Debre Berhan University

College of Agriculture and Natural Resource Sciences

Program: Animal Sciences

Revised (Community Based Breeding Program (CBBP) integrated Undergraduate Animal Breeding Course (AnSc 311) Curriculum:

Background

Community Based Breeding Program is an alternative Breeding Strategy in small holder and resource poor farmers' flock. The program was initiated in 2010 in four sites and now extended to more than 100 sites. The increase in farmers' income has reached up to 20% that has triggered to upscale and out scale CBBP initiatives. Ensuring sustainability of CBBP is a critical issue. One of the strategies to ensuring sustainability of CBBP is integration of CBBP in the curriculum. The integration of CBBP in a curriculum has also added advantages that, graduating students will implement the program right away in their assignment as extension and research staff. Graduates can create knowledge based jobs. International Center for Agricultural Research in Dry Areas (ICARDA) took the initiative and consulted Ethiopian Universities in the integration of CBBP in the undergraduate Animal Science Program. The first workshop was organized on July, 20, 2021 and the second workshop was organized on July 27, 2021 with theme " **Scaling up Community Based Breeding Programs through Ethiopian Universities**". Representatives from ten federal Universities were involved in the first workshop. In the second workshop, 11 federal state Universities were involved. The representatives were Animal Breeders and University community service directors, which can implement CBBP in their respective Universities. The workshop formed a committee to amend a curriculum with CBBP practices in Animal Breeding course. Based on the recommendations of the workshop, amendment of the curriculum was made as described below and highlighted by yellow colour for a wider circulation and comments. Universities are expected to implement the CBBP initiatives.

Course clusters: Animal Breeding and Breed Improvement

- Animal Genetics
- Reproductive physiology and Artificial Insemination
- **Animal Breeding**
- Animal Biotechnology

Table 1: List of core courses

Sr/N	Course Name	Cr.HR	ECTS
1	Anatomy and Physiology of Farm Animals	3	5
2	Fishery and Aquaculture	3	5
3	Swine Production and Management	2	3
4	**Principle of Genetics**	**3**	**5**
5	Principle of Animal Nutrition	3	5
6	Sheep and Goat Production and Management	3	5
7	Forage and Pasture Production and Management	3	5
8	Camel Production and Management	2	3
9	**Animal Breeding**	**3**	**5**
10	Reproductive Physiology and Artificial Insemination	2	3
11	Applied Animal Nutrition	4	6
12	Poultry Production and Hatchery Management	4	6
13	Dairy Cattle Production and Management	3	5
14	Practical in Animal Science I	1	2
15	Beef Cattle Production and Management	3	5
16	Equine Production and Draft Animals Management	3	5
17	Biometry	3	5
18	Research Methods in Animal Sciences	2	3
19	**Animal Biotechnology**	**3**	**5**
20	Range Ecology and Management	3	5
21	Veterinary Parasitology	2	3
22	Practical in Animal Science II	1	2
23	Practical Attachment	2	3
24	Apiculture	3	5
25	Sericulture	2	3
26	Animal Behavior and Welfare	2	3
27	Hide and Skin Processing	2	3
28	Animal Health and Disease Control	3	5
29	Senior Seminar	1	2
30	Food Hygiene and Veterinary Public Health	2	3
31	Livestock Products Processing Technology	3	5
32	Senior Research Project	2	3

Course Title: Animal Breeding

Course Code: AnSc 311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of Genetics

Course Category: Core

Course Description:

This course deals with the historical back ground of animal breeding; characterization of indigenous livestock/poultry/, alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, definition of breeding objectives and identification of economically important traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; estimating breeding values and genetic parameters including heritability, genetic correlation and repeatability; the bases of establishing breeding programs, types of selection, Mating systems (inbreeding and crossbreeding); hybrid vigor and inbreeding depression and principles and methods of conservation of animal genetic resources;

Learning Outcomes: Upon successful completion of this course, students should be able to:

- Participatory definition of breeding objectives
- Understand selection theory and breeding methods;
- Understand tools available to maximize response to genetic selection;
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation;
- Optimize selection and mating decisions;
- Estimate genetic parameters and breeding values; and
- Understanding the concept of alternative breeding programs.

Mode of Delivery:

Lecture, discussions, assignment, practical sessions based on filed data and field visits to livestock farms including livestock research centers and community-based breeding program villages.

Teaching Aids:

Reference books, handouts, animal farms, teaching videos.

Course Contents:

1. Introduction
   - 1.1. Definition and history of animal breeding
   - 1.2. Goals of animal breeding
   - 1.3. Overview of animal breeding industries
     - 1.3.1. Value of improvement
     - 1.3.2. Role of the government
   - 1.4. Contribution of animal breeding to livestock and poultry improvement
   - 1.5. Genetic vs. environmental improvement

2. Categories of Traits in Livestock and Poultry
    2.1. Qualitative traits
    2.2. Quantitative traits
    2.3. Threshold traits
    2.4. Component traits
    2.5. Economically important traits: description, measurement and inheritance
        2.5.1. Growth, feed efficiency and carcass traits
        2.5.2. Milk production and composition traits
        2.5.3. Reproduction and survival traits
        2.5.4. Type and conformation traits
        2.5.5. Egg production traits (quantitative and qualitative)
        2.5.6. Other Traits (wool, pelt, ...)
3. Quantitative Effects of Genes in Populations
    3.1. Genetic and environmental effects
    3.2. Genetic components of variance
    3.3. Additive variance
    3.4. Dominance variance
        3.4.1. Epistatic variance
    3.5. Environmental components of variance
    3.6. Resemblance between relatives
        3.6.1. Phenotypic resemblance
        3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)
    3.7. Heritability and repeatability
        3.7.1. Concepts and usefulness of heritability
        3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)
        3.7.3. Repeatability
        3.7.4. Basic concepts
        3.7.5. Heritability vs repeatability
    3.8. Correlations (phenotypic, genetic and environmental correlations)
4. Selection
    4.1. Natural vs. artificial selection
    4.2. Classification of selection
        4.2.1. Individual (mass / phenotypic) selection
        4.2.2. Selection based on performance of relatives
        4.2.3. Family selection
        4.2.4. Sib selection
        4.2.5. Selection on progeny performance
    4.3. Methods of selection
        4.3.1. Tandom method of selection
        4.3.2. Independent culling level
        4.3.3. Total score or selection index method

4.4. Response to selection and prediction of genetic gain
    4.4.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)
    4.4.2. Correlated response to selection

5. Mating Systems
    5.1. Inbreeding and line breeding
        5.1.1. Classification of mating systems
            5.1.1.1. Random mating (panmixia)
            5.1.1.2. Non-random mating
            5.1.1.3. Mating based on phenotypic relationship
            5.1.1.4. Mating based on degree of genetic/pedigree relationship
        5.1.2. Inbreeding
        5.1.3. Genetic consequences of inbreeding
        5.1.4. Measurement of inbreeding and relationship coefficients
    5.2. Line breeding
    5.3. Outbreeding and heterosis
        5.3.1. Genetic effects of outbreeding
        5.3.2. Phenotypic effects of outbreeding: hybrid vigor
        5.3.3. Types and measurements of heterosis
    5.4. Systems of crossbreeding
        5.4.1. Uses of crossbreeding
        5.4.2. Two-, three-, four-breed crossing
        5.4.3. Terminal crossbreeding
        5.4.4. Rotational crossbreeding
        5.4.5. Grading-up
        5.4.6. Species hybridization

6. Genotype by Environment Interaction
    6.1. Classification of G x E interaction
    6.2. Extent of G x E interactions
    6.3. Examples of G x E interaction

7. Animal Evaluation and Computation of Breeding Values (BVs)
    7.1. Station vs field test/evaluation
    7.2. Performance testing
    7.3. Progeny testing
    7.4. Why compute BV?
    7.5. Different criteria used for predicting BV
        7.5.1. Individual's own performance (single and repeated records)
        7.5.2. Pedigree performance
        7.5.3. Family performance
        7.5.4. Performance of sibs
        7.5.5. Performance of progeny

8. Breeding Structures and schemes

8.1. Closed nucleus breeding scheme
8.2. Open nucleus breeding scheme
8.3. Community Based Breeding Program
    8.3.1. Concepts of CBBP and Applications
    8.3.2. Components and steps in setting CBBPs in villages
8.4. Group breeding scheme
8.5. Sire referencing scheme
8.6. Comparison of CBBP and Hierarchical Breeding program

9. Animal Genetic Resources (AnGR) and Conservation
    9.1. Characterization of Indigenous livestock
    9.2. Breed and species diversity
    9.3. Global breed risk status
    9.4. Causes of loss of AnGR
    9.5. Why conserve genetic diversity: rational for conservation
    9.6. Methods of conservation

Practical:

- Pedigreed and phenotypic data [performance and linear body measurement data collection] generation and analyses from CBBP villages
- Estimation of variance components
    - Phenotypic
    - genetic and
    - environmental
- Heritability and repeatability
- Coefficient of inbreeding and relationship •
- Practical application of methods for genetic evaluation
- Estimation of breeding value

Assessment:

- Practical/lab/field report work and report 25%
- Quizzes and assignment 20%
- Mid exam 20%
- Final exam 35%

References

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F.D.R.E. [illegible] Education
Wolaita Sodo University
College of [illegible]

Department of Animal and Ran[illegible]

ቁጥር/Ref.No: ARSc870/01/2013
ቀን/Date: 02/09/2021

For College of Agriculture

Subject: **Sending DC Minute**

As for mentioned this is to send 5 pages DC minute held on 13/12/2013EC on the issue of Animal Breeding Curriculum Amendment to your esteemed office attached hereunder with this official letter.

With Regards

Asrat Ayza Workaso
Head, Department of Animal and Range Sciences

Cc:-

- ✓ ICARDA
- ✓ ARSc Dep't

[illegible] 138 ☎ 251-46-1805054/251-913292891 [illegible] Fax 251-46-5515113 In replying, please quote our ref. number

DC Meeting

Place of meeting ARSC Office

Date of meeting 13/12/2013 E.C

Meeting time: 2:00AM

Name of Participants

1. Mr. Asrat Ayza.....Chairperson
2. Mr. Abera Anja .....Secretary
3. Mr. Ermias Belete .....Member
4. Mr Takele Geta .....Member
5. Mrs. Almaz Bekele.....Member
6. Mrs. Mebrat Alemayehu.....Member
7. Dr. Tibebu Kochare .....Member
8. Dr. Yonatan Kassu .....Member
9. Mr. Feleke Assefa.....Member
10. Mr. Gizachew Delilo.....Member
11. Mr. Gizachew Lemma.....Member

Agenda: Curriculum Amendment

The chairman welcomed all the DC members and has elaborated the agendum on Integrating community based Breeding Program (CBBP) in undergraduate curriculum of Animal breeding course.

The DC has made discussion on the agenda of course composition revision of course description, course outline and course material) and the DC has also elaborated the integration of CBBP in a course has also added advantages, that graduating students will implement the program right way in their assignment as extension and research staffs. Therefore, the DC has approved the integration of community based Breeding Program (CBBP) in undergraduate curriculum of Animal breeding course and highlighted the direction to the department, is expected to implement the CBBP initiatives and regular follow up with the collaboration of ICARDA.

Course Title: Animal Breeding
Course Code: AnSc 311
Course Credit Hours: 3 (2+1)
Course Pre-requites: Principles of Genetics
Course Category: Core
Course Description:
This course deals with the historical back ground of animal breeding; characterization of indigenous livestock/poultry/, alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, definition of breeding objectives and identification of economically important traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; estimating breeding values and genetic parameters including heritability, genetic correlation and repeatability; the bases of establishing breeding programs, types of selection, Mating systems (inbreeding and crossbreeding); hybrid vigor and inbreeding depression and principles and methods of conservation of animal genetic resources;

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Injibara University

College of Agriculture, Food and Climate Science

Program : Animal Science

Revised (Community Based Breeding Program (CBBP)) Integrated in the Undergraduate Harmonized Curriculum in the Animal Breeding Course (AnSc 311)

Background

Community Based Breeding Program is an alternative Breeding Strategy in small holder and resource poor farmers' flock. The program was initiated in 2010 in four sites and now extended more than 100 sites. The increase in farmers' income has reached up to 20% that has triggered to upscale and out scale CBBP initiatives. Ensuring sustainability of CBBP is a critical issue. One of the strategies to ensuring sustainability of CBBP is integration of CBBP in the curriculum. The integration of CBBP has also added advantages that included graduating students will implement the program right away in their assignment as extension and research staff. Graduates can create knowledge based jobs. International Center for Agricultural Research in Dry Areas (ICARDA) took the initiative and consulted Ethiopian Universities in the integration of CBBP in the undergraduate Animal Science Program. The first workshop was organized on July, 20, 2021 and the second workshop was organized on July 27, 2021 with theme " **Scaling up Community Based Breeding Programs through Ethiopian Universities".** Representatives from ten federal Universities were involved in the first workshop. In the second workshop, 11 federal state Universities were involve. The representatives were Animal Breeders and University community service officers, which can implement CBBP in their respective Universities. The workshop formed a committee to amend a curriculum with CBBP practices in Animal Breeding course. Based on the recommendations of the workshop amendment of the curriculum was made as described below and highlighted by yellow colour for a wider circulation and comments. Universities are expected to implement the CBBP initiatives.

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- Reproductive physiology and Artificial Insemination
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7	Forage and Pasture Production and Management	3	5
8	Camel Production and Management	2	3
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13	Dairy Cattle Production and Management	3	5
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Department of animal Sci.

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Course Code: AnSc 311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of Genetics

Course Category: Core

Course Description:

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Learning Outcomes: Upon successful completion of this course, students should be able to:

- Define breeding objectives in participatory way
- Understand selection theory and breeding methods
- Understand tools available to maximize response to genetic selection;
- Predict the rate of genetic improvement
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation
- Optimize selection and mating decisions
- Estimate genetic parameters and breeding values

Mode of Delivery:

Lecture, discussions, assignment, practical sessions based on filed data and field visits to livestock farms including livestock research centers and community-based breeding program villages.

Teaching Aids:

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6.2. Extent of G x E interactions

6.3. Examples of G x E interaction

7. Animal Evaluation and Computation of Breeding Values (BVs)

7.1. Station vs field test/evaluation

7.2. Performance testing

7.3. Progeny testing

7.4. Why compute BV?

7.5. Different criteria used for predicting BV

7.5.1. Individual's own performance (single and repeated records)

7.5.2. Pedigree performance
7.5.3. Family performance
7.5.4. Performance of sibs
7.5.5. Performance of progeny

8. Breeding Structure and schemes
   8.1. Nucleus Breeding Schemes
      8.1.1. Open Nucleus breeding scheme
      8.1.2. Closed Nucleus breeding schemes
   8.2. Community-based breeding program (CBBP)
      8.2.1. Concepts of CBBP and Applications
      8.2.2. Components and steps in setting CBBPs in villages
   8.3. Group breeding scheme
   8.4. Sire referencing scheme
   8.5. Comparison of CBBP and Hierarchal Breeding Program
9. Animal Genetic Resources (AnGR) and Conservation
   9.1. Characterization of livestock
   9.2. Breed and species diversity
   9.3. Global breed risk status
   9.4. Causes of loss of AnGR
   9.5. Why conserve genetic diversity: rational for conservation
   9.6. Methods of conservation

Practical:

- Pedigreed and phenotypic data [performance and linear body measurement data collection] generation and analyses from CBBP villages
- Estimation of variance components
  - Phenotypic
  - genetic and
  - environmental
- Heritability and repeatability
- Coefficient of inbreeding and relationship
- Practical application of methods for genetic evaluation
- Estimation of breeding value

Assessment:

- Practical/lab/field report work and report 25%
- Quizzes and assignment 20%
- Mid exam 20%
- Final exam 35%

References

1. Bourdon, Richard M. (2000) Understanding Animal Breeding
2. Daniel L. Hart and Andrew G. Clark (1997). Principles of Population Genetics
3. Falconer D.S. (1989). Introduction to Quantitative Genetics. 3rd ed.
4. Gerald Wiener (1994) Animal Breeding 5. Malcolm, B. W. (1991)
5. Dalton's Introduction to Practical Animal Breeding
6. Michael L. and Bruce W. (1998). Genetics and Analysis of Quantitative Traits Citation:
7. Haile A., Wurzinger M., Mueller J., Mirkena T., Duguma G., Rekik M., Mwacharo J., Mwai O., Sölkner J. and Rischkowsky B. 2018. Guidelines for Setting Up community-based small ruminants breeding programs in Ethiopia. ICARDA—Tools and guidelines No.1. Beirut, Lebanon: ICARDA.

Department of animal Sci

Meeting Minutes

Call to order

A meeting of CANR (College of Agriculture & Natural Resource) was held in the office of CANR on 06/09/2021 at 2:00 PM.

Attendees

Tilahun Negash Chairman

Seid Mohammed Member

Gedefaw Abebe Member

Atinafu Mengesha Member

Genet Dinku Member

Sosna Kassa Member

Temesgen Tafesse Member

Lidetu Shanko Member

Meeting Agenda: Approving animal breeding course curriculum modified by Animal science department instructors at Bonga University College of Agriculture & Natural Resource

Reports

The department of animal science modified the developed curriculum by Haramaya University. Bonga University participated in a workshop organized under the theme "Scaling up community based breeding programs through Ethiopian University.'' Accordingly, the Animal Breeding course offered by the Department of Animal Science has been directed to improve. According to the direction, the community-based breeding program has been improved by the instructors who have graduated in the the animal breeding and genetics program. We have gone through the paper and approve the modification of the curriculum.

