University of Gondar

College of Veterinary Medicine and Animal Sciences

Department of Animal Production and Extension

Advance in Animal Breeding (ANGB 5022)

Course Title: Advance in Animal Breeding

Course Code: ANGB 5022

Course Credit: 3 hours **Instructors:** Yohannes Dagnew (PhD)

Course Descriptions

This course is designed for the advanced study of modern breeding concepts and tools that make use of these tools and their potential advantages for animal breeding and health will be discussed. Relevant principals of population genetics and quantitative genetics will be taught that allow understanding the fundamental concepts and modern breeding tools and their applications. The Topics covered include scope and importance of animal breeding; genetic improvement tools-selection and mating systems; multiple ad mono traits selection; response to selection, prediction and measurement of genetic gain; importance and effects of inbreeding depression and hetrosis; crossbreeding systems and appropriate level of exotic blood; inheritance of single and polygenic traits; different models and their analytical techniques on simulated and actual animal breeding data using computer applications and use of program in the field of animal breeding; breeding values and their estimation; genetic evaluation methods; Performance evaluation of indigenous and exotic breeds and their crosses; formulation of breeding plans, breed improvement programs and their impact analysis in various species; advanced techniques in genetic manipulation for multiplication and improvement of livestock species; new approaches in livestock breeding and genetics; review of experimental results in animal genetics and breeding. Furthermore, application of scientific methods to animal breeding has led to major improvements in the output, cost and quality of meat, milk and fibre. The course is based on the idea that students can and should take responsibility for their own learning. Because this is an upper-level course,

lectures will be interactive and will build on, rather than just summarize assigned readings, and therefore, the course requires active involvement of students in all facets of the learning experience.

Course Objective

Upon successful completion of this course, students will be able to:

- Demonstrate an understanding of the state of the art of applications of animal breeding to the genetic improvement of livestock
- To impart knowledge about the latest tools & techniques of animal genetics & their uses in genetic improvement of livestock
- Demonstrate an understanding of sources of variation in performance of animals, and the methods used to control or adjust for this variation.
- Differentiate, understand and estimate the importance of genetic parameter and basic breeding tools
- Use different methods to genetic evaluation
- To acquaint with recent trends in animal breeding & designing of need, based breeding strategies

Course Contents

Week	Lecture (hr)	Conceptual Focus
1	4	**Chapter 1. Introduction to Advanced Animal Breeding**
		1. 1. Definition of Animal breeding, recent concept of gene & molecular bases of inheritance in relation to animal breeding
		1.2 Important Terms and Terminologies
		1.3 History of animal breeding
		1.4 Modern concept of animal breeding
		1.5 Over view of animal breeding in Ethiopia

3		**Chapter 2 Basic Tools of Animal breeding**
		3.1 Methods of genetic improvement
		3.2 **S**election Mating
		3.3 Breeding
		3.4 Source of information for selection
		3.5 Individual Selection (Mass Selection)
		3.6 Pedigree Selection
		3.7 Progeny selection
		3.8 Steps of selection
		3.9 Types of selection
3		**Chapter 3. Multiple and Mono Trait Selection**
		4.1 Tandem selection
		4.2 Selection using independent culling level
		4.3 Selection using selection index and economic value of traits
		4.3 .1 Index of scores
		4.3.2 Base index
		4.6.3 Heritability index
		4.3.4 Optimal index
		Chapter 4. Expected genetic improvement
		5.1 Selection response
		5.2 Genetic correlation and correlated response
4	2	**Chapter 5. Mating system in Farm Animals**
		5.1 Inbreeding systems and inbreeding depression
		5.2 Crossbreeding systems and Heterosis
5	2	**Chapter 6. Genetic model for quantitative traits**
		6.1 Simple inherited and polygenic trait
		6.2. Mean and genetic variance for quantitative traits
		6.3. Genetic value and breeding value
6	3	**Chapter 7. Genetic Parameters**

		7.1 Components of phenotypic variation 7.2 Heritability ad repeatability 7.3 Estimation of genetic parameters 7.4 Breeding value estimation/ BLUP - Animal model
		Chapter 8. Genetic Evaluation
		8.1 Genetic evaluation
		8.1 Prediction of breeding values from different sources
	4	**Chapter 9. Genetic improvement schemes**
		8.1 MOET and Progeny testing schemes
		8.2 Nucleus breeding program Selection Pyramid
		8.3 Community Based Breeding Program
12	2	**Chapter 10. New approaches in animal breeding**
		Gene detection and gene mapping Major genes and QTL Marker assisted selection

Teaching and Learning Methods

The mode of the delivery semester ways of the course combines lecture, discussions, question and answering readings, assignments and/or group works and presentations.

