete randomized design-randomization, layout and analysis of variance
 - 16.5 Randomized complete block design-layout, randomization, analysis of variance
 - 16.6 Two factorial experiment- randomization, layout and analysis of variance, interaction
 - 16.7 Comparison - pair comparison by least significant difference, group comparison-between group comparison, within group comparison
 - 16.8 Regression and correlation - simple linear and nonlinear, multiple linear and nonlinear; correlation
 - 16.9 Importance and use of Statistics in bio-sciences research
- 17. Other**
- 17.1 The present contribution and future potential of livestock for national agricultural development
 - 17.2 Role of livestock/veterinary research for overall livestock development
 - 17.3 Main constraints of livestock/veterinary research in Nepal and the ways to alleviate these constraints
 - 17.4 Agriculture Development Strategy and the projected role of livestock in it
 - 17.5 National and International ethics in research
 - 17.6 Office International Epizootics (OIE) and sanitary and Phytosanitary Measures (SPS) and international standards in relation to research

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