Temesgen T. seid Lidetu

Tilahun Gedefaw A.

Genet

Bonga University College of Agriculture & Natural Resource

ቀን: 20/12/2013 ዓ.ም

የእንስሳት ሳይንስ ትምህርት ክፍል

ቃለ ጉባኤ

ቦታ: የእንስሳት ሳይንስ ትምህርት ክፍል ቢሮ

ሰዓት: 9:00

ሰብሳቢ: መ/ር ልደቱ ሻንቆ (የእንስሳት ሳይንስ ት/ክፍል ሀላፊ)

የስብሰባዉ ተሳታፊዎች

1. መ/ርት ሙሉአመቤት ንጋቱ (ፀሃፊ)
2. መ/ር ሰይድ መሃመድ ·
3. መ/ር አለበል ሙሌ
4. መ/ር ዋርዮ ዱባ
5. መ/ር ደገፋ ቦለጩ
6. መ/ር ማትቻ ኮራቶ
7. መ/ርት ስንታየዉ ሲሳይ
8. መ/ር አያሌዉ አበበ
9. መ/ር ሞሀመድ አሊ

የስብሰባዉ አጀንዳ

1. በ Animal Breeding ኮርስ ላይ የተዘጋጀዉን የሥርዓተ ትምህርት ማሻሻያ (የኮርስ መግለጫ ፣ የኮርስ ዝርዝር እና የኮርስ መማርያ) መገምገም እና ማፅደቅ::

ቦንጋ ዩኒቨርሲቲ "Scaling up community based breeding programs through Ethiopian University" በሚል መሪ ቃል በተዘጋጀዉ ወርክሾፕ ላይ ተሳትፏል:: በዚዉ መሰረት በእንስሳት ሳይንስ ትምህርት ክፍል ስር ከሚሰጡት ኮርሶች መካከል በ Animal Breeding ኮርስ ላይ የሥርዓተ ትምህርት ማሻሻያ እንዲደረግ አቅጣጫ ተሰጥቷል:: በተሰጠዉ አቅጣጫ መሰረት ማህበተሰብ አቀፍ የእርባታ ፕሮግራም (Community Based Breeding Program) በAnimal Breeding ኮርስ ላይ እንዲጨመር በቀረበዉ ሀሳብ ላይ የትምህርት ክፍሉ መምህራን የሀሳቡን ተገቢነት በማመን እና በማጠናከር ወደስራ ተገብቷል:: በዚዉ መሰረት ማሻሻያ በሚደረግበት ኮርስ ላይ ቅድመ ዝግጅት መድረግ አስፈላጊ ሁኖ በመገኘቱ በ Animal Breeding and Genetics ትምህርት ፕሮግራም የተመረቁ የትምህርት ክፍሉ መምህራንን:-

1ኛ. መ/ርት ስንታየዉ ሲሳይ

2ኛ. መ/ር አለበል ሙሌ

3ኛ. መ/ር ማትቻ ኮራቶ

4ኛ. መ/ር ዋርዮ ዱባ

በማቀናጀት የሥርዓተ ትምህርት ማሻሻያ እንዲያዘጋጁ ተደርጓል። ይሄንን የተዘጋጀዉን ማሻሻያ ማለትም የኮርስ መግለጫ ፣ የኮርስ ዝርዝር እና የኮርስ መማርያ ፤ በተመረጡት ነምጋሚ መምህራን በቀን 18/12/2013ዓ.ም አስታየት ተሰቶባቸዋል። የተሰጠዉን አስታየት በመቀበል የሥርዓተ ትምህርት ማሻሻያዉን እንደገና ማስተካከያ በማድረግ ለዲፓርትመንቱ ጉባኤ አቅርበዋል። የዲፓርትመንት ጉባኤም የተዘጋጀዉን የAnimal Breeding ሥርዓተ ትምህርት ማሻሻያ ያፀደቀ ሲሆን ከ2014 ዓ/ም ጀምሮ ለሶስተኛ አመት ተማሪዎች ኮርሱ መሰጠት እንዳለበት ወስኖል።

BONGA UNIVERSITY

COLLEGE OF AGRICULTURE AND NATURAL RESOURCE

DEPARTMENT OF ANIMAL SCIENCE

Approved Course Amendment on Animal Breeding Course (BSc.)

Prepared by:

Sintayehu Sisay (MSc. in Animal Breeding and Genetics)

Maticha Korato (MSc. in Animal Breeding and Genetics)

Alebel Mulia (MSc. in Animal Breeding and Genetics)

Wario Duba (MSc. in Animal Breeding and Genetics)

August, 2021

Bonga, Ethiopia

Course Title: Animal Breeding

Course Code: AnSc311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of

GeneticsCourse Status: Core

Course Description:

Traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; genetic parameters including heritability, genetic correlation and repeatability; selection and mating systems (inbreeding and crossbreeding); hybrid vigourand inbreeding depression; characterization of indigenous livestock /poultry/ and principles and methods of conservation of animal genetic resources; breeding schemes, components and steps in community based breeding program application and use of biotechnology in animal breeding.

Learning Outcomes:
Upon successful completion of this course, students should be able to:

- Understand tools available to maximize response to genetic selection
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, andbreeding value estimation
- Understand selection theory and breeding methods
- Predicting the rate of genetic improvement
- Optimize selection and mating decisions
- Estimate genetic parameters and breeding values
- Designing breeding program
- Familiar with the concept of Community based breeding program

Mode of Delivery:
Lecture, discussions, assignment, practical sessions and field visits

Teaching Aids:
Reference books, hand-out, animal farms, teaching videos

Course Contents:

1. **Introduction**
   - 1.1. Definition and history of animal breeding
   - 1.2. Goals of animal breeding
   - 1.3. Overview of animal breeding industries
     - 1.3.1. Value of Improvement
     - 1.3.2. Role of the Government

1.4. Contribution of animal breeding to livestock and poultry improvement
1.5. Genetic vs. environmental improvement

2. Categories of Traits in Livestock and Poultry

2.1. Qualitative traits
2.2. Quantitative traits
2.3. Threshold traits
2.4. Component traits
2.5. Economically important traits: description, measurement and inheritance
2.5.1. Growth, feed efficiency and carcass traits
2.5.2. Milk production and composition traits
2.5.3. Reproduction and survival traits
2.5.4. Type and conformation traits
2.5.5. Egg production traits (quantitative and qualitative)
2.5.6. Other Traits (Wool, Pelt, …)

3. Quantitative Effects of Genes in Populations

3.1. Genetic and environmental effects
3.2. Genetic components of variance
3.3. Additive variance
3.4. Dominance variance
3.4.1. Epistatic variance
3.5. Environmental components of variance
3.6. Resemblance between relatives
3.6.1. Phenotypic resemblance
3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)
3.7. Heritability and repeatability
3.7.1. Concepts and usefulness of heritability
3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-siband full-sib)
3.7.3. Repeatability
3.7.3.1.Basic concepts
3.7.3.2. Heritability vs repeatability
3.8. Correlations (phenotypic, genetic and environmental correlations)

4. Selection

4.1. Natural vs. artificial selection
4.2. Classification of Selection
4.2.1. Individual (Mass / Phenotypic) selection
4.2.2. Selection based on performance of relatives
4.2.3. Family selection
4.2.4. Sib selection
4.2.5. Selection on progeny performance
4.3. Methods of selection
4.3.1. Tandem method of selection
4.3.2. Independent culling level
4.3.3. Total score or selection index method

4.4. Response to selection and prediction of genetic gain
4.4.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)
4.4.2. Correlated response to selection

5. Mating Systems
5.1. Inbreeding and line breeding
5.1.1. Classification of mating systems
5.1.1.1. Random mating (Panmixia)
5.1.1.2. Non-random mating
5.1.1.3. Mating based on phenotypic relationship
5.1.1.4. Mating based on degree of genetic/pedigree relationship
5.1.2. Inbreeding
5.1.3. Genetic consequences of inbreeding
5.1.4. Measurement of inbreeding and relationship coefficients
5.2. Line breeding
5.3. Outbreeding and heterosis
5.3.1. Genetic effects of outbreeding
5.3.2. Phenotypic effects of outbreeding: Hybrid vigor
5.3.3. Types and measurements of heterosis
5.4. Systems of crossbreeding
5.4.1. Uses of crossbreeding
5.4.2. Two-, three-, four-breed crossing
5.4.3. Terminal crossbreeding
5.4.4. Rotational crossbreeding
5.4.5. Grading-up
5.4.6. Species hybridization

6. Genotype by Environment Interaction
6.1. Classification of G x E interaction
6.2. Extent of G x E interactions
6.3. Examples of G x E interaction

7. Animal Evaluation and Computation of Breeding Values (BVs)
7.1. Station vs field test/evaluation
7.2. Performance testing
7.3. Progeny testing
7.4. Why compute BV?
7.5. Different criteria used for predicting BV
7.5.1. Individual's own performance (single and repeated records)
7.5.2. Pedigree performance
7.5.3. Family performance
7.5.4. Performance of sibs
7.5.5. Performance of progeny

8. Breeding Industry Structure
8.1. Nucleus breeding scheme
8.1.1. Traditional breeding pyramid: closed nucleus breeding scheme
8.1.2. Open nucleus breeding scheme
8.2. Community based breeding program (CBBP)

8.2.1. Concepts of CBBP and its application
8.2.2. Components and steps in setting CBBPs in villages
8.3. Group breeding scheme
8.4. Sire referencing scheme

9. Animal Genetic Resources (AnGR) and Conservation

9.1. Vastness of AnGR
9.2. Breed and species diversity
9.3. Global breed risk status
9.4. Causes of loss of AnGR
9.5. Why conserve genetic diversity: rational for conservation
9.6. Methods of conservation

Practical:

- Estimation of variance components
  - phenotypic
  - genetic and
  - environmental
- Heritability and repeatability
- Coefficient of inbreeding and relationship
- Practical application of methods for genetic evaluation
- Estimation of breeding value

Assessment:

Practical/lab/field report work and report	25%
Quizzes and assignment	20%
Mid exam	20%
Final exam	35%

References

1. Bourdon, Richard M. (2000) Understanding Animal Breeding
2. Daniel L. Hart and Andrew G. Clark (1997). Principles of Population Genetics
3. Falconer D.S. (1989). Introduction to Quantitative Genetics. 3rd ed.
4. Gerald Wiener (1994) Animal Breeding
5. Malcolm, B. W. (1991) Dalton's Introduction to Practical Animal Breeding
6. Michael L. and Bruce W. (1998). Genetics and Analysis of Quantitative Traits

CHAPTER EIGHT

8. BREEDING INDUSTRY STRUCTURE

General overview of the chapter:

This chapter mainly covers about animal breed improvement and its structure to setup a community based breeding program at a smallholder level, genetic improvement strategies, nucleus breeding scheme (open and closed nucleus breeding scheme), concept and application of community based breeding program (CBBP), components of community based breeding program, steps in implementing community based breeding program, group breeding scheme and sire reference scheme.

Learning outcome:

At the end of the chapter students will able to:

- Describe the concept of animal breeding program
- Differentiate open and closed nucleus breeding scheme
- Familiar with the concept of Community based breeding program
- Mention the steps and components of community based breeding program
- Have the concept of group breeding scheme
- Know the concept of sire reference scheme

INTRODUCTION

The main objective of animal breeding is to genetically improve population of livestock which is achieved through selecting the best individuals of the current generation and using them as parents of the next generation. Genetic improvement aimed to exploit the current within and between breed variations.

Animal breeding is now a major concern in science and technology. In some species, animal breeding is in the hands of large companies, and the role of individual breeders seems to have decreased. There are several reasons for this change. First, the breeding industry adheres to scientific principles. Observation is replaced by measurement, and intuition is partially replaced by calculations and scientific predictions. Other major advances have been made through the

introduction of biotechnology. Technologies like ovum pick up, in vitro fertilization, embryo transfer, cloning of individuals, cloning of genes, and selection with the use of DNA markers are all on the ground. No doubt that the technology had a major impact on rates on genetic improvement in livestock population including dairy cattle, beef, sheep, goat, pig and poultry farm; and it is very important on the structure of animal breeding programs. Genetic improvement strategies fall into three main categories:

1. Selection between breeds;
2. Selection within breeds or lines and;
3. Cross-breeding.

Selection implies genetic improvement based on variation among individuals within the population (breed). Cross-breeding involves making use of variation among populations (breeds).To be successful in genetic improvement of livestock, appropriate breeding programs need to be planned, implemented and maintained. Breeding program is defined as the organized structure that is set up in order to realize the desired genetic improvement of the population.

In breeding programs a permanent selection response is created for the breeding goal traits by collection of information on selection population, estimation of breeding values, and selection among selection population in combination with a mating scheme for these populations. Breeding programs aim at generating genetic improvement in a population. Thus, the genetic improvement generated by the selection of animals in phase 5 in the breeding program is disseminated in phase 6: the structure of breeding programs (Figure 1).

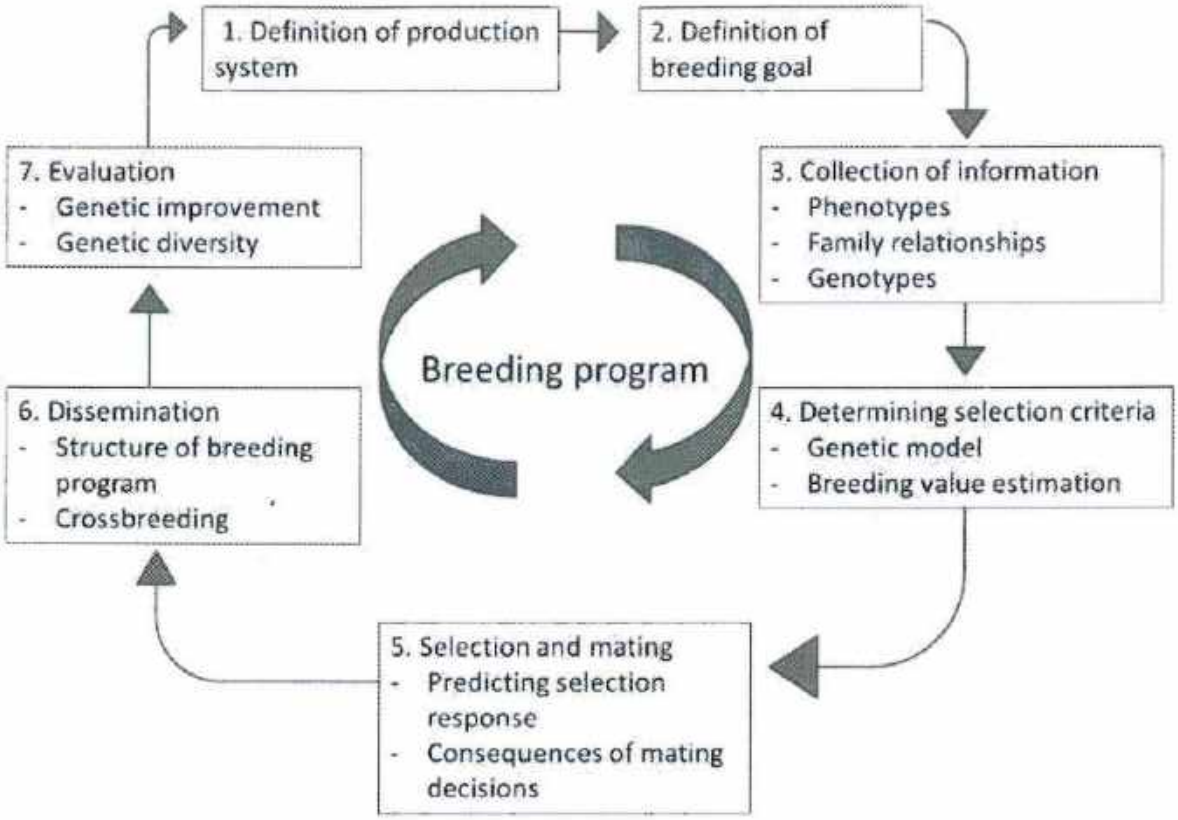


Figure 1: Structure of animal breeding program

Important factors in breeding programs

In essence, the two key questions in animal breeding are: Where to go? and How to get there? Running an animal breeding program involves the answer to these questions, which can be worked out in a bit more detail as:

1. What is the breeding objective: which traits need to be improved and how important are different traits in relation to each other?
2. What and who do we measure? Which traits, which animals?
3. Do we need to use any reproductive technology (Artificial Insemination, Embryo Transfer) if possible?
4. How many and which animals do we need to select as parents for the next generation
5. How to mate the selected males and females?