1. Lecture: Reflections:

Keep a weekly written reflection of your reactions questions about the readings and discussions in class.

2. Home Work:

Home work assignments are given to help reinforce some topics covered or not covered.

3. Seminar:

All students will be required to complete literature and current topic review, and term paper based papers to complete this course.

4. Assessment Methods:

Evaluation will be carried out based on continuous assessment which comprises relevant quizzes, tests, assignments, presentation, group works and final examination and grading is the university's regulation

Textbook: The following sources are valuable for the course:

1) Understanding Animal Breeding, 2nd edn (1999). Richard Bourdon. Prentice-Hall, Upper Saddle River, New Jersey

2) Falconer and MacKey (1996). Introduction to quantitative Genetics, Fourth edition, Longman Group Ltd., Burnt Mill, Harlow, Essex.

3) Mrode, R. A. (1996). Linear models for the prediction of animal breeding values. CAB International, Wallingfrd, UK.

Introduction to Bioinformatics (ANGB 5013)

Course Title: Bioinformatics

Course Code: ANGB 5013

Course Credit: 2 hours

Instructors: Yohannes Dagnew (PhD)

Course Description

This course is designed for the study of bioinformatics techniques as these techniques used in academics, biotech and genetic laboratories for analyzing DNA and protein sequences. It introduces fundamental concepts and methods of bioinformatics and structural bioinformatics. Topics covered include database concept, information resources for protein and genome databases: Gene Bank, EMBL, SWISS-PROT, PROSITE; nucleotide and protein sequence analysis, phylogeny, micro-array processing, clustering, analysis software, secondary data search; genetic characterization, use of bioinformatics tools for identifying QTL and selection of elite germplasm. Emphasis of the classes is on the understanding of bioinformatics concepts and the practical utilization, with the objective to help students to use bioinformatics tools/methods to solve problems in their own research. Moreover, the focus is extensive hands-on experience using mainstream web-based bioinformatics tools. Students learn how to evaluate data sources and choose the correct paths to solutions. Throughout the semester, interesting biological questions are addressed by analyzing sequences, searching databases and interpreting results. The course is based on the idea that students can and should take responsibility for their own learning. Because this is an upper-level course, lectures will be interactive and will build on, rather than just summarize assigned readings, and therefore, the course requires active involvement of students in all facets of the learning experience.

Course Objectives/outcomes

After completion of this course, the student will

- Have a solid understanding of the field of bioinformatics sequence analysis and their applications in Animal Breeding and Genetics
- To educate about basic concepts of bioinformatics
- have a good skill and extensive experience using common sequence analysis tools and databases
- have a good exposure to a variety of sequence analysis problems and understand how to solve them
- be able to address their own sequence analysis problems and to develop new methods for analysis of biological data
- know how to convey what they have learned in clearly composed documents or brief demonstrations

Week of delivery	Lecture hours	Topics
1	2	1. **Introduction To Bioinformatics**
		Bioinformatics introduction Major research efforts in the field Major Research Areas of Bioinformatics
1	2	2. **Bioinformatics Database**
		Database Concept Evolution of database and DBMS technology General-purpose DBMS Type of bioinformatics databases
3-5	**6**	3. **Protein Sequence Analysis**

		How protein sequences are determined Proteomics Development of protein sequence databases Comparative protein sequence analysis and evolution Comparing proteins Protein sequence alignment Protein sequence analysis
6-8	6	4. **Phylogeny**
		Phylogenetics phylogenetic tree Phylogeny and classification Paraphyletic groups Testing evolutionary hypotheses
9-10	4	5. **Micro-Array Technology**
		DNA microarray Gene Expression Monitoring changes in genomic DNA Microarray technology
11-14	8	6. **Cluster Analysis**
		Analysis of Micro array Data Types of Analysis Clustering Gene Prediction and Annotation Probe Design System

15	2	7. **Secondary Data Search**
		Biological databases Different classifications of databases
16	2	8. **Genetic Characterization**
		Genetic markers Types of genetic markers RFLP, SSLP, AFLP, RAPD,VNTR Microsatellite polymorphism, SNP, STR, SFP, DArT, RAD
		9. **Quantitative Trait Loci**
		Concepts Methods to detect QTLs Marker Assisted Selection Selection for major genes linked to markers QTL Mapping Techinques Tool for QTL analysis
		Final Exam week