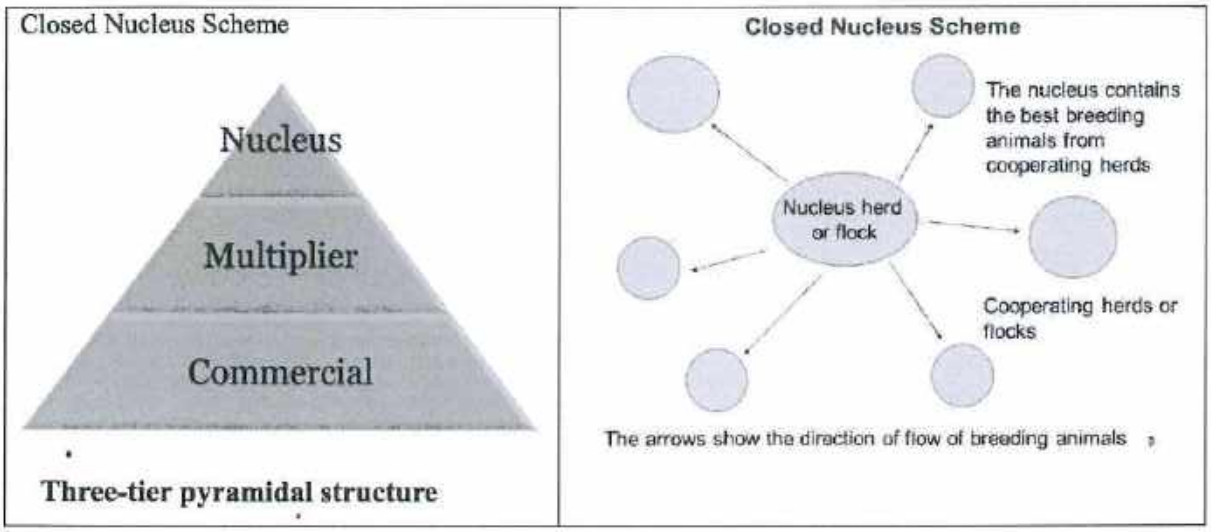
8.1. Nucleus breeding scheme

Nucleus (open and closed) breeding schemes are the most used and recommended tools for animal genetic improvement programs. The principle of nucleus breeding program is to bring the best breeding males and females from the participants (population) to a central place to create elite breeding animals and to make strong selection there. The selected animals (mostly male animals) will be distributed to participating farmers to disseminate the genetic superiority obtained at the nucleus to the whole population.

Nucleus breeding schemes where the selection of breeding stock is concentrated in a few herds from which the selected animals are spread to other herds are attractive in many developing countries. A nucleus breeding scheme is based on the principle that in each herd there is a small number of genetically very superior animals which if brought together will form a nucleus whose average genetic merit is far greater than that in any of the base population. A nucleus herd programme is used to both conserve an indigenous breed and to upgrade the local population.

8.1.1. Traditional Breeding Pyramid: Closed Nucleus Breeding Scheme

In closed nucleus breeding scheme, the flow of germ plasm (breeding animals) is only in one direction: from the nucleus to the cooperating farm. The breeding organization takes the decisions on selection and mating in the nucleus. As a consequence breeding goals are used steadily, recording of traits and pedigree is complete, selection and mating in the nucleus is under full control. This results in a high genetic improvement rate over generations. Once the breeding animals for the nucleus are chosen at the start, no animals from outside the nucleus are added to the nucleus population. The traditional model here is the pyramid with a small group of breeding animals that are actually improved (the 'elite breeders' in the nucleus) and underlying levels of (possibly) a multiplier and a commercial.



Closed schemes have been evolved in most animal industries, driven largely by market forces. Here are some key properties of closed schemes:

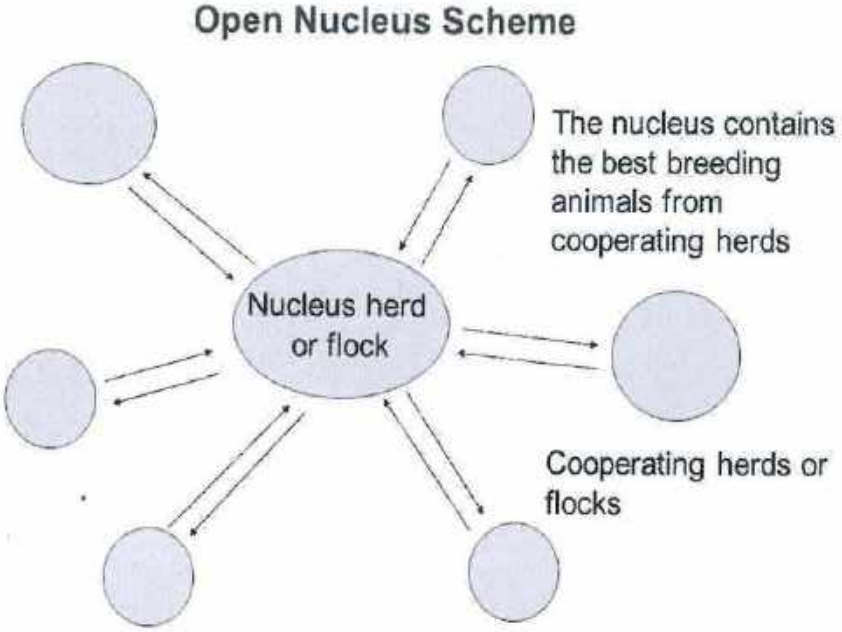
1. Selection effort is only permanently effective in the nucleus - any temporary changes in lower tiers are diluted by importation from the nucleus
2. Nucleus breeding objectives impact on the whole scheme.
3. If lower tiers buy average sire (and no dams) from the tier above, they will lag behind the tier above by a certain generations of selection response.

8.1.2. Open Nucleus Breeding Scheme

Open nucleus breeding scheme allow the flow of animals in both directions from the nucleus to the population and vice versa. Superior animals from outside the nucleus (the base population) are allowed in this structure implies that some recording takes place in the rest of the population.Open nucleus systems require base farmers to do some selection, usually on the females. Usually females for the nucleus are supplied in exchange for males, but other arrangements are possible (e.g. cash, in kind exchanges, or percentage of sales). A very important feature of open nucleus systems is that adaptation traits and other breeding objective preferences in the base population can be secured in the males produced, assuming that such traits are used in the selection of the "best" base females. Typical open nucleus design is to have 5–15 percent of the total female population in the nucleus and to have about half of the nucleus replacements come from the base.

Open nucleus breeding programs can be considered in species where the present breeding programs have a flat structure: horses, cattle, sheep and goats. In cattle breeding artificial reproduction techniques, in particular artificial insemination techniques and in vitro fertilization in combination with embryo implantation are well developed and heavily used in the open nucleus. This gives the opportunity to produce high numbers of offspring from superior sires and dams and disseminating the genes of these superior animals widely in the production population. In the disseminated part of the population (mainly used for production purposes = production population), the offspring of the sires is tested for important traits. When the estimated breeding value of females in the production population is higher than the breeding value in the nucleus population they can enter the nucleus.

The rate of inbreeding reduces and genetic progress increases as superior animals are available with farmers. This kind of breeding system can be observed only in Cattle, Buffalo, Sheep and Goat. The ONBS can be useful in the developing countries where herd or flock size is small. ONBS can lead to a 10-15% increase in annual response to selection which substantially reduces the rate of inbreeding in the nucleus. Open nucleus breeding system provides an approach to develop breeding system with simultaneous assimilation of modern reproductive and biotechnological tools in effective.



The arrows show the direction of flow of breeding animals [8]

8.3. Community-Based Breeding Programme (CBBP)

8.3.1. Concepts of CBBP and application

Modern livestock breeding methods are often unsuitable for poor households with small flocks of livestock; and many nucleus breeding programs in tropics were failed due to the lack of sustainable support and inadequate involvement of the community at the beginning of the program. To effectively allow for ownership and sustainability of genetic improvement programs, designing of Community Based Breeding Programs (CBBP) is important. Village/Community based breeding programs are organized breeding activities that are planned, designed and implemented by smallholder farmers individually or in cooperation with technical stakeholders to effect genetic improvement within their livestock and conserve indigenous genetic resource. Community-based breeding program focused on indigenous breeds, and suited to smallholder conditions and it has been promoted as a strategy for smallholder farmers to improve indigenous breeds. It has a potential role in increasing the productivity and profitability of indigenous breeds without undermining their resilience and genetic integrity, and without expensive (and potentially diversity-reducing) interventions.

Community-based livestock breeding programmes (CBBPs) have emerged as a potential approach to implement sustainable livestock breeding in smallholder systems. CBBPs are commonly implemented among keepers of small ruminants of local breeds in developing countries. CBBPs are distinct in a few important ways: First, farmers in these programmes determine which traits to select for and are trained to incorporate these traits into their breeding practices. Secondly, farmers work together as a group thereby creating a bigger and more diverse flock, and they receive support from scientists/researchers to set up local recording systems to monitor the performance of their animals on the selected traits over a period.

The strategy to effectively design structure and organization of the CBBP require full participation of the main stakeholders, the farming community in understanding their production system and defining appropriate breeding objectives. Thus, selective pure breeding of the adapted indigenous breeds is the best possible option of genetic improvement in the tropical countries. Indigenous breeds in harsh tropical environmental conditions have special adaptive features such as tolerance of a wide range of disease, water scarcity tolerance and ability to better utilize the limited and poor quality feed. This makes them survive and be productive in the prevailing environment. To efficiently utilize these special features of indigenous breeds, there is a need of planning and implementing viable breeding programs that fit to the existing low input production systems. Maintaining diversity of livestock genetic resources is instrumental for sustainable agricultural production.

8.3.2. Components and Steps in Setting Community Based Breeding Program

Since community based breeding program is working with low input small holder farming system which is interaction with livestock production must be considered. Breeding programs involve the description and decisions about a series of interacting components. Community based breeding programs take into account the indigenous knowledge of the communities on breeding practices and breeding objectives.

Among them the most important components to be considered in breeding program design are:

- Description of production environment and production system, identify;
- Characterization of the available local breed population; identify and describe the representative samples of animals from targeted populations, breeds or breed groups,
- Definition of breeding objectives, the success of CBBPs depends on understanding livestock keepers' breeding objectives and selection criteria. To do so, homogeneity and heterogeneity of breeding objectives and selection criteria need to be assessed among community members and between neighboring communities.
- Identification of traits to be selected,
- Decision about breeding methods and breeding population and
- Understanding of structure and organization of community involved

Breeding programs need to adopt a value chain approach. The success of a breeding program is determined by:

- The suitability of the breeding design to the target community's breeding practices
- Provision of appropriate extension services to improve the production environment
- Existence of a mechanism for accessible and affordable input supply
- Availability of market incentives for products.

Steps in Implementing Community Based Program

Step 1: Selecting target breeds and communities

A) **Selection of breeds**

When initiating and implementing CBBPs, it is important to pick the right breeds, populations and locations to work with. There are a number of criteria to follow in selecting target breeds and communities. The primary focus in this regard is farmer's choice of breeds. Traditional farming communities commonly prefer to keep their own indigenous breeds to meet their multiple breeding objectives. However, farmer's preferences are usually influenced by market forces to adopt cross-breeding. Positive evaluation of indigenous breeds by their owners creates a favorable ground for introducing selective breeding program.The criteria below should be considered when selecting breeds:

- The breeds should be among the most populous in the country with a wide area coverage
- Breeds should be kept by resource-poor farmers/ pastoralists
- The breeds should be genetically diverse as evidenced by phenotypic and potentially molecular characteristics
- The breeds should have potential for genetic improvement
- Research/development centers with relevant expertise and interests are available within reasonable reach of the communities who keep those breeds
- Reasonably good background information is available on relevant breeds and production systems, so that planned and future research and development work has an extant foundation

B) Selection of community

Selection of the right community has been recognized as key to the success of community-based programs. Some essential factors to consider in selecting target communities for a CBBP include:

I) External factors

- Market access, including distance to markets, transportation of products and quality of roads.
- Potential negative or positive impacts by other projects. For example, irrigation might result in more cropping and less livestock activities. A crossbreeding program could risk the long-term breeding programs as farmers could see short-term impacts that cause them to abandon or disregard agreed-upon breeding plans.
- Collaboration with other projects. It is important to be aware of the possible involvement of other stakeholders in associated projects and allow room for their participation.
- Government support. The availability of good extension services to support CBBPs is also crucial.
- Support from NGOs.
- Availability of inputs and services (public vs private): These include feeds resource, veterinary services, and market information systems.

II) Community-related factors

- Willingness/interest of the community to participate in the program.
- Key species should be a priority. A substantial portion of income should be generated from targeted livestock species.
- The community should have a sufficiently large (combined) and equitably distributed herd/flock.
- Existence of communal/shared resources or institutional arrangements. For example, common grazing land or watering points and/or common use of breeding rams, herding or marketing facilities is ideal. Such arrangements indicate that some common facilities that require collective action already exist. The existing institutional setup can therefore be used as a starting point for developing institutional structures for the breeding program.
- Presence of community leaders (elders) and champion farmers/ pastoralists who are important to social and traditional structures in the region. They should be involved as community-level facilitators to work closely with the project's team.

Suggested steps to follow for selecting the communities:

- Consult with extension representatives, researchers working in the area, former livestock specialists who know the area, NGOs and development project staff.
- Visit the communities
- Organize a participatory workshop this is an important key step. The key stakeholders in the workshop include: extensions, researchers, cooperatives, microfinance administration and private sectors should be carefully identified for participation.
- Document the whole process, a task preferably undertaken by a communications expert.

Step 2: Characterization of target sites and breeds

1. Description of the production system

Community-based breeding requires a full description of the existing environment, the current level of productivity, breeding objectives, and the selection criteria of herders, available indigenous knowledge and breeding practices, and the full participation of farmers from the beginning. Livestock genetic improvement programs should incorporate improvements in the

production environment and the traditional management practices. Characterization of the production environment consists of a description of the climatic conditions, feed resources, prevalence of diseases, and constraints to increases in productivity. Assuming that some broad information on the production system is already available from secondary sources, the characterization of production systems for the purpose of the breeding program should concentrate on these additional issues:

- Importance and function of livestock in the system and use of livestock products
- Economic evaluation of production (costs and returns from sales)
- Current breeding practices (management of males and females, herd structure, gene flows, including exchange and/or introduction of new breeding animals)
- Marketing system and opportunities for livestock and livestock products.
- Institutional settings that affect breeding and animal management, including marketing (decision mechanisms within the community)

2. Breed characterization

Two important aspects of characterizing breed resources maintained by a targetcommunity are eliciting the community's perceptions of their animal and describing thelivestock population (breed type, adaptive features, and production traits). So thatthe community's preferences are accommodated and the desirable characteristics ofthe indigenous breeds are maintained when designing genetic improvement programs. Determining the community's perceptions involves listing what they like and what they do not like about their breed(s).

Populations of livestock species in developing regions are traditionally recognized as distinct types by ethnic group or geographical location, from which they often derive their names. Preliminary identification of breeds or populations involves phenotypic characterization of distinct populations using a combination of stratified and purposive sampling strategies. Qualitative and quantitative descriptions, including morphometric measurements of animals, are collected through farm-level surveys to identify and describe the representative samples of animals from targeted populations, breeds or breed groups.

Phenotypic characterization

Qualitative and quantitative variables to be observed and recorded include:

- Phenotype, including qualitative variables such as coat color, fiber type, face profile, presence of horn and tail type, and quantitative variables including body weight, withers height, body length and heart girth;
- Phenotypic performance characteristics, such as body weight at birth, at weaning and six months, adult weights and daily milk yield at onset or peak lactation, as well as lactation length; and
- Flock/herd-level reproductive performance data (e.g. ewe/doe/cow fertility, lambing/kidding/calving rates, prolificacy and pre-weaning survival rates).

Means for each quantitative measurement are calculated to describe each population sampled. Related indigenous knowledge systems can also be collected at this stage.

Step 3: Definition of breeding objectives

The success of CBBPs depends on understanding livestock keepers' breeding objectives and selection criteria. Defining the production objectives identifies the tangible and intangible uses of animal breeds reared by a community. The uses are equivalent to 'gross trait categories' which form the basis for identifying specific breeding objective traits.Knowledge of the reasons for keeping animals is a prerequisite for deriving operational breeding goals. Uniform and consistent views among farmers facilitate the creation of a common understanding and a clear formulation of common objectives. The long-term economic benefits of keeping certain breeds or breed combinations depend on market demand for livestock and livestock products; as such, data on current and predicted consumer demands (e.g. size of carcass and meat quality) from several markets including traders, abattoirs, butchers, food industries, restaurants, and in some cases, individual consumers (end-users) must be collected and analyzed. A cross-check of community breeding objectives and market demands allow a validation of the suitability of current objectives. The findings from the market study have to be presented to involved communities in the case of inconsistency should be adjusted.

Step 4: Assessment of alternative breeding plans

There is no single best method for designing breeding plans to fit all possible circumstances. Thus, one option is to evaluate the results of alternative designs through modeling in order to choose the best under the given circumstances. There are two basic approaches for modeling and evaluating breeding programs: deterministic and stochastic models.Deterministic models generate the exact same outcomes under a given set of initial conditions while stochastic models are the outcomes will differ due to inherent randomness. Deterministic models assume that known average rates with no random deviations are applied to large populations. In stochastic models, in contrast, there are random variations due either to uncertainties on the parameter or to small population sizes for which it may not be reasonable to apply average rates.

Step 5: Developing adequate breeding structures

Step 1 and 2 discussed critical aspects of selecting target communities, farmer groups and breeds in CBBP creation and implementation, including selection of target population for genetic improvement. This section of the breeding program considers the identified animal population in terms of its biological characteristics, the husbandry practices under which it is raised, prevailing and anticipated infrastructure, as well as the constraints and opportunities all of which, if appropriately considered, enable the design of a program that maximizes both genetic gain and profit for the community.

The simplest and most straightforward design is one in which the best males and females are selected as replacements (i.e. the future parents of the next generation) from an entire population. This means that all the herds/flocks in a community are monitored and screened to identify the "best" individual animals. The challenge with such a design is that each member of the participating community has to be somehow involved in the selection process. Each farmer has to therefore undertake performance recording, pedigree recording and rearing of selected male animals.

An alternative design is to have some farmers with the "best" animals and often "best or average practices" to breed males for use by the whole population. Such designs with structured populations are called "nucleus systems." Nucleus farmers concentrate on maximizing genetic gains while the remaining "base" farmers can concentrate on production. In this case best males

and females are mated in the nucleus in order to produce the "best" next generation of young animals, thus increases the probability of better gene combinations in nucleus progeny compared to the rest of the population.

For the designs above to deliver, the nucleus must be functional; that is, nucleus farmers not only have to make genetic progress but also have to consistently produce and disseminate appropriate numbers of genetically superior males to nucleus and base populations (farmers' flocks/ herds). Thus, the size of the nucleus, or the proportion of females to the total community herd/flock which should be in the nucleus, depends on the number of males needed by the entire system, taking into consideration a desired selection pressure or intensity. A minimum effective population size is also required to avoid inbreeding at the nucleus.

Animal Identification, data recording and selecting breeding male

Animal identification

Animal identification is crucial in genetic improvement programs. Animals should be uniquely identified, so as to accurately trace their respective pedigrees and link the performance of individual animals to her/his progeny and relatives through known genetic relationships. Combining performance and pedigree records enables more accurate computations of the genetic worth or breeding values of the animals to be estimated or predicted and used for selection.

Ear tags, collars, tattoos, branding and ear notches can be used in identification methods. Ear tags are the most commonly used identification methods because they are relatively cheap, easy to apply and are less stressful to animals. However, in some situations, where for some reasons ear tags are not acceptable or practical because of cultural taboos or shape of the ear, for example other alternatives can be sought.

The identification of the base population can also be undertaken by a research/extension team. Thereafter, identification of newly born lambs could be undertaken by village enumerators. Ultimately, community members should be trained to handle animal identification by themselves.

Data recording and management

Development and use of a simple, flexible and cost-effective performance recording and evaluation system is essential for a breeding program. Recording formats should be kept as simple and as practical as possible for easy use and adoption.

Selection of breeding male

Breeding should be selected based on recorded data (own and maternal performance) for the set of agreed selection traits. The stages at which the selection process takes place depend on both the existing traditional practices of breeding male selection and use, as well as on scientific and practical requirements. If the selection decision can be made in line with traditional practices, it will improve the probability of acceptance by the community.

Management and use of breeding sire

The management of selected breeding sires to be used by the community should be based on pre-agreed modalities. Some of the options include:

- Managing the sire in rotation
- Keeping the sire in one agreed household and those who use the ram/buck pay an agreed amount for the service
- Keeping the sire in one agreed household and other community members contribute in kind (e.g. feed and veterinary drugs) to keeping the sire

The best way to use sires communally is by forming "sire-user-groups." This can be based on criteria such as number of breeding dams, settlement patterns and use of communal grazing areas. Traditional sire use groups are often based on social networks and resource availability and thus these should be considered where and when applicable. In order to minimize inbreeding, a sire rotation strategy among the sire groups has to be established through a consultative process. The best way is to use a sire in the flocks for one year, after which it is rotated to another group within the community. Sire rotation records must be diligently kept to avoid inbreeding. *In addition, the following points need to be considered to make community based breeding program sustainable:*

Institutional backup: organizational issues

Community-based breeding programs need to be initially supported by a committed team of researchers, extension personnel, the NGO community, and project staff. The institutional backup needed to implement such a project can vary depending on expertise and resource availability. Local communities and their supporting national research institutions must have sufficient learning curves and continued government support take over full responsibilities and ensure sustainability and success of CBBP.

Reproductive technologies for scaling up the benefits from CBBPs

To scale up the genetic progress made and expand the use of improved rams/bucks/bull, reproductive options may be brought up together in specific packages to support delivering improved genetics. In scaling up of CBBPs, reproductive technologies can increase the rate of genetic improvement, but they have the potential to cause an even greater increase in the rate of inbreeding. Determining how to gain genetic advantage from these technologies, while at the same time minimizing their genetic disadvantages, has provided a major challenge for breeders. Artificial insemination (AI), semen sexing, embryo sexing, embryo cloning, in vitro embryo production (IVEP) and multiple ovulation and embryo transfer (MOET) can produce substantial increases in the rate of genetic improvement, with acceptable rates of inbreeding. Reproductive technologies also have a major role to play in the important task of conserving animal genetic resources: in particular, there is an urgent need for methods of gamete cryopreservation that can be applied in isolated field conditions, for all of the major domesticated species.

8.4. Group Breeding Schemes

A group of farmers get together and form a group breeding scheme. It has been developed to enable several small-scale breeders to combine into an effective breeding operation, involving the screening of large numbers of high producing females from the contributing flock to use in a nucleus flock. The nucleus flock in turn supplies sire to the contributing flocks. Interest in such schemes is generated by the basic genetic principle that it is possible to apply selection pressure in a large population than on a small one. Group breeding schemes have been developed to enable several small-scale breeders to combine into an effective breeding operation, involving the screening of large numbers of females for use in a nucleus flock. The group breeding scheme

involves the two-way movement of males and females between the nucleus or sire breeding unit and contributing flocks or herds.

Procedures:

1. Interested breeders join the group.
2. Members contribute top performing females to the nucleus herd.
3. Practice selection of females in the nucleus. Replacements can also be obtained from outside the nucleus herd (open nucleus).
4. Elite females are mated to top sires to breed sires for use within the nucleus.
5. Members of the group receive males from the nucleus

The initiation and successful operation of a group-breeding scheme is dependent on a number of important considerations which are not always easily met, and for this reason the formation of large numbers of group breeding schemes is unlikely.

- The choice of a nucleus manager is probably the most important consideration for the success of a scheme.
- The choice of group members, though not as critical, is also an important consideration.
- Participating members of a group should be located in more or less the same environment to ensure maximum adaptability of the breed. Contributing flocks should preferably not be situated too far from the nucleus since distance is an important consideration in limiting transport costs of animals to and from the nucleus.
- Once prospective group members and the nucleus manager have agreed on their breeding objectives and have drawn up and agreed to the conditions of the constitution (an essential requirement of group schemes), screening of member flocks should commence as soon as possible.
- The identification of the highest producers can be accomplished in several ways.
- The use of sires, genetically inferior to the high standard of dames in the newly formed nucleus, could quite conceivably lower the standard of the first progeny, thus reducing the important selection advantage achieved in the nucleus.

8.5. Sire Referencing Scheme

Sire referencing schemes are cooperative breeding schemes that create genetic links among participating flocks (or herds). These links are usually created through the use of artificial insemination from elite sires.In sire referencing scheme, genetic links are created among flocks by the mutual use of some reference sires. These connections allow for cross-flock genetic evaluations offering a larger pool of population for selection. Using stochastic simulation, the effect of three characteristics of the design of such schemes on rates of genetic response and inbreeding were investigated. We need to consider:

(i) The selection intensity for reference sires (highest ranking, or from the top sixth or top third of available candidates),

(ii) The criteria on which reference sires were chosen (BLUP breeding value or phenotypic performance), and

(iii) The extent to which the reference sires were used.

In theory, sire referencing schemes permit across flock genetic evaluation, increased selection intensity and, ultimately, increased rates of genetic gain. A sire-referencing scheme (SRS) is a system for comparing the breeding values of sires in different herds through objective measurement of the production of their progeny. An SRS allows such comparisons to be made despite the management and environmental differences between herds.

Related animals in different herds or flocks (e.g., the progeny of the same sires) provide genetic links between them. When these links are sufficiently strong and BLUP is used, the EBV of animals can be compared fairly across herds or flocks.This has a positive effect on the number of animals that can be compared fairly, and thus on the selection intensity and genetic gain that can be achieved. These benefits are augmented when reproductive techniques such as AI are used to increase the use of elite parents. Because related animals are recorded in successive years, it is also possible to compare EBV across years, to estimate genetic trends in evaluated traits and associated indexes. This is valuable for breeders to monitor progress in their improvement programs, and for commercial producers to identify individual stud flocks or breeding schemes making most progress.

The main goal of most SRS is to create a structure that accelerates the rate of genetic improvement, for an agreed objective in members' of flocks. To do this, genetic links are created across members' flocks by the use of AI rams on a portion of the ewes in each flock, or by sharing rams for natural service. In a sense, SRS are a means to an end; they create the genetic links that would occur naturally if there is wider use of AI in purebred herd/flocks. However, if they are organized properly they can also result in faster rates of progress than would be achieved with the ad hoc use of AI.

Miazn-Tepi University
Department of Animal Science

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Date

To: CANR

MTU

Subject: Sending the DC minute (2014 E.C.)

As expressed above, the DC throughly looked the case of incorporating Community base breeding program (CBBP) in **Animal Breeding course** of regular Animal science BSc students. Finaly, the DC passesed a descison to include CBBP as a subtopics in the course braekdown. Thus, I have attached 8 pages of the minute here with this letter.

With best regards,

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Mequanent baye wubetu
Head, Department of
Animal Science

Cc:-
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Integrating Community Based Breeding Program (CBBP) in Undergraduate Harmonized Curriculum of Animal breeding course: Animal Sciences

Background

Community Based Breeding Program is an alternative Breeding Strategy in small holder and resource poor farmers' flock. The program was initiated in 2010 in four sites and now extended to more than 100 sites. The increase in farmers' income has reached up to 20% that has triggered to upscale and out scale CBBP initiatives. Ensuring sustainability of CBBP is a critical issue. One of the strategies to ensuring sustainability of CBBP is integration of CBBP in the curriculum. The integration of CBBP in a curriculum has also added advantages that, graduating students will implement the program right away in their assignment as extension and research staff. Graduates can create knowledge based jobs. International Center for Agricultural Research in Dry Areas (ICARDA) took the initiative and consulted Ethiopian Universities in the integration of CBBP in the undergraduate Animal Science Program. The first workshop was organized on July, 20, 2021 and the second workshop was organized on July 27, 2021 with theme " **Scaling up Community Based Breeding Programs through Ethiopian Universities".** Representatives from ten federal Universities were involved in the first workshop. In the second workshop, 11 federal state Universities were invoived. The representatives were Animal Breeders and University community service directors, which can implement CBBP in their respective Universities. The workshop formed a committee to amend a curriculum with CBBP practices in Animal Breeding course. Based on the recommendations of the workshop, amendment of the curriculum was made as described below and highlighted by yellow colour for a wider circulation and comments. Universities are expected to implement the CBBP initiatives.

What is required to enter into action and report the integration of CBBP in the curriculum?

- Course Team of Animal breeding and genetics review the proposed curriculum amendment and submit to the head of department with recommendations.
- The department council, chaired by the head of department approves the amendment supported by a minutes
- A cover letter and the approved course amendment (Course description, course outline and later on course material) with University logo passed to Animal breeding and genetics course team for implementation. The same cover letter and course amendment with stamped copy and logo sent to ICARDA.
- Documentation of the amendment and minutes in head department office and make a follow up of the implementation
- Final date of submission End of August 2021.

Course clusters: Animal Breeding and Breed Improvement

- Animal Genetics
- Reproductive physiology and Artificial Insemination
- **Animal Breeding**
- Animal Biotechnology

Table 1: List of core courses

Sr/N	Course Name	Cr.HR	ECTS
1	Anatomy and Physiology of Farm Animals	3	5
2	Fishery and Aquaculture	3	5
3	Swine Production and Management	2	3
4	**Principle of Genetics**	**3**	**5**
5	Principle of Animal Nutrition	3	5
6	Sheep and Goat Production and Management	3	5
7	Forage and Pasture Production and Management	3	5
8	Camel Production and Management	2	3
9	**Animal Breeding**	**3**	**5**
10	Reproductive Physiology and Artificial Insemination	2	3
11	Applied Animal Nutrition	4	6
12	Poultry Production and Hatchery Management	4	6
13	Dairy Cattle Production and Management	3	5
14	Practical in Animal Science I	1	2
15	Beef Cattle Production and Management	3	5
16	Equine Production and Draft Animals Management	3	5
17	Biometry	3	5
18	Research Methods in Animal Sciences	2	3
19	**Animal Biotechnology**	**3**	**5**
20	Range Ecology and Management	3	5
21	Veterinary Parasitology	2	3
22	Practical in Animal Science II	1	2
23	Practical Attachment	2	3
24	Apiculture	3	5
25	Sericulture	2	3
26	Animal Behavior and Welfare	2	3
27	Hide and Skin Processing	2	3
28	Animal Health and Disease Control	3	5
29	Senior Seminar	1	2
30	Food Hygiene and Veterinary Public Health	2	3
31	Livestock Products Processing Technology	3	5
32	Senior Research Project	2	3

Course Title: Animal Breeding

Course Code: AnSc 311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of Genetics

Course Category: Core

Course Description:

This course deals with the historical back ground of animal breeding; characterization of indigenous livestock/poultry/, alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, definition of breeding objectives and identification of economically important traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; estimating breeding values and genetic parameters including heritability, genetic correlation and repeatability; the bases of establishing breeding programs, types of selection, Mating systems (inbreeding and crossbreeding); hybrid vigor and inbreeding depression and principles and methods of conservation of animal genetic resources;

Learning Outcomes: Upon successful completion of this course, students should be able to:

- Participatory definition of breeding objectives
- Understand selection theory and breeding methods;
- Understand tools available to maximize response to genetic selection;
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation;
- Optimize selection and mating decisions;
- Estimate genetic parameters and breeding values; and
- Understanding the concept of alternative breeding programs.

Mode of Delivery:

Lecture, discussions, assignment, practical sessions based on filed data and field visits to livestock farms including livestock research centers and community-based breeding program villages.

Teaching Aids:

Reference books, handouts, animal farms, teaching videos.

Course Contents:

1. Introduction
   - 1.1. Definition and history of animal breeding
   - 1.2. Goals of animal breeding
   - 1.3. Overview of animal breeding industries
     - 1.3.1. Value of improvement
     - 1.3.2. Role of the government
   - 1.4. Contribution of animal breeding to livestock and poultry improvement
   - 1.5. Genetic vs. environmental improvement
2. Categories of Traits in Livestock and Poultry
   - 2.1. Qualitative traits
   - 2.2. Quantitative traits
   - 2.3. Threshold traits
   - 2.4. Component traits
   - 2.5. Economically important traits: description, measurement and inheritance
     - 2.5.1. Growth, feed efficiency and carcass traits
     - 2.5.2. Milk production and composition traits
     - 2.5.3. Reproduction and survival traits
     - 2.5.4. Type and conformation traits
     - 2.5.5. Egg production traits (quantitative and qualitative)
     - 2.5.6. Other Traits (wool, pelt, ...)
3. Quantitative Effects of Genes in Populations
   - 3.1. Genetic and environmental effects
   - 3.2. Genetic components of variance
   - 3.3. Additive variance
   - 3.4. Dominance variance
     - 3.4.1. Epistatic variance
   - 3.5. Environmental components of variance
   - 3.6. Resemblance between relatives
     - 3.6.1. Phenotypic resemblance
     - 3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)
   - 3.7. Heritability and repeatability
     - 3.7.1. Concepts and usefulness of heritability
     - 3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)
     - 3.7.3. Repeatability
     - 3.7.4. Basic concepts
     - 3.7.5. Heritability vs repeatability

3.8. Correlations (phenotypic, genetic and environmental correlations)

4. Selection
   - 4.1. Natural vs. artificial selection
   - 4.2. Classification of selection
     - 4.2.1. Individual (mass / phenotypic) selection
     - 4.2.2. Selection based on performance of relatives
     - 4.2.3. Family selection
     - 4.2.4. Sib selection
     - 4.2.5. Selection on progeny performance
   - 4.3. Methods of selection
     - 4.3.1. Tandom method of selection
     - 4.3.2. Independent culling level
     - 4.3.3. Total score or selection index method
   - 4.4. Response to selection and prediction of genetic gain
     - 4.4.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)
     - 4.4.2. Correlated response to selection

5. Mating Systems
   - 5.1. Inbreeding and line breeding
     - 5.1.1. Classification of mating systems
       - 5.1.1.1. Random mating (panmixia)
       - 5.1.1.2. Non-random mating
       - 5.1.1.3. Mating based on phenotypic relationship
       - 5.1.1.4. Mating based on degree of genetic/pedigree relationship
     - 5.1.2. Inbreeding
     - 5.1.3. Genetic consequences of inbreeding
     - 5.1.4. Measurement of inbreeding and relationship coefficients
   - 5.2. Line breeding
   - 5.3. Outbreeding and heterosis
     - 5.3.1. Genetic effects of outbreeding
     - 5.3.2. Phenotypic effects of outbreeding: hybrid vigor
     - 5.3.3. Types and measurements of heterosis
   - 5.4. Systems of crossbreeding
     - 5.4.1. Uses of crossbreeding
     - 5.4.2. Two-, three-, four-breed crossing
     - 5.4.3. Terminal crossbreeding
     - 5.4.4. Rotational crossbreeding
     - 5.4.5. Grading-up