TEACHING METHOD AND ASSESSEMENT

Summary of Teaching Learning Methods	Summary of Assessment Methods
Lecture methods	Continuous assessments
web-based bioinformatics tools practice	Individual and group presentations and assignments
Reading assignments	Final examination

CONTINUOUS ASSESSMENT SCHEDULE

Type of Continuous Assessment	Objectives to be Assessed	Main Contents	Date of Submission or Examination	Date of Feedback	Weight
Test1					20%
Assignment1					10%
Test2					30%
Final exam					40%

COURSE POLICIES

a) Ground Rules

The course is delivered based on the rules and regulations of the university and the following rules must be kept for classroom purpose

- Attending all class is a must
- Punctuality in class and assignment is mandatory
- Active participation is required at most
- Misbehaving at class is highly forbidden
- Disabling a cell-phone is a must

b) Late work

- Students may take any missed exam by the consent of the department members and students are expected to provide their evidence for missing exam for 5 days after the onset of the exam.

c) Disclaimer

- This syllabus represents a best plan for the course, but, as with most plans, it is subject to changes made necessary by time, space and personal constraints as the course progresses.

Required Text Books and Materials

References

1. Hui-Huang Hsu.ce. 2006. Advanced Data Mining Technologies in Bioinformatics. 1st ed. Ideal Group publishing. London. Pp 1-343.
2. Raina S.R, James R.K, Robin L.D, Leon S.F, Michael L.J, Boris P.K, and Marty Straume. 2008. An Invitation to Biomathematics, 1st ed. Academic Press is an imprint of Elsevier. 30 Corporate Drive, Suite 400, Burlington, MA 01803, USA 525 B Street, Suite 1900, San Diego, California 92101-4495, USA 84 Theobald's Road, London WC1X 8RR, UK
3. Jeremy Ramsden, 2009. *Introduction to Bioinformatics*. Pearson Education.
4. Thomas Lengauer, 2007. Bioinformatics-from Genomes to Therapies
5. Zoe Lacroix and Terence Critchlow, 2003. Bioinformatics: Managing Scientific Data. Morgan Kaufmann Publishers, USA.
6. David E, Jason S and David Hansen, 2009. Bioinformatics: tools and applications. Springer New York Dordrecht Hidelberg, Califoria, USA.
7. Shui Qing Ye, 2008. Bioinformatics: A Practical Approach. Taylor ad Francis Group, New York

Farm Animal Genetic Resources and Conservation (ABGP-5014)

University of Gondar

College of Veterinary Medicine and Animal Sciences

Department of Animal Production and Extension

Courses title	**Farm Animal Genetic Resources and Conservation**
Courses code	ABGP-5014
Name of instructor	Addis Getu
E-mail address	Addisgetu2002@yahoo.com
Office location	CVMAS office No 36
Online office	All days through the week
Hour credit (cp)	2
Delivery	Semester
Year of study /semester	Semester II

Course Description:

The courses consists of definition of different conservation Genetics, historically cause of Inbreeding, bottlenecks and loss of genetic diversity, Actions to made, Origin and Classification of livestock, Origin of Ethiopian of livestock, Identified Resources in Ethiopia, Status of AnGR, Cause of risk and extinction, Classification of identified livestock breeds in Ethiopia, Rationales of Conserving Indigenous Breeds, Needs of conservations, Risk of cross breeding vs. Mendelian genetics and its extension, Sex determination and its breeding ratio designing of sustainable community- based management of AnGR, steps for community-based conservation of livestock breeds for sustainable use, The determinants of success in conservation program, Endangered Indicators, Categories of endangered AnGR, Types of conservation, Cost of Animal Genetic Resource Conservation. At the end of the course, the student will be able to familiarize with the Course of Farm Animal Genetic Resources and Conservation methods.