5.4.6. Species hybridization

6. Genotype by Environment Interaction
   - 6.1. Classification of G x E interaction
   - 6.2. Extent of G x E interactions
   - 6.3. Examples of G x E interaction
7. Animal Evaluation and Computation of Breeding Values (BVs)
   - 7.1. Station vs field test/evaluation
   - 7.2. Performance testing
   - 7.3. Progeny testing
   - 7.4. Why compute BV?
   - 7.5. Different criteria used for predicting BV
     - 7.5.1. Individual's own performance (single and repeated records)
     - 7.5.2. Pedigree performance
     - 7.5.3. Family performance
     - 7.5.4. Performance of sibs
     - 7.5.5. Performance of progeny
8. Breeding Structures and schemes
   - 8.1. Closed nucleus breeding scheme
   - 8.2. Open nucleus breeding scheme
   - ***8.3. Community Based Breeding Program***
     - ***8.3.1. Concepts of CBBP and Applications***
     - ***8.3.2. Components and steps in setting CBBPs in villages***

     Incorporated subtopic for CBBP
   - 8.4. Group breeding scheme
   - 8.5. Sire referencing scheme
   - **8.6. Comparison of CBBP and Hierarchical Breeding program**

     Incorporated Subtopics for CBBP
9. Animal Genetic Resources (AnGR) and Conservation
   - 9.1. Characterization of Indigenous livestock
   - 9.2. Breed and species diversity
   - 9.3. Global breed risk status
   - 9.4. Causes of loss of AnGR
   - 9.5. Why conserve genetic diversity: rational for conservation
   - 9.6. Methods of conservation

Practical:

- Pedigreed and phenotypic data [performance and linear body measurement data collection] generation and analyses from CBBP villages
- Estimation of variance components

- Phenotypic
- genetic and
- environmental

- Heritability and repeatability
- Coefficient of inbreeding and relationship •
- Practical application of methods for genetic evaluation
- Estimation of breeding value

Assessment:

- Practical/lab/field report work and report 25%
- Quizzes and assignment 20%
- Mid exam 20%
- Final exam 35%

References

1. Bourdon, Richard M. (2000) Understanding Animal Breeding
2. Daniel L. Hart and Andrew G. Clark (1997). Principles of Population Genetics
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4. Gerald Wiener (1994). Animal Breeding
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7. Haile A., Wurzinger M., Mueller J., Mirkena T., Duguma G., Rekik M., Mwacharo J., Mwai O., Sölkner J. and Rischkowsky B. 2018. Guidelines for Setting Up community-based small ruminants breeding programs in Ethiopia. ICARDA—Tools and guidelines No.1. Beirut, Lebanon: ICARDA.

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MEKDELA AMBA UNIVERSITY
COLLEGE OF AGRICULTURE AND NATURAL RESOURCE
DEPARTMENT OF ANIMAL SCIENCE

Integrating Community Based Breeding Program (CBBP) in Undergraduate Curriculum: Animal Sciences

Background

Community Based Breeding Program is an alternative Breeding Strategy in small holder and resource poor farmers' flock. The program was initiated in 2010 in four sites and now extended to more than 100 sites. The increase in farmers' income has reached up to 20% that has triggered to upscale and out scale CBBP initiatives. Ensuring sustainability of CBBP is a critical issue. One of the strategies to ensuring sustainability of CBBP is integration of CBBP in the curriculum. The integration of CBBP in a curriculum has also added advantages that, graduating students will implement the program right away in their assignment as extension and research staff. Graduates can create knowledge based jobs. International Center for Agricultural Research in Dry Areas (ICARDA) took the initiative and consulted Ethiopian Universities in the integration of CBBP in the undergraduate Animal Science Program. The first workshop was organized on July, 20, 2021 and the second workshop was organized on July 27, 2021 with theme " **Scaling up Community Based Breeding Programs through Ethiopian Universities".** Representatives from ten federal Universities were involved in the first workshop. In the second workshop, 11 federal state Universities were involved. The representatives were Animal Breeders and University community service directors, which can implement CBBP in their respective Universities. The workshop formed a committee to amend a curriculum with CBBP practices in Animal Breeding course. Based on the recommendations of the workshop, amendment of the curriculum was made as described below and highlighted by yellow colour for a wider circulation and comments. Universities are expected to implement the CBBP initiatives.

Course clusters: Animal Breeding and Breed Improvement

- Animal Genetics
- Reproductive physiology and Artificial Insemination
- **Animal Breeding**
- Animal Biotechnology

Table 1: List of core courses

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ግብርናና ተፈጥሮ ሃብት ኮሌጅ
የእንስሳት ሳይንስ ትክፍል

MEKDELA AMBA UNIVERSITY
COLLEGE OF AGRICULTURE AND NATURAL RESOURCE
DEPARTMENT OF ANIMAL SCIENCE

Sr/N	Course Name	Cr.HR	ECTS
1	Anatomy and Physiology of Farm Animals	3	5
2	Fishery and Aquaculture	3	5
3	Swine Production and Management	2	3
4	**Principle of Genetics**	**3**	**5**
5	Principle of Animal Nutrition	3	5
6	Sheep and Goat Production and Management	3	5
7	Forage and Pasture Production and Management	3	5
8	Camel Production and Management	2	3
9	**Animal Breeding**	**3**	**5**
10	Reproductive Physiology and Artificial Insemination	2	3
11	Applied Animal Nutrition	4	6
12	Poultry Production and Hatchery Management	4	6
13	Dairy Cattle Production and Management	3	5
14	Practical in Animal Science I	1	2
15	Beef Cattle Production and Management	3	5
16	Equine Production and Draft Animals Management	3	5
17	Biometry	3	5
18	Research Methods in Animal Sciences	2	3
19	**Animal Biotechnology**	**3**	**5**
20	Range Ecology and Management	3	5
21	Veterinary Parasitology	2	3
22	Practical in Animal Science II	1	2

Mekdela Amba University Department of Animal Sciences

23	Practical Attachment	2	3
24	Apiculture	3	5
25	Sericulture	2	3
26	Animal Behavior and Welfare	2	3
27	Hide and Skin Processing	2	3
28	Animal Health and Disease Control	3	5
29	Senior Seminar	1	2
30	Food Hygiene and Veterinary Public Health	2	3
31	Livestock Products Processing Technology	3	5
32	Senior Research Project	2	3

Course Title: Animal Breeding

Course Code: AnSc 311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of Genetics

Course Category: Core

Course Description:

This course deals with the historical back ground of animal breeding; characterization of indigenous livestock/poultry/, alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, definition of breeding objectives and identification of economically important traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; estimating breeding values and genetic parameters including heritability, genetic correlation and repeatability; the bases of establishing breeding programs, types of selection, Mating systems (inbreeding and crossbreeding); hybrid vigor and inbreeding depression and principles and methods of conservation of animal genetic resources.

Learning Outcomes: Upon successful completion of this course, students should be able to:

- Participatory definition of breeding objectives
- Understand selection theory and breeding methods;

- Understand tools available to maximize response to genetic selection;
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation;
- Optimize selection and mating decisions;
- Estimate genetic parameters and breeding values; and
- Understanding the concept of alternative breeding programs.

Mode of Delivery:

Lecture, discussions, assignment, practical sessions based on filed data and field visits to livestock farms including livestock research centers and community-based breeding program villages.

Teaching Aids:

Reference books, handouts, animal farms, teaching videos.

Course Contents:

1. Introduction
   - 1.1. Definition and history of animal breeding
   - 1.2. Goals of animal breeding
   - 1.3. Overview of animal breeding industries
     - 1.3.1. Value of improvement
     - 1.3.2. Role of the government
   - 1.4. Contribution of animal breeding to livestock and poultry improvement
   - 1.5. Genetic vs. environmental improvement
2. Categories of Traits in Livestock and Poultry
   - 2.1. Qualitative traits
   - 2.2. Quantitative traits
   - 2.3. Threshold traits
   - 2.4. Component traits
   - 2.5. Economically important traits: description, measurement and inheritance
     - 2.5.1. Growth, feed efficiency and carcass traits
     - 2.5.2. Milk production and composition traits
     - 2.5.3. Reproduction and survival traits
     - 2.5.4. Type and conformation traits
     - 2.5.5. Egg production traits (quantitative and qualitative)
     - 2.5.6. Other Traits (wool, pelt, ...)
3. Quantitative Effects of Genes in Populations
   - 3.1. Genetic and environmental effects
   - 3.2. Genetic components of variance
   - 3.3. Additive variance

3.4. Dominance variance
    3.4.1. Epistatic variance
3.5. Environmental components of variance
3.6. Resemblance between relatives
    3.6.1. Phenotypic resemblance
    3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)
3.7. Heritability and repeatability
    3.7.1. Concepts and usefulness of heritability
    3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)
    3.7.3. Repeatability
    3.7.4. Basic concepts
    3.7.5. Heritability vs repeatability
3.8. Correlations (phenotypic, genetic and environmental correlations)

4. Selection
    4.1. Natural vs. artificial selection
    4.2. Classification of selection
        4.2.1. Individual (mass / phenotypic) selection
        4.2.2. Selection based on performance of relatives
        4.2.3. Family selection
        4.2.4. Sib selection
        4.2.5. Selection on progeny performance
    4.3. Methods of selection
        4.3.1. Tandom method of selection
        4.3.2. Independent culling level
        4.3.3. Total score or selection index method
    4.4. Response to selection and prediction of genetic gain
        4.4.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)
        4.4.2. Correlated response to selection

5. Mating Systems
    5.1. Inbreeding and line breeding
        5.1.1. Classification of mating systems
            5.1.1.1. Random mating (panmixia)
            5.1.1.2. Non-random mating
            5.1.1.3. Mating based on phenotypic relationship
            5.1.1.4. Mating based on degree of genetic/pedigree relationship
        5.1.2. Inbreeding
        5.1.3. Genetic consequences of inbreeding
        5.1.4. Measurement of inbreeding and relationship coefficients

5.2. Line breeding

5.3. Outbreeding and heterosis

5.3.1. Genetic effects of outbreeding

5.3.2. Phenotypic effects of outbreeding: hybrid vigor

5.3.3. Types and measurements of heterosis

5.4. Systems of crossbreeding

5.4.1. Uses of crossbreeding

5.4.2. Two-, three-, four-breed crossing

5.4.3. Terminal crossbreeding

5.4.4. Rotational crossbreeding

5.4.5. Grading-up

5.4.6. Species hybridization

6. Genotype by Environment Interaction

6.1. Classification of G x E interaction

6.2. Extent of G x E interactions

6.3. Examples of G x E interaction

7. Animal Evaluation and Computation of Breeding Values (BVs)

7.1. Station vs field test/evaluation

7.2. Performance testing

7.3. Progeny testing

7.4. Why compute BV?

7.5. Different criteria used for predicting BV

7.5.1. Individual's own performance (single and repeated records)

7.5.2. Pedigree performance

7.5.3. Family performance

7.5.4. Performance of sibs

7.5.5. Performance of progeny

8. Breeding Structures and schemes

8.1. Closed nucleus breeding scheme

8.2. Open nucleus breeding scheme

8.3. Community Based Breeding Program

8.3.1. Concepts of CBBP and Applications

8.3.2. Components and steps in setting CBBPs in villages

8.4. Group breeding scheme

8.5. Sire referencing scheme

8.6. Comparison of CBBP and Hierarchical Breeding program

9. Animal Genetic Resources (AnGR) and Conservation

9.1. Characterization of Indigenous livestock

9.2. Breed and species diversity

9.3. Global breed risk status

9.4. Causes of loss of AnGR
9.5. Why conserve genetic diversity: rational for conservation
9.6. Methods of conservation

Practical:

- Pedigreed and phenotypic data [performance and linear body measurement data collection] generation and analyses from CBBP villages
- Estimation of variance components
  - Phenotypic
  - genetic and
  - environmental
- Heritability and repeatability
- Coefficient of inbreeding and relationship •
- Practical application of methods for genetic evaluation
- Estimation of breeding value

Assessment:

- Practical/lab/field report work and report 25%
- Quizzes and assignment 20%
- Mid exam 20%
- Final exam 35%

References

1. Bourdon, Richard M. (2000) Understanding Animal Breeding
2. Daniel L. Hart and Andrew G. Clark (1997). Principles of Population Genetics
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College of Agricultural Sciences

Department of Animal Science

Amendment of harmonized curriculum of Animal breeding (ANSC 311) (incorporation of Community Based Breeding Program CBBP))

Background

Community Based Breeding Program is an alternative Breeding Strategy in small holder and resource poor farmers' flock. The program was initiated in 2010 in four sites and now extended more than 100 sites. The increase in farmers' income has reached up to 20% that has triggered to upscale and out scale CBBP initiatives. Ensuring sustainability of CBBP is a critical issue. One of the strategies to ensuring sustainability of CBBP is integration of CBBP in the curriculum. The integration of CBBP has also added advantages that included graduating students will implement the program right away in their assignment as extension and research staff. Graduates can create knowledge based jobs. International Center for Agricultural Research in Dry Areas (ICARDA) took the initiative and consulted Ethiopian Universities in the integration of CBBP in the undergraduate Animal Science Program. The first workshop was organized on July, 20, 2021 and the second workshop was organized on July 27, 2021 with theme '' **Scaling up Community Based Breeding Programs through Ethiopian Universities''.** Representatives from ten federal Universities were involved in the first workshop. In the second workshop, 11 federal state Universities were involve. The representatives were Animal Breeders and University community service officers, which can implement CBBP in their respective Universities. The workshop formed a committee to amend a curriculum with CBBP practices in Animal Breeding course. Based on the recommendations of the workshop amendment of the curriculum was made as follows.

Course clusters: Animal Breeding and Breed Improvement

- Animal Genetics
- Reproductive physiology and Artificial Insemination

Wachemo University
Faculty of Agricultural Sciences

- Animal Breeding
- Animal Biotechnology
- Table 1: List of core courses

Sr/N	Course Name	Cr.HR	ECTS
1	Anatomy and Physiology of Farm Animals	3	5
2	Fishery and Aquaculture	3	5
3	Swine Production and Management	2	3
4	**Principle of Genetics**	**3**	**5**
5	Principle of Animal Nutrition	3	5
6	Sheep and Goat Production and Management	3	5
7	Forage and Pasture Production and Management	3	5
8	Camel Production and Management	2	3
9	**Animal Breeding**	**3**	**5**
10	**Reproductive Physiology and Artificial Insemination**	**2**	**3**
11	Applied Animal Nutrition	4	6
12	Poultry Production and Hatchery Management	4	6
13	Dairy Cattle Production and Management	3	5
14	Practical in Animal Science I	1	2
15	Beef Cattle Production and Management	3	5
16	Equine Production and Draft Animals Management	3	5
17	Biometry	3	5
18	Research Methods in Animal Sciences	2	3
19	**Animal Biotechnology**	**3**	**5**
20	Range Ecology and Management	3	5
21	Veterinary Parasitology	2	3
22	Practical in Animal Science II	1	2
23	Practical Attachment	2	3
24	Apiculture	3	5
25	Sericulture	2	3
26	Animal Behavior and Welfare	2	3
27	Hide and Skin Processing	2	3
28	Animal Health and Disease Control	3	5
29	Senior Seminar	1	2
30	Food Hygiene and Veterinary Public Health	2	3
31	Livestock Products Processing Technology	3	5
32	Senior Research Project	2	3

Course Title: Animal Breeding

Course Code: AnSc 311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of Genetics

Course Category: Core

Course Description:

This course deals with the historical back ground of animal breeding; characterization of indigenous livestock/poultry/, alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, definition of breeding objectives and identification of economically important traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; estimating breeding values and genetic parameters including heritability, genetic correlation and repeatability; the bases of establishing breeding programs, types of selection, Mating systems (inbreeding and crossbreeding); hybrid vigor and inbreeding depression and principles and methods of conservation of animal genetic resources;

Learning Outcomes: Upon successful completion of this course, students should be able to:

- Define breeding objectives in participatory way
- Understand selection theory and breeding methods
- Understand tools available to maximize response to genetic selection;
- Predict the rate of genetic improvement
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation
- Optimize selection and mating decisions
- Estimate genetic parameters and breeding values

Mode of Delivery:

- Lecture, discussions, assignment, practical sessions based on filed data and field visits to livestock farms including livestock research **centers** and community-based breeding program villages.

Teaching Aids:

- Reference books, handouts, animal farms, teaching videos

Course Contents:

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    2.5.2. Milk production and composition traits
    2.5.3. Reproduction and survival traits
    2.5.4. Type and conformation traits
    2.5.5. Egg production traits (quantitative and qualitative)
    2.5.6. Other Traits (wool, pelt, …)

3. Quantitative Effects of Genes in Populations
    3.1.Genetic and environmental effects
    3.2.Genetic components of variance
    3.3.Additive variance
    3.4.Dominance variance
        3.4.1. Epistatic variance
    3.5.Environmental components of variance
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        3.6.1. Phenotypic resemblance
        3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)
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        3.7.1. Concepts and usefulness of heritability
        3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)
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        3.7.5. Heritability vs repeatability
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    4.2.Classification of selection
        4.2.1. Individual (mass / phenotypic) selection
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        4.2.3. Family selection
        4.2.4. Sib selection
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    4.3.Methods of selection
        4.3.1. Tandem method of selection
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    4.4.Response to selection and prediction of genetic gain
        4.4.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)
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5.1.1.4.Mating based on degree of genetic/pedigree relationship
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5.1.3. Genetic consequences of inbreeding
5.1.4. Measurement of inbreeding and relationship coefficients
5.2. Line breeding
5.3.Outbreeding and heterosis
5.3.1. Genetic effects of outbreeding
5.3.2. Phenotypic effects of outbreeding: hybrid vigor
5.3.3. Types and measurements of heterosis
5.4.Systems of crossbreeding
5.4.1. Uses of crossbreeding
5.4.2. Two-, three-, four-breed crossing
5.4.3. Terminal crossbreeding
5.4.4. Rotational crossbreeding
5.4.5. Grading-up
5.4.6. Species hybridization

6. Genotype by Environment Interaction
6.1.Classification of G x E interaction
6.2.Extent of G x E interactions
6.3.Examples of G x E interaction

7. Animal Evaluation and Computation of Breeding Values (BVs)
7.1. Station vs field test/evaluation
7.2.Performance testing
7.3.Progeny testing
7.4.Why compute BV?
7.5.Different criteria used for predicting BV
7.5.1. Individual's own performance (single and repeated records)
7.5.2. Pedigree performance
7.5.3. Family performance
7.5.4. Performance of sibs
7.5.5. Performance of progeny

8. Breeding Industry Structure and schemes
8.1.Nucleus breeding schemes
8.1.1. Open nucleus breeding schemes
8.1.2. Closed nucleus breeding schemes
8.2.Community based breeding programs (CBBP)
8.2.1. Concepts of CBBP and applications
8.2.2. Components and steps in setting CBBP Ivillages
8.3.Group breeding schemes
8.4.Sire referencing scheme
8.5.Comparison of CBBP and hierarchal breeding program

9. Animal Genetic Resources (AnGR) and Conservation
    9.1.Characterization of livestock
    9.2.Breed and species diversity
    9.3.Global breed risk status
    9.4.Causes of loss of AnGR
    9.5.Why conserve genetic diversity: rational for conservation
    9.6.Methods of conservation

Practical:

- Pedigreed and phenotypic data [performance and linear body measurement data collection] generation and analyses from CBBP villages
- Estimation of variance components
    - Phenotypic
    - genetic and
    - environmental
- Heritability and repeatability
- Coefficient of inbreeding and relationship
- Practical application of methods for genetic evaluation
- Estimation of breeding value

Assessment:

- Practical/lab/field report work and report 25%
- Quizzes and assignment 20%
- Mid exam 20%
- Final exam 35%

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Werabe University

College of Agriculture and Natural Resource

Department of Animal Science

Integrating Community Based Breeding Program (CBBP) in Undergraduate Curriculum: Animal Sciences

Background

Community Based Breeding Program is an alternative Breeding Strategy in small holder and resource poor farmers' flock. The program was initiated in 2010 in four sites and now extended to more than 100 sites. The increase in farmers' income has reached up to 20% that has triggered to upscale and out scale CBBP initiatives. Ensuring sustainability of CBBP is a critical issue. One of the strategies to ensuring sustainability of CBBP is integration of CBBP in the curriculum. The integration of CBBP in a curriculum has also added advantages that, graduating students will implement the program right away in their assignment as extension and research staff. Graduates can create knowledge based jobs. International Center for Agricultural Research in Dry Areas (ICARDA) took the initiative and consulted Ethiopian Universities in the integration of CBBP in the undergraduate Animal Science Program. The first workshop was organized on July, 20, 2021 and the second workshop was organized on July 27, 2021 with theme '' **Scaling up Community Based Breeding Programs through Ethiopian Universities''.** Representatives from ten federal Universities were involved in the first workshop. In the second workshop, 11 federal state Universities were involved. The representatives were Animal Breeders and University community service directors, which can implement CBBP in their respective Universities. The workshop formed a committee to amend a curriculum with CBBP practices in Animal Breeding course. Based on the recommendations of the workshop, amendment of the curriculum was made as described below and highlighted by yellow colour for a wider circulation and comments. Universities are expected to implement the CBBP initiatives.

Course clusters: Animal Breeding and Breed Improvement

- Animal Genetics
- Reproductive physiology and Artificial Insemination
- Animal Breeding
- Animal Biotechnology

Table 1: List of core courses

Sr/N	Course Name	Cr.HR	ECTS
1	Anatomy and Physiology of Farm Animals	3	5
2	Fishery and Aquaculture	3	5
3	Swine Production and Management	2	3
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5	Principle of Animal Nutrition	3	5
6	Sheep and Goat Production and Management	3	5
7	Forage and Pasture Production and Management	3	5
8	Camel Production and Management	2	3
9	**Animal Breeding**	**3**	**5**
10	Reproductive Physiology and Artificial Insemination	2	3
11	Applied Animal Nutrition	4	6
12	Poultry Production and Management	4	6
13	Dairy Cattle Production and Management	3	5
14	Practical in Animal Science I	1	2
15	Beef Cattle Production and Management	3	5
16	Equine Production and Draft Animals Management	3	5
17	Biometry	3	5
18	Research Methods in Animal Sciences	2	3
19	**Animal Biotechnology**	**3**	**5**
20	Range Ecology and Management	3	5
21	Veterinary Parasitology	2	3
22	Practical in Animal Science II	1	2

23	Practical Attachment	2	3
24	Apiculture	3	5
25	Sericulture	2	3
26	Animal Behavior and Welfare	2	3
27	Hide and Skin Processing	2	3
28	Animal Health and Disease Control	3	5
29	Senior Seminar	1	2
30	Food Hygiene and Veterinary Public Health	2	3
31	Livestock Products Processing Technology	3	5
32	Senior Research Project	2	3

Course Title: Animal Breeding

Course Code: AnSc 311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of Genetics

Course Category: Core

Course Description:

This course deals with the historical back ground of animal breeding; characterization of indigenous livestock/poultry/, alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, definition of breeding objectives and identification of economically important traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; estimating breeding values and genetic parameters including heritability, genetic correlation and repeatability; the bases of establishing breeding programs, types of selection, Mating systems (inbreeding and crossbreeding); hybrid vigor and inbreeding depression and principles and methods of conservation of animal genetic resources;

Learning Outcomes: Upon successful completion of this course, students should be able to:

- Participatory definition of breeding objectives
- Understand selection theory and breeding methods;
- Understand tools available to maximize response to genetic selection;
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation;

- Optimize selection and mating decisions;
- Estimate genetic parameters and breeding values; and
- Understanding the concept of alternative breeding programs.

Mode of Delivery:

Lecture, discussions, assignment, practical sessions based on filed data and field visits to livestock farms including livestock research centers and community-based breeding program villages.

Teaching Aids:

Reference books, handouts, animal farms, teaching videos.

Course Contents:

1. Introduction
   - 1.1 Definition and history of animal breeding
   - 1.2 Goals of animal breeding
   - 1.3 Overview of animal breeding industries
     - 1.3.1. Value of improvement
     - 1.3.2. Role of the government
   - 1.4. Contribution of animal breeding to livestock and poultry improvement
   - 1.5. Genetic vs. environmental improvement
2. Categories of Traits in Livestock and Poultry
   - 2.1 Qualitative traits
   - 2.2. Quantitative traits
   - 2.3. Threshold traits
   - 2.4 Component traits
   - 2.5. Economically important traits: description, measurement and inheritance
     - 2.5.1. Growth, feed efficiency and carcass traits
     - 2.5.2. Milk production and composition traits
     - 2.5.3. Reproduction and survival traits
     - 2.5.4. Type and conformation traits
     - 2.5.5. Egg production traits (quantitative and qualitative)
     - 2.5.6. Other Traits (wool, pelt, …)
3. Quantitative Effects of Genes in Populations

3.1. Genetic and environmental effects

3.2. Genetic components of variance

3.3. Additive variance

3.4. Dominance variance

3.4.1. Epistatic variance

3.5. Environmental components of variance

3.6. Resemblance between relatives

3.6.1. Phenotypic resemblance

3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)

3.7. Heritability and repeatability

3.7.1. Concepts and usefulness of heritability

3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)

3.7.3. Repeatability

3.7.4. Basic concepts

3.7.5. Heritability vs repeatability

3.8. Correlations (phenotypic, genetic and environmental correlations)

4. Selection

4.1. Natural vs. artificial selection

4.2. Classification of selection

4.2.1. Individual (mass / phenotypic) selection

4.2.2. Selection based on performance of relatives

4.2.3. Family selection

4.2.4. Sib selection

4.2.5. Selection on progeny performance

4.3. Methods of selection

4.3.1. Tandom method of selection

4.3.2. Independent culling level

4.3.3. Total score or selection index method

4.4. Response to selection and prediction of genetic gain

4.4.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)

4.4.2. Correlated response to selection

5. Mating Systems

5.1. Inbreeding and line breeding

5.1.1. Classification of mating systems

5.1.1.1. Random mating (panmixia)

5.1.1.2. Non-random mating

5.1.1.3. Mating based on phenotypic relationship

5.1.1.4. Mating based on degree of genetic/pedigree relationship

5.1.2. Inbreeding

5.1.3. Genetic consequences of inbreeding

5.1.4. Measurement of inbreeding and relationship coefficients

5.2. Line breeding

5.3. Outbreeding and heterosis

5.3.1. Genetic effects of outbreeding

5.3.2. Phenotypic effects of outbreeding: hybrid vigor

5.3.3. Types and measurements of heterosis

5.4. Systems of crossbreeding

5.4.1. Uses of crossbreeding

5.4.2. Two-, three-, four-breed crossing

5.4.3. Terminal crossbreeding

5.4.4. Rotational crossbreeding

5.4.5. Grading-up

5.4.6. Species hybridization

6. Genotype by Environment Interaction

6.1. Classification of G x E interaction

6.2. Extent of G x E interactions

6.3. Examples of G x E interaction

7. Animal Evaluation and Computation of Breeding Values (BVs)

7.1. Station vs field test/evaluation

7.2. Performance testing

7.3. Progeny testing

7.4. Why compute BV?

7.5. Different criteria used for predicting BV

7.5.1. Individual's own performance (single and repeated records)

7.5.2. Pedigree performance

7.5.3. Family performance

7.5.4. Performance of sibs

7.5.5. Performance of progeny

8. Breeding Structures and schemes

8.1.Closed nucleus breeding scheme

8.2. Open nucleus breeding scheme

8.3.Community Based Breeding Program

8.3.1. Concepts of CBBP and Applications

8.3.2. Components and steps in setting CBBPs in villages

8.4.Group breeding scheme

8.5.Sire referencing scheme

8.6.Comparison of CBBP and Hierarchical Breeding program

9. Animal Genetic Resources (AnGR) and Conservation

9.1.Characterization of indigenous livestock

9.2.Breed and species diversity

9.3.Global breed risk status

9.4.Causes of loss of AnGR

9.5.Why conserve genetic diversity: rational for conservation

9.6.Methods of conservation

Practical:

- Pedigreed and phenotypic data [performance and linear body measurement data collection] generation and analyses from CBBP villages
- Estimation of variance components
  - Phenotypic
  - genetic and
  - environmental
- Heritability and repeatability
- Coefficient of inbreeding and relationship
- Practical application of methods for genetic evaluation
- Estimation of breeding value

Assessment:

- Practical/lab/field report work and report 25%
- Quizzes and assignment 20%
- Mid exam 20%
- Final exam 35%

References

1. Bourdon, Richard M. (2000) Understanding Animal Breeding
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3. Falconer D.S. (1989). Introduction to Quantitative Genetics. 3rd ed.
4. Gerald Wiener (1994). Animal Breeding
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7. Haile A., Wurzinger M., Mueller J., Mirkena T., Duguma G., Rekik M., Mwacharo J., Mwai O., Sölkner J. and Rischkowsky B. 2018. Guidelines for Setting Up community-based small ruminants breeding programs in Ethiopia. ICARDA—Tools and guidelines No.1. Beirut, Lebanon: ICARDA.

Haramaya University

College of Agriculture and Environmental Sciences

Program: Animal Science

Revised (Community Based Breeding Program (CBBP)) Integrated in the Undergraduate HarmonizedCurriculum in the Animal Breeding Course (AnSc 311)

Background

Community Based Breeding Program is an alternative Breeding Strategy in small holder and resource poor farmers' flock. The program was initiated in 2010 in four sites and now extended to more than 100 sites. The increase in farmers' income has reached up to 20% that has triggered to upscale and out scale CBBP initiatives. Ensuring sustainability of CBBP is a critical issue. One of the strategies to ensuring sustainability of CBBP is integration of CBBP in the curriculum. The integration of CBBP in a curriculum has also added advantages that, graduating students will implement the program right away in their assignment as extension and research staff. Graduates can create knowledge-based jobs. International Center for Agricultural Research in Dry Areas (ICARDA) took the initiative and consulted Ethiopian Universities in the integration of CBBP in the undergraduate Animal Science Program. The first workshop was organized on July, 20, 2021 and the second workshop was organized on July 27, 2021 with theme ''**Scaling up Community Based Breeding Programs through Ethiopian Universities''.** Representativesfrom ten federal Universities were involved in the first workshop.In the second workshop, 11 federal state Universities were involved. The representatives were Animal Breeders and University community service directors, which can implement CBBP in their respective Universities. Theworkshop formed a committee to amend a curriculum with CBBP practices in Animal Breeding course. Based on the recommendations of the workshop, amendment of the curriculum was made as described below and highlighted by yellow colour for a wider circulation and comments. Universities are expected to implement the CBBP initiatives.

Hirut Yirga (PhD)

Course clusters: Animal Breeding and Breed Improvement

- Animal Genetics
- Reproductive physiology and Artificial Insemination
- **Animal Breeding**
- Animal Biotechnology

Table 1: List of core courses

Sr/N	Course Name	Cr.HR	ECTS
1	Anatomy and Physiology of Farm Animals	3	5
2	Fishery and Aquaculture	3	5
3	Swine Production and Management	2	3
4	**Principle of Genetics**	**3**	**5**
5	Principle of Animal Nutrition	3	5
6	Sheep and Goat Production and Management	3	5
7	Forage and Pasture Production and Management	3	5
8	Camel Production and Management	2	3
9	**Animal Breeding**	**3**	**5**
10	Reproductive Physiology and Artificial Insemination	2	3
11	Applied Animal Nutrition	4	6
12	Poultry Production and Hatchery Management	4	6
13	Dairy Cattle Production and Management	3	5
14	Practical in Animal Science I	1	2
15	Beef Cattle Production and Management	3	5
16	Equine Production and Draft Animals Management	3	5
17	Biometry	3	5
18	Research Methods in Animal Sciences	2	3
19	**Animal Biotechnology**	**3**	**5**
20	Range Ecology and Management	3	5
21	Veterinary Parasitology	2	3
22	Practical in Animal Science II	1	2
23	Practical Attachment	2	3
24	Apiculture	3	5
25	Sericulture	2	3
26	Animal Behavior and Welfare	2	3
27	Hide and Skin Processing	2	3
28	Animal Health and Disease Control	3	5
29	Senior Seminar	1	2
30	Food Hygiene and Veterinary Public Health	2	3
31	Livestock Products Processing Technology	3	5
32	Senior Research Project	2	3

Hirut Yirga (PhD)

Course Title: Animal Breeding

Course Code: AnSc 311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of Genetics

Course Category: Core

Course Description:

This course deals with the historical back ground of animal breeding; characterization of indigenous livestock/poultry/, alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, definition of breeding objectives and identification of economically important traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; estimating breeding values and genetic parameters including heritability, genetic correlation and repeatability; the bases of establishing breeding programs, types of selection, Mating systems (inbreeding and crossbreeding); hybrid vigor and inbreeding depression and principles and methods of conservation of animal genetic resources;

Learning Outcomes: Upon successful completion of this course, students should be able to:

- Participatory definition of breeding objectives
- Understand selection theory and breeding methods;
- Understand tools available to maximize response to genetic selection;
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation;
- Optimize selection and mating decisions;
- Estimate genetic parameters and breeding values; and
- Understanding the concept of alternative breeding programs.
- Understanding breeding schemes
- Elaborate about the community-based breeding Program

Mode of Delivery:

Lecture, discussions, assignment, practical sessions based on filed data and field visits to livestock farms including livestock research centersand community-based breeding program villages.

Teaching Aids:

Reference books, handouts, animal farms, teaching videos.