Schedule of Lecture Topics, Activities and reading

Week	Lecture(hr	Conceptual focus	Reading references
1	2	**Chapter 1** : **Definition of** Farm Animal Genetic Resources and Conservation courses 1.1 Introduction 1.2 cause of Inbreeding 1.3 bottlenecks and loss of genetic diversity	
2	2	**Chapter 2.** Actions to made 2.1 Origin and Classification of livestock 2.2 Origin of Ethiopian of livestock 2.3 Identified Resources in Ethiopia 2.4 Status of AnGR	
3	2	C**hapter 3.** Cause of risk and extinction 3.1 Conserving Indigenous Breeds 3.2 Needs of conservations 3.3 Risk of cross breeding vs. Mendelian genetics and its extension,	
4	2	**Chapter 4.** Success in conservation program 4.1 Designing of sustainable community- based management of AnGR 4.2 Steps for community-based conservation 4.3 Endangered Indicators 4.4 Categories of endangered AnGR	
5	2	**Chapter 5.** Endangered Indicators **5.**1 Categories of endangered AnGR	
6	2	**Chapter 6.** Types of conservation 6.1 Introductions 6.2 **In-situ** (**in vetro**) 6.2.3 **Ex-situ (in vivo)**	
8	2	**Chapter 7.** Cost of Conservation 7.1 Introduction	

Teaching and learning methods

The mode of the delivery semester ways of the course combines lecture, discussions, question and answering readings, assignments and/or group works and presentations.

1. Lecture: Reflections: keep a weekly written reflection of your reactions questions about the readings and discussions in class.

2. Home work: home work assignments are given to help reinforce some topics covered or not covered

3. Seminar: All students will be required to complete literature review based papers to complete this course

4. Assessment Methods: Evaluation will be carried out based on continuous assessment which comprises relevant quizzes, tests, assignments, presentation, group works and final examination and **Grading is the** university's regulation

5. Course policy: All students are expected to conduct the articulated of the university. Academic dishonesty, including cheating, fabrication, and plagiarism will not be tolerated and will be reported to concerned bodies.

Class activities will every day to day, ranging from lectures to discussions. I expect you to do all the assignments you are supposed to accomplish. You are required to submit and present the assignments provided according to the time table indicated. I will give out the directions, assignments one week prior to their due date though they are explained at each content of your course guidebook.

Note on class attendance and participation: You are expected to attend class regularly. I will take attendance on random days during the semester to ensure that students are coming to class, and if you miss class repeatedly, your grade will be affected. If you miss more than 15% of the class attendance you will not sit for final exams. Please try to be on time for class. I will not allow you enter if you are late more than five minutes. Cell phones**:** Cell phones must be turned off before entering to class.

Additional Required References

- https://www.researchgate.net/publication/272544748_Conservation_Genetics_Techniques_and_Fundamentals
- https://www.researchgate.net/publication/8343015_The_expansion_of_conservation_genetics

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Population and Quantitative Genetics (ANGB-5021)

University of Gondar

College of Veterinary Medicine and Animal Sciences

Department of Animal Production and Extension

Courses title	Population and quantitative genetics
Courses code	ANGB-5021
Name of instructor	Addis Getu
E-mail address	Addisgetu2002@yahoo.com
Office location	CVMAS office No 36
Online office	All days through the week
Hour credit (cp)	(3+1)
Delivery	Semester
Year of study /semester	Semester II

Course Description:

The courses consists of definition of population genetics, biodiversity, focused of population genetics, sources of variation, selection and migration as a source of variation, Gene, genotypic composition and sources of variations, gene, genotype frequencies and Sources of variation in a population, Occurrences and Sources of Variation, Hardy Weinberg Equilibrium Model, meaning of Quantitative genetics, population means and values, Traits, genetic parameter, heritability, Fragmented populations and genetic structure, Population Fragmentation, Wright's F statistics. At the end of the course, the student will be able to familiarize with the Course of Population and quantitative genetics.

Schedule of Lecture Topics, Activities and reading

Week	Lecture (hr	Conceptual focus	Reading references
1	2	**Chapter 1 : Definition of Population and quantitative genetics** 1.1 Introduction 1.2 Cause of **Biodiversity** 1.3 Focused on gene and genomes 1.4 Identify sources of variations 1.5 Gene and genotype level • structural polymorphisms • Recombination • Gene conversion • Mutation (abnormal cell division) 1.6 Both at population level and molecular level 1.6.1 selection and migration	
2	2	**Chapter 2. Gene, genotypic composition and sources of variations of animals in a breed**	