Hirut Yirga (PhD)

Course Contents:

1. Introduction
   - 1.1. Definition and history of animal breeding
   - 1.2. Goals of animal breeding
   - 1.3. Overview of animal breeding industries
     - 1.3.1. Value of improvement
     - 1.3.2. Role of the government
   - 1.4. Contribution of animal breeding to livestock and poultry improvement
   - 1.5. Genetic vs. environmental improvement
2. Categories of Traits in Livestock and Poultry
   - 2.1. Qualitative traits
   - 2.2. Quantitative traits
   - 2.3. Threshold traits
   - 2.4. Component traits
   - 2.5. Economically important traits: description, measurement and inheritance
     - 2.5.1. Growth, feed efficiency and carcass traits
     - 2.5.2. Milk production and composition traits
     - 2.5.3. Reproduction and survival traits
     - 2.5.4. Type and conformation traits
     - 2.5.5. Egg production traits (quantitative and qualitative)
     - 2.5.6. Other Traits (wool, pelt, …)
3. Quantitative Effects of Genes in Populations
   - 3.1. Genetic and environmental effects
   - 3.2. Genetic components of variance
   - 3.3. Additive variance
   - 3.4. Dominance variance
     - 3.4.1. Epistatic variance
   - 3.5. Environmental components of variance
   - 3.6. Resemblance between relatives
     - 3.6.1. Phenotypic resemblance
     - 3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)
   - 3.7. Heritability and repeatability
     - 3.7.1. Concepts and usefulness of heritability
     - 3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)
     - 3.7.3. Repeatability
     - 3.7.4. Basic concepts
     - 3.7.5. Heritability vs repeatability
   - 3.8. Correlations (phenotypic, genetic and environmental correlations)
4. Selection
   - 4.1. Natural vs. artificial selection
   - 4.2. Classification of selection
     - 4.2.1. Individual (mass / phenotypic) selection

Hirut Yirga (PhD)
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4.2.2. Selection based on performance of relatives
4.2.3. Family selection
4.2.4. Sib selection
4.2.5. Selection on progeny performance

4.3. Methods of selection
4.3.1. Tandem method of selection
4.3.2. Independent culling level
4.3.3. Total score or selection index method

4.4. Response to selection and prediction of genetic gain
4.4.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)
4.4.2. Correlated response to selection

5. Mating Systems
5.1. Inbreeding and line breeding
5.1.1. Classification of mating systems
5.1.1.1. Random mating (panmixia)
5.1.1.2. Non-random mating
5.1.1.3. Mating based on phenotypic relationship
5.1.1.4. Mating based on degree of genetic/pedigree relationship
5.1.2. Inbreeding
5.1.3. Genetic consequences of inbreeding
5.1.4. Measurement of inbreeding and relationship coefficients
5.2. Line breeding
5.3. Outbreeding and heterosis
5.3.1. Genetic effects of outbreeding
5.3.2. Phenotypic effects of outbreeding: hybrid vigor
5.3.3. Types and measurements of heterosis
5.4. Systems of crossbreeding
5.4.1. Uses of crossbreeding
5.4.2. Two-, three-, four-breed crossing
5.4.3. Terminal crossbreeding
5.4.4. Rotational crossbreeding
5.4.5. Grading-up
5.4.6. Species hybridization

6. Genotype by Environment Interaction
6.1. Classification of G x E interaction
6.2. Extent of G x E interactions
6.3. Examples of G x E interaction

7. Animal Evaluation and Computation of Breeding Values (BVs)
7.1. Station vs field test/evaluation
7.2. Performance testing
7.3. Progeny testing
7.4. Why compute BV?
7.5. Different criteria used for predicting BV

7.5.1. Individual's own performance (single and repeated records)
7.5.2. Pedigree performance
7.5.3. Family performance
7.5.4. Performance of sibs
7.5.5. Performance of progeny

8. Breeding Structures and schemes
   8.1. Definition of breeding Structure
   8.2. Breeding Schemes
      8.2.1. Closed nucleus breeding scheme
      8.2.2. Open nucleus breeding scheme
   8.3. Community Based Breeding Program
      8.3.1. Concepts of CBBP and Applications
      8.3.2. Prerequisites and Enabling environments for CBBPs
      8.3.3. Components and steps in setting CBBPs in villages
   8.4. Group breeding scheme
   8.5. Sire referencing scheme
   8.6. Comparison of CBBP and Hierarchical Breeding program
   8.7. Case studies in CBBPs
9. Animal Genetic Resources (AnGR) and Conservation and management
   9.1. Characterization of Indigenous livestock and poultry
   9.2. Breed and species diversity
   9.3. Global breed risk status
   9.4. Causes of loss of AnGR
   9.5. Why conserve genetic diversity: rational for conservation
   9.6. Methods of conservation

Practical:

- Pedigreed and phenotypic data [performance and linear body measurement data collection] generation and analyses from CBBP villages
- Estimation of variance components
  - Phenotypic
  - genetic and
  - environmental
- Heritability and repeatability
- Coefficient of inbreeding and relationship •
- Practical application of methods for genetic evaluation
- Estimation of breeding value

Assessment:

- Practical/lab/field report work and report 25%
- Quizzes and assignment 20%
- Mid exam 20%
- Final exam 35%

Hirut Yirga (PhD)
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References

1. Bourdon, Richard M. (2000) Understanding Animal Breeding
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Wolkite University
College of Agriculture and Natural Resource
Department of Animal Science
Integrating Community Based Breeding Program (CBBP) in Undergraduate Curriculum: Animal Sciences

Background

Community Based Breeding Program is an alternative Breeding Strategy in small holder and resource poor farmers' flock. The program was initiated in 2010 in four sites and now extended to more than 100 sites. The increase in farmers' income has reached up to 20% that has triggered to upscale and out scale CBBP initiatives. Ensuring sustainability of CBBP is a critical issue. One of the strategies to ensuring sustainability of CBBP is integration of CBBP in the curriculum. The integration of CBBP in a curriculum has also added advantages that, graduating students will implement the program right away in their assignment as extension and research staff. Graduates can create knowledge based jobs. International Center for Agricultural Research in Dry Areas (ICARDA) took the initiative and consulted Ethiopian Universities in the integration of CBBP in the undergraduate Animal Science Program. The first workshop was organized on July, 20, 2021 and the second workshop was organized on July 27, 2021 with theme " **Scaling up Community Based Breeding Programs through Ethiopian Universities**". Representatives from ten federal Universities were involved in the first workshop. In the second workshop, 11 federal state Universities were involved. The representatives were Animal Breeders and University community service directors, which can implement CBBP in their respective Universities. The workshop formed a committee to amend a curriculum with CBBP practices in Animal Breeding course. Based on the recommendations of the workshop, amendment of the curriculum was made as described below and highlighted by yellow colour for a wider circulation and comments. Universities are expected to implement the CBBP initiatives.

What is required to enter into action and report the integration of CBBP in the curriculum?

- Course Team of Animal breeding and genetics review the proposed curriculum amendment and submit to the head of department with recommendations.
- The department council, chaired by the head of department approves the amendment supported by a minutes
- A cover letter and the approved course amendment (Course description, course outline and later on course material) with University logo passed to Animal breeding and genetics course team for implementation. The same cover letter and course amendment with stamped copy and logo sent to ICARDA.

- Documentation of the amendment and minutes in head department office and make a follow up of the implementation
- Final date of submission End of August 2021.

Course clusters: Animal Breeding and Breed Improvement

- Animal Genetics
- Reproductive physiology and Artificial Insemination
- **Animal Breeding**
- Animal Biotechnology

Table 1: List of core courses

Sr/N	Course Name	Cr.HR	ECTS
1	Anatomy and Physiology of Farm Animals	3	5
2	Fishery and Aquaculture	3	5
3	Swine Production and Management	2	3
4	**Principle of Genetics**	**3**	**5**
5	Principle of Animal Nutrition	3	5
6	Sheep and Goat Production and Management	3	5
7	Forage and Pasture Production and Management	3	5
8	Camel Production and Management	2	3
9	**Animal Breeding**	**3**	**5**
10	Reproductive Physiology and Artificial Insemination	2	3
11	Applied Animal Nutrition	4	6
12	Poultry Production and Hatchery Management	4	6
13	Dairy Cattle Production and Management	3	5
14	Practical in Animal Science I	1	2
15	Beef Cattle Production and Management	3	5
16	Equine Production and Draft Animals Management	3	5
17	Biometry	3	5
18	Research Methods in Animal Sciences	2	3
19	**Animal Biotechnology**	**3**	**5**
20	Range Ecology and Management	3	5
21	Veterinary Parasitology	2	3
22	Practical in Animal Science II	1	2
23	Practical Attachment	2	3
24	Apiculture	3	5
25	Sericulture	2	3
26	Animal Behavior and Welfare	2	3
27	Hide and Skin Processing	2	3
28	Animal Health and Disease Control	3	5
29	Senior Seminar	1	2
30	Food Hygiene and Veterinary Public Health	2	3
31	Livestock Products Processing Technology	3	5
32	Senior Research Project	2	3

Course Title: Animal Breeding

Course Code: AnSc 311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of Genetics

Course Category: Core

Course Description:

This course deals with the historical back ground of animal breeding; characterization of indigenous livestock/poultry/, alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, definition of breeding objectives and identification of economically important traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; estimating breeding values and genetic parameters including heritability, genetic correlation and repeatability; the bases of establishing breeding programs, types of selection, Mating systems (inbreeding and crossbreeding); hybrid vigor and inbreeding depression and principles and methods of conservation of animal genetic resources;

Learning Outcomes: Upon successful completion of this course, students should be able to:

- Participatory definition of breeding objectives
- Understand selection theory and breeding methods;
- Understand tools available to maximize response to genetic selection;
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation;
- Optimize selection and mating decisions;
- Estimate genetic parameters and breeding values; and
- Understanding the concept of alternative breeding programs.

Mode of Delivery:

Lecture, discussions, assignment, practical sessions based on filed data and field visits to livestock farms including livestock research centers and community-based breeding program villages.

Teaching Aids:

Reference books, handouts, animal farms, teaching videos.

Course Contents:

1. Introduction
   1.1. Definition and history of animal breeding
   1.2. Goals of animal breeding

1.3. Overview of animal breeding industries
    1.3.1. Value of improvement
    1.3.2. Role of the government
1.4. Contribution of animal breeding to livestock and poultry improvement
1.5. Genetic vs. environmental improvement

2. Categories of Traits in Livestock and Poultry
2.1. Qualitative traits
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2.3. Threshold traits
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    2.5.1. Growth, feed efficiency and carcass traits
    2.5.2. Milk production and composition traits
    2.5.3. Reproduction and survival traits
    2.5.4. Type and conformation traits
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    2.5.6. Other Traits (wool, pelt, ...)

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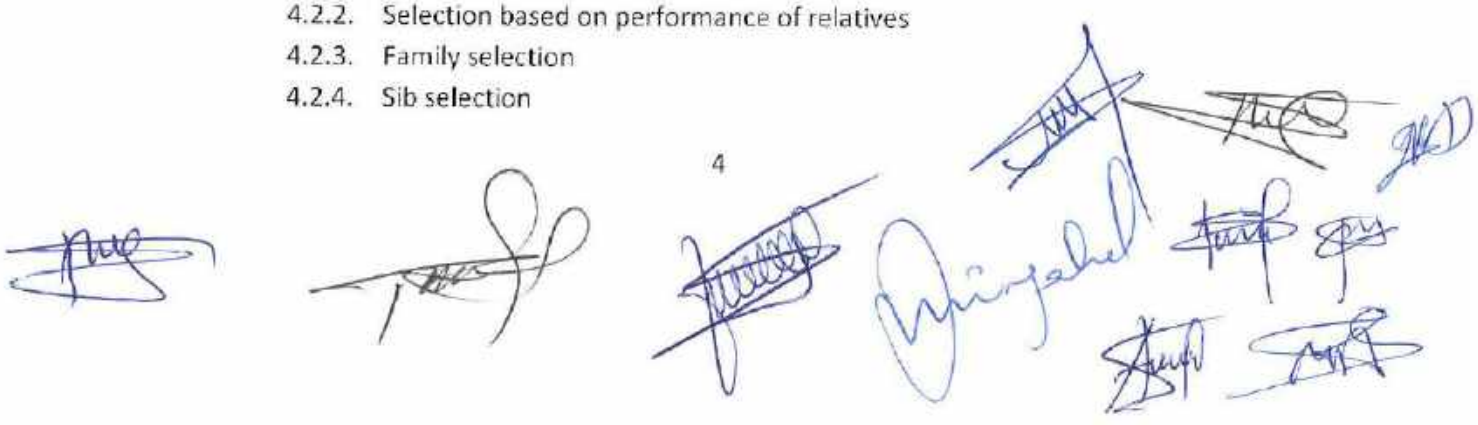
3.1. Genetic and environmental effects
3.2. Genetic components of variance
3.3. Additive variance
3.4. Dominance variance
    3.4.1. Epistatic variance
3.5. Environmental components of variance
3.6. Resemblance between relatives
    3.6.1. Phenotypic resemblance
    3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)
3.7. Heritability and repeatability
    3.7.1. Concepts and usefulness of heritability
    3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)
    3.7.3. Repeatability
    3.7.4. Basic concepts
    3.7.5. Heritability vs repeatability
3.8. Correlations (phenotypic, genetic and environmental correlations)

4. Selection
4.1. Natural vs. artificial selection
4.2. Classification of selection
    4.2.1. Individual (mass / phenotypic) selection
    4.2.2. Selection based on performance of relatives
    4.2.3. Family selection
    4.2.4. Sib selection



4.2.5. Selection on progeny performance

4.3. Methods of selection

4.3.1. Tandom method of selection

4.3.2. Independent culling level

4.3.3. Total score or selection index method

4.4. Response to selection and prediction of genetic gain

4.4.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)

4.4.2. Correlated response to selection

5. Mating Systems

5.1. Inbreeding and line breeding

5.1.1. Classification of mating systems

5.1.1.1. Random mating (panmixia)

5.1.1.2. Non-random mating

5.1.1.3. Mating based on phenotypic relationship

5.1.1.4. Mating based on degree of genetic/pedigree relationship

5.1.2. Inbreeding

5.1.3. Genetic consequences of inbreeding

5.1.4. Measurement of inbreeding and relationship coefficients

5.2. Line breeding

5.3. Outbreeding and heterosis

5.3.1. Genetic effects of outbreeding

5.3.2. Phenotypic effects of outbreeding: hybrid vigor

5.3.3. Types and measurements of heterosis

5.4. Systems of crossbreeding

5.4.1. Uses of crossbreeding

5.4.2. Two-, three-, four-breed crossing

5.4.3. Terminal crossbreeding

5.4.4. Rotational crossbreeding

5.4.5. Grading-up

5.4.6. Species hybridization

6. Genotype by Environment Interaction

6.1. Classification of G x E interaction

6.2. Extent of G x E interactions

6.3. Examples of G x E interaction

7. Animal Evaluation and Computation of Breeding Values (BVs)

7.1. Station vs field test/evaluation

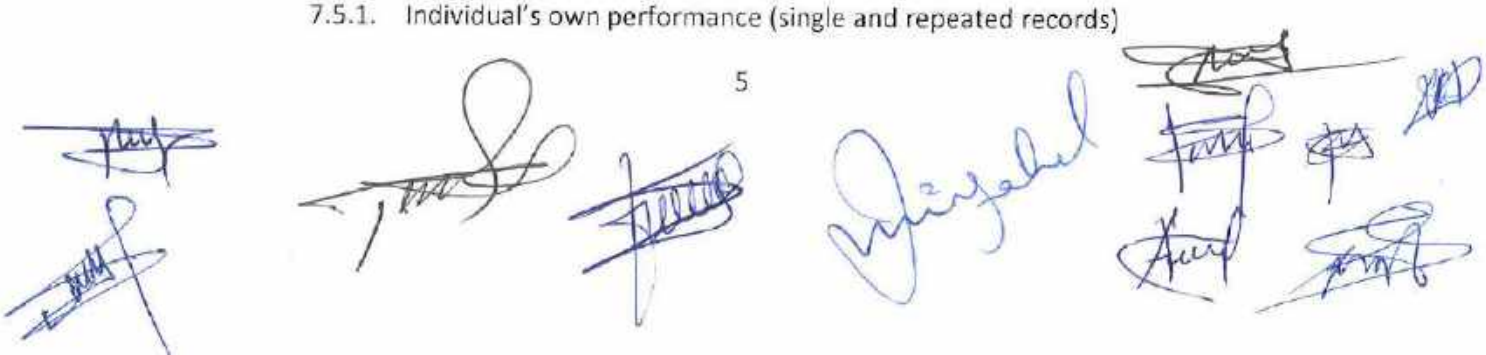
7.2. Performance testing

7.3. Progeny testing

7.4. Why compute BV?

7.5. Different criteria used for predicting BV

7.5.1. Individual's own performance (single and repeated records)



7.5.2. Pedigree performance
7.5.3. Family performance
7.5.4. Performance of sibs
7.5.5. Performance of progeny

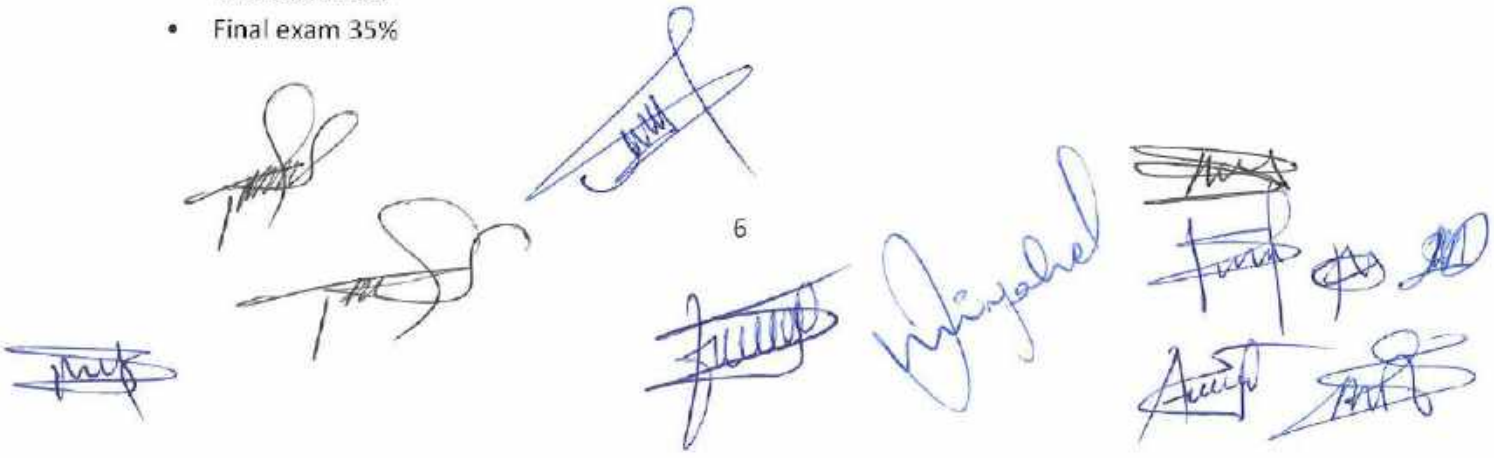
8. Breeding Structures and schemes
   8.1. Closed nucleus breeding scheme
   8.2. Open nucleus breeding scheme
   8.3. Community Based Breeding Program
      8.3.1. Concepts of CBBP and Applications
      8.3.2. Components and steps in setting CBBPs in villages
   8.4. Group breeding scheme
   8.5. Sire referencing scheme
   8.6. Comparison of CBBP and Hierarchical Breeding program
9. Animal Genetic Resources (AnGR) and Conservation
   9.1. Characterization of Indigenous livestock
   9.2. Breed and species diversity
   9.3. Global breed risk status
   9.4. Causes of loss of AnGR
   9.5. Why conserve genetic diversity: rational for conservation
   9.6. Methods of conservation