		2.1 gene, genotype composition 2.2 gene, genotype frequencies 2.3 Sources of variation in a population	
3	2	**Chapter 3. hardy Weinberg equilibrium model / HWE** 3.1 Assumptions of **HWE** **3.2 Hardy-Weinberg equilibrium equation** 3.3 Hypothesis of **HWE**	
4	2	**Chapter 4. Diversity of populations**	
5	2	**Chapter 5. Quantitative genetics** **5.**1 qualitative genetics **5.2 Population means and values** 5.3 Genotype, Frequency, Value and Freq*Value 5.3.1 Population mean 5.3.2 genotypic effects 5.3.3 allelic effects 5.3.4 Breeding value 5.3.5 Dominance effects 5.4 variance components	
6	2	**Chapter 6. Biometrical model** 6.1 Meaning of Quantitative genetics 6.2 Correlation 6.3 Relationship 6.4 dependant and independent variable 6.5 model to predict the dependant variable	
8	2	**Chapter 7. Genetic Parameter** 7.1 Heritability/ h^2 7.1.1 Narrow sense 7.1.2 Broad sense	

		7.2 Uses of heritability 7.3 Ways to increase h^2	
		Chapter 8. concept of Biometry/2/ 8.1 definition 8.2 concept of biometry and genetics	
		Chapter 9. Fragmented populations and genetic structure 9.1. Population Fragmentation 9.2 Wright's F statistics 9.2.1 heterozygosity	

Teaching and learning methods

The mode of the delivery semester ways of the course combines lecture, discussions, question and answering readings, assignments and/or group works and presentations.

1. Lecture: Reflections: keep a weekly written reflection of your reactions questions about the readings and discussions in class.

2. Home work: home work assignments are given to help reinforce some topics covered or not covered

3. Seminar: All students will be required to complete literature review based papers to complete this course

4. Assessment Methods: Evaluation will be carried out based on continuous assessment which comprises relevant quizzes, tests, assignments, presentation, group works and final examination and **Grading is the** university's regulation

5. Course policy: All students are expected to conduct the articulated of the university. Academic dishonesty, including cheating, fabrication, and plagiarism will not be tolerated and will be reported to concerned bodies.

Class activities will every day to day, ranging from lectures to discussions. I expect you to do all the assignments you are supposed to accomplish. You are required to submit and present the assignments provided according to the time table indicated. I will give out the directions, assignments one week prior to their due date though they are explained at each content of your course guidebook.

Note on class attendance and participation: You are expected to attend class regularly. I will take attendance on random days during the semester to ensure that students are coming to class, and if you miss class repeatedly, your grade will be affected. If you miss more than 15% of the class attendance you will not sit for final exams. Please try to be on time for class. I will not allow you enter if you are late more than five minutes. Cell phones**:** Cell phones must be turned off before entering to class.

Additional Required References

- https://www.intechopen.com/books/integrated-view-of-population-genetics/introductory-chapter-population-genetics-the-evolution-process-as-a-genetic-function
- https://www.ncbi.nlm.nih.gov/books/NBK21834/
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2842708/
- https://www.researchgate.net/publication/267845714_Lecture_Notes_in_Population_Genetics
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COURSE TITLE: Advanced Dairy Production

COURSE CODE: ANDP-5033

CREDIT HOURS: 3 (2+1)

COURSE DESCRIPTION

Constraints of dairy development in Ethiopia, Milk production - national and international situation. Role of cattle, Camel, Goat and Sheep. Dairy production systems in the tropics, Recent practices of optimizing immune competency of young stock, growth rate and puberty. Pre and post parturition practices to maximize reproduction and milk production. Dairy cattle, nutrient requirements, ration

formulation, budgeting feed needs and storage capacity; Breeding dairy cattle. Principles of replacement and culling. Housing, equipment and management in warm climate. Modern milking management- milking method, milk quality, handling and marketing, pre and post-harvest loss of milk. Maintenance of herd health and productivity. Small and large scale commercial dairying- project proposal, establishment and expansion. Administration- technical and financial records. Efficient utilization of land, labour, feed and fodder. Technical and financial evaluation of dairy enterprise.

Practical

Dairy cattle judging, condition scoring, dairy feed formulation, hand and machine milking and other dairy routines. Record keeping and analysis of dairy record for optimum production and reproduction, Visit to dairy farm and milk processing plants

Course objectives	At the end of the course the students are expected to be able to: ➢ Describe dairy cattle breeds and production systems; ➢ Manage dairy cattle farms properly ➢ Run dairy products handling and processing ➢ Perform technical and financial evaluation of dairy enterprise

Week	Chapter	Topics and Subtopics
1-3	1	**Introduction** • History and development of dairy industry in Ethiopia • Role of cattle, Camel, Goat and Sheep in milk production • Challenges of and opportunities dairy production • Effects of climate change in dairy cattle production
4-6	2	**Dairy Production in the Tropics, Breeds of Dairy cattle**
		• Dairy production systems in the tropics • Important dairy cattle breeds in the world • Dairy cattle selection and Judging
7&8	3	**Feeds and Feeding Dairy Cattle**
		• Nutrient requirement of dairy cattle • Ration formulation for dairy cattle
9	4	**Reproduction and Breeding of Dairy Cattle**
		• Reproductive Management of Dairy Cows • Breeding of Dairy Cattle • Pre and post-partum cow mgt practices to increase milk management

		• Recent practices of optimizing immuno competency of young stock • Principles of replacement and culling
10-13	5	**Milking and Milk management**
		• Milk let down and hormonal regulation • Factors affecting milk yield and milk composition • Modern milking management • Pre and post-harvest loss of milk • Milk Processing and marketing practices
14	6	**Dairy Cattle Housing** ✓ Selecting Farm Site ✓ Dairy cattle Housing, Equipment required in housing
15	7	**Dairy Herd Health Care**
		• Disease prevention and health control mechanisms • Major Causes of Disease • Common Dairy Cow Diseases and Disorders
16	8	**Identification and Record Keeping in Dairy Farm**
		• Accurate identification • Dairy herd recording and Its relevance
		Final Exam Week (Final exam 50%)

Mode of delivery/Teaching and learning methods:

Gap lecture, Demonstration, Discussion , Lab, Individual study, Group work , Presentation

Assessment Methods	Term paper 15 % Presentation 10 % Test 25 Final Exam 50 %
Course Polices	Preparedness : bring all the necessary items for your study and avail yourself on time Participation : Class/Practical Attendance is mandatory Plagiarism : properly acknowledge your sources Grading System: criteria referenced
References	**1.** Dairy Farmers Training Manual, Ministry of Livestock Development, Nairobi, Kenya, 2012 **2.** User Guide on Dairy Husbandry, Ministry of Agriculture, Animal Industry and Fisheries, 2011 **3.** Kurwijila, L.R. 2006. Hygienic milk handling, processing and marketing:

	reference guide for training and certification of small-scale milk traders in Eastern Africa. ILRI (International Livestock Research Institute), Nairobi, Kenya. **4.** Moran, 2005, Tropical Dairy Farming, Feeding Management for Small Holder Dairy Farmers in the Humid TropicsMerle Cunningham, Mickey Latour, Duane Acker2009. Animal science and Industry. **5.** Seykora and Hansen, 2002. Judging Dairy Cattle. University of Minnesota.

COURSE TITLE: Population and quantitative genetics

COURSE CODE: ANGB, 5021

CREDIT HOURS: 3 (2+1)

Objective - To study genetic structure of animal population and importance of genetic variation and covariation among traits.

Chapter one

Individual verses population, Genetic Structure of population.

Factors affecting changes in gene and genotypic frequencies and their effect on genetic structure of animal populations.

Approach to equilibrium under different situations: Viz: Single autosomal locus with two alleles, single sex, linked locus, two pairs of autosomal linked and unlinked loci

Chapter Two

Small population: random genetic drift, effective population size, pedigreed populations, regular and irregular inbreeding systems.

Chapter Three

Quantitative genetics, gene effects, population mean and variance and its partitioning, biometric relations between relatives.

Chapter Four

Genetic and phenotypic parameters, their methods of estimation, uses, possible biases and precision. Scale effects and threshold traits.

Practical Problems relating to gene and genotypic frequencies under different conditions. Estimation of inbreeding in regular and irregular systems. Estimation of effective population size. Estimation of variance components. Computation of heritability, repeatability, genetic, environmental and phenotypic correlations and their standard errors.

Suggested Readings

Bulmer MG. 1980. *The Mathematical Theory of Quantitative Genetics*. Clarendon Press.

Crow JF & Kimura M. 1970. *An Introduction to Population Genetics. Theory*. Harper & Row.

Falconer DS & Mackay TFC 1996. *An Introduction to Quantitative Genetics*.

Longman. Jain JP. 1982. *Statistical Techniques in Quantitative Genetics*. Tata McGraw, Hill.
Pirchner F. 1981. *Population Genetics in Animal Breeding*. S. Chand.