Practical:

- Pedigreed and phenotypic data [performance and linear body measurement data collection] generation and analyses from CBBP villages
- Estimation of variance components
  - Phenotypic
  - genetic and
  - environmental
- Heritability and repeatability
- Coefficient of inbreeding and relationship •
- Practical application of methods for genetic evaluation
- Estimation of breeding value

Assessment:

- Practical/lab/field report work and report 25%
- Quizzes and assignment 20%
- Mid exam 20%
- Final exam 35%



References

1. Bourdon, Richard M. (2000) Understanding Animal Breeding
2. Daniel L. Hart and Andrew G. Clark (1997). Principles of Population Genetics
3. Falconer D.S. (1989). Introduction to Quantitative Genetics. 3rd ed.
4. Gerald Wiener (1994). Animal Breeding
5. Malcolm, B. W. (1991). Dalton's Introduction to Practical Animal Breeding,
6. Michael L. and Bruce W. (1998). Genetics and Analysis of Quantitative Traits
7. Haile A., Wurzinger M., Mueller J., Mirkena T., Duguma G., Rekik M., Mwacharo J., Mwai O., Sölkner J. and Rischkowsky B. 2018. Guidelines for Setting Up community-based small ruminants breeding programs in Ethiopia. ICARDA—Tools and guidelines No.1. Beirut, Lebanon: ICARDA.

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ANIMAL SCIENCES DEPARTMENT

Ref. No.: DTU-AG/AnSc/ 241/2014

Date: 27/01/2014 E.C

To: College of Agricultural and Environmental Sciences

Debre Tabor University

Subject: To dispatch DAC Minute:

The Department of Animal Science accadamic council heled its regular meeting on 27/01/2014 E.C to incorporate the Community based breeding program in the harmonized curiculem. Per the meeting the department is dispatching the minute of the meeting attaching 10 pages as an appendex withis official letter.

"With Regards"

Welelaw Edmew Worku

Head Department of Animal Science

Cc// to:

- **College of Agricultural and Environmental Sciences RCC**
- Department of Animal Science

Debre Tabor University

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TIN 002 524 4653

Minute No: AnSc 02/2014

Date: 26/01/2014 E.C

Venue : Department office

Time: 2:00

Animal Science Department Academic Counsel Assembly

Participants of the Assembly:

1. Welelaw Edmew ---------- Department head, Chair person
2. Birhanu Yeserah ---------- Staff, secretary
3. Melese Dejen ---------- Staff, Member
4. Alubel Alemu ---------- Staff, Member
5. Mekuanint Bikis ---------- Staff, Member
6. Hirut Ketemaw ---------- Staff, Member
7. Mekuanint Gashaw ---------- Staff, Member
8. Rediet Mammo ---------- Staff, Member

Agenda: to incorporate CBBP in the harmonized curriculum!

Community-based breeding programs (CBBPs) so viable approach to improve the livelihoods smallholders. CBBPs aim to initiate systematic breeding at the community level, including an organized animal identification and recording of performance and pedigree data. To ensure the breeding programs' continuity and efficiency, building capacities is essential to the approach. Hence, the program should have to be incorporated in the curricula of higher education institutions in Animal science and related stream to equip students with necessary knowledge, skill and attitude towards Community Based Breeding Program. Having this in mind, ICARDA is motivating higher education institutions including Debre Tabor University to so. Accordingly, we are incorporating Community Based Breeding Program in the harmonized curriculum of Animal Science under two major courses i.e., Sheep and Goats Production & Management and Animal Breeding. The detail of the contents where Community Based Breeding Program is incorporate has been described as follows.

1. መኳንንት ጋሻው
2. ብርሃኑ የሰራህ
3. መለሰ ደጀን
4. መኳንንት ቢከስ
5. ረድኤት ማሞ
6. ወለላው አድመው
7. ጎኖት ከተማው
8. አሉበል አለሙ

1. Course Title: Sheep and Goats Production and Management

Course Code: AnSc 232

Course Credit Hour: 3 (2+1)

Course Pre-requisites: None

Course Category: Core

Course Description: The course intends to provide students with both theoretical knowledge and practical skills. It focuses on sheep and goat husbandry practices for understanding and analysing commercial and small scale small ruminant production with special reference to traditional production systems in Ethiopia. An overview of anatomy and physiology of sheep and goats shall be looked into; however, more attention should be given to the management aspects. In addition to theory, substantial amount of time should be alloted for the practical aspect of the course which can enable students to apply theoretical knowledge obtained in class.

Learning Outcomes:

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

- Have a clear image of domestication and distribution of sheep and goats;
- Get scientific and theoretical background of sheep and goats management leading to improved production and give professional advice;
- Develop keen interest in sheep and goats farming practices; and
- Advise and encourage farmers to involve in modern sheep and goat farming

Mode of Delivery: Lecture, discussions, assignment, demonstration and practical sessions

Teaching Aids:

Reference books, handouts, sheep and goat farms, teaching videos

Course Contents:

1. Introduction

    1.1. Common terminologies used in sheep and goat production

    1.2. Taxonomic classification of sheep and goat

    1.3. Origin and domestication of sheep and goats

    1.4. Geographical distribution

    1.5. Advantages of small ruminants over large ruminants

    1.6. Disadvantages of small ruminant keeping

2. Types and Breeds of Sheep and Goats
    2.1. Methods of sheep and goat classification
    2.2. Exotic breeds of sheep and goat breeds
    2.3. Types, breeds and common characteristics of Ethiopian sheep and goats
3. Sheep and Goat Production Systems in Ethiopia
    3.1. Highland sheep–barley system
    3.2. Mixed crop–livestock system
    3.3. Pastoral and agro-pastoral production systems
    3.4. Urban and peri-urban (landless) sheep and goat production system
    3.5. Ranching
4. Reproduction and Breeding of Sheep and Goats
    4.1. Reproductive system
    4.2. Hormones controlling reproduction
    4.3. Reproductive performance
    4.4. Reproductive behaviour
    4.5. Mating management and pregnancy testing
    4.6. Breeding systems employed in sheep and goat production
    4.6.1. Breeding schemes
    4.7. Selection of breeding stock
5. Growth and Development of Sheep and Goats
    5.1. Definition of development and growth
    5.2. Pre and postpartum growth and development
    5.3. Factors influencing growth and development
6. Sheep and Goats Feeding
    6.1. Nutrients requirement
    6.2. Feed intake and feeding strategies
    6.3. The feeding habits
    6.4. Ration formulation
7. Sheep and Goat Management
    7.1. Lactating, and dry ewes and does
    7.2. Buck/Ram

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2. ብርሃኑ የሰራህ
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4. መኳንንት ቢከሰ
5. ረድኤት ማሞ
6. ወለላው አደመዉ
7. ጎሩት ከተማው
8. አሉበል አለሙ

7.3. Lambs and kids

7.3.1. Birth to weaning

7.3.2. Weaning management

7.4. Management for meat, milk and hair/wool production

8. Routine Husbandry Practices and Housing

8.1. Routine husbandry practices

8.1.1.Identification methods

8.1.2. Routine managements

8.2. Housing and handling facilities

8.2.1. Housing

8.2.2. Farm facilities (troughs…)

8.2.3. Handling facilities (collecting yard, crush…)

8.3. Record keeping

9. Processing and Marketing of Sheep and Goats Products

9.1. Market classes (grades) and marketing of live animals

9.2. Slaughtering and carcass processing

9.3. Processing and marketing of wool

10. Sheep and Goat Health Care

10.1. Factors that predispose animals for disease

10.2. Major sheep and goat diseases and prevention and control mechanisms

11. Sheep and Goat Stress Management, and Welfare Issues

11.1. Major stress factors

11.2. Methods to reduce stress

11.3. Sheep and goat welfare issues

Practical:

- Individual identification and breed characterization
- Body condition scoring of small ruminants
- Farm visit and report about sheep and goat house and facilities
- Common husbandry techniques
  - Dentition
  - Hoof trimming, castration. dehorning tail docking and disbudding

- Restraining and treatment

❖ Farm visit and report about mating management of particular sheep/goat farm
- Mating management
- Heat detection

❖ Weight and linear body measurements

❖ Ration formulation for
- Kids/lamb/doe/dam/buck/ram
- Pregnant, lactating and dry
- Meat/milk sheep/goat

❖ Record Keeping and examination for culling decision

❖ Slaughtering procedure (visit)

❖ Breeding animal selection procedure

Assessments:

• Practical/ laboratory work and report 25%

• Quizzes and assignment 20%

• Mid exam 20%

• Final exam 35%

References:

1. Cottle, DJ. 2010. International Sheep and Wool Handbook. Nottingham University Press. United Kingdom.
2. Devendra, C. and Mcleroy, G., B. 1987. Goat and Sheep in the Tropics. Long man Scientific Technical. Singapore.
3. Ethiopia Sheep and Goat productivity Improvement Program (ESGPIP). 2008. Sheep and Goat Production Handbook for Ethiopia. ESGPIP.
4. James R. Gillespie, Frank B. Flanders. 2016. Modern Livestock and Poultry Production. Delmar.9th ed.
5. Margaret Melling. 1998. Sheep and Goat Practice 2, the In Practice Handbooks.
6. Niemann, Deborah. 2018. Raising goats naturally: the complete guide to milk, meat, and more. New Society Publishers.
7. Veerasamy Sejian, Raghavendra Bhatta, John Gaughan, Pradeep Kumar Malik, S.M.K. Naqvi, Rattan Lal (eds.), 2017. Sheep Production Adapting to Climate Change. Springer Singapore.

I. Course Title: Animal Breeding

Course Code: AnSc 311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of Genetics

Course Category: Core

Course Description:

Traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; genetic parameters including heritability, genetic correlation and repeatability; selection and mating systems (inbreeding and crossbreeding); hybrid vigour and inbreeding depression; characterization of indigenous livestock /poultry/ and principles and methods of conservation of animal genetic resources; breeding schemes, application and use of biotechnology in animal breeding.

Learning Outcomes:

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

- Understand tools available to maximize response to genetic selection;
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation;
- Understand selection theory and breeding methods;
- Predicting the rate of genetic improvement;
- Optimize selection and mating decisions;
- Estimate genetic parameters and breeding values; and
- Designing breeding program.

Mode of Delivery: Lecture, discussions, assignment, practical sessions and field visits

Teaching Aids: Reference books, handouts, animal farms, teaching videos

Course Contents:

1. Introduction
    - 1.1. Definition and history of animal breeding
    - 1.2. Goals of animal breeding
    - 1.3. Overview of animal breeding industries
    - 1.3.1. Value of improvement

1.3.2. Role of the government

1.4. Contribution of animal breeding to livestock and poultry improvement

1.5. Genetic vs. environmental improvement

2. Categories of Traits in Livestock and Poultry

2.1. Qualitative traits

2.2. Quantitative traits

2.3. Threshold traits

2.4. Component traits

2.5. Economically important traits: description, measurement and inheritance

2.5.1. Growth, feed efficiency and carcass traits

2.5.2. Milk production and composition traits

2.5.3. Reproduction and survival traits

2.5.4. Type and conformation traits

2.5.5. Egg production traits (quantitative and qualitative)

2.5.6. Other Traits (wool, pelt, …)

3. Quantitative Effects of Genes in Populations

3.1. Genetic and environmental effects

3.2. Genetic components of variance

3.3. Additive variance

3.4. Dominance variance

3.4.1. Epistatic variance

3.5. Environmental components of variance

3.6. Resemblance between relatives

3.6.1. Phenotypic resemblance

3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)

3.7. Heritability and repeatability

3.7.1. Concepts and usefulness of heritability

3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)

3.7.3. Repeatability

3.7.3.1. Basic concepts

3.7.3.2. Heritability vs repeatability

3.8. Correlations (phenotypic, genetic and environmental correlations)

4. Selection

4.1. Natural vs. artificial selection

4.2. Classification of selection

4.2.1. Individual (mass / phenotypic) selection

4.2.2. Selection based on performance of relatives

4.2.3. Family selection

4.2.4. Sib selection

4.2.5. Selection on progeny performance

4.3. Methods of selection

4.3.1. Tandom method of selection

4.3.2. Independent culling level

4.3.3. Total score or selection index method

4.4. Response to selection and prediction of genetic gain

4.4.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)

4.4.2. Correlated response to selection

5. Mating Systems

5.1. Inbreeding and line breeding

5.1.1. Classification of mating systems

5.1.1.1. Random mating (panmixia)

5.1.1.2. Non-random mating

5.1.1.3. Mating based on phenotypic relationship

5.1.1.4. Mating based on degree of genetic/pedigree relationship

5.1.2. Inbreeding

5.1.3. Genetic consequences of inbreeding

5.1.4. Measurement of inbreeding and relationship coefficients

5.2. Line breeding

5.3. Outbreeding and heterosis

5.3.1. Genetic effects of outbreeding

5.3.2. Phenotypic effects of outbreeding: hybrid vigor

5.3.3. Types and measurements of heterosis

5.4. Systems of crossbreeding

5.4.1. Uses of crossbreeding

5.4.2. Two-, three-, four-breed crossing

5.4.3. Terminal crossbreeding

5.4.4. Rotational crossbreeding

5.4.5. Grading-up

5.4.6. Species hybridization

6. Genotype by Environment Interaction

6.1. Classification of G x E interaction

6.2. Extent of G x E interactions

6.3. Examples of G x E interaction

7. Animal Evaluation and Computation of Breeding Values (BVs)

7.1. Station vs field test/evaluation

7.2. Performance testing

7.3. Progeny testing

7.4. Why compute BV?

7.5. Different criteria used for predicting BV

7.5.1. Individual's own performance (single and repeated records)

7.5.2. Pedigree performance

7.5.3. Family performance

7.5.4. Performance of sibs

7.5.5. Performance of progeny

8. Breeding Industry Structure

8.1. Traditional breeding pyramid: closed nucleus breeding scheme

8.2. Open nucleus breeding scheme

8.3. Group breeding scheme

8.4. Sire referencing scheme

9. Animal Genetic Resources (AnGR) and Conservation

9.1. Vastness of AnGR

9.2. Breed and species diversity

9.3. Global breed risk status

9.4. Causes of loss of AnGR

9.5. Why conserve genetic diversity: rational for conservation

9.6. Methods of conservation

Practical:

- Estimation of variance components
  - phenotypic
  - genetic and
  - environmental
- Heritability and repeatability
- Coefficient of inbreeding and relationship
- Practical application of methods for genetic evaluation
- Estimation of breeding value
- Data collection and interpretation in community-based breeding program

Assessment:

- Practical/lab/field report work and report 25%
- Quizzes and assignment 20%
- Mid exam 20%
- Final exam 35%

References

1. Bourdon, Richard M. (2000) Understanding Animal Breeding
2. Daniel L. Hart and Andrew G. Clark (1997). Principles of Population Genetics
3. Falconer D.S. (1989). Introduction to Quantitative Genetics. 3rd ed.
4. Gerald Wiener (1994) Animal Breeding
5. Malcolm, B. W. (1991) Dalton's Introduction to Practical Animal Breeding
6. Michael L. and Bruce W. (1998). Genetics and Analysis of Quantitative Traits

Integrating Community Based Breeding Program (CBBP) in Undergraduate Curriculum: Animal Sciences

Background

Community Based Breeding Program is an alternative Breeding Strategy in small holder and resource poor farmers' flock. The program was initiated in 2010 in four sites and now extended to more than 100 sites. The increase in farmers' income has reached up to 20% that has triggered to upscale and out scale CBBP initiatives. Ensuring sustainability of CBBP is a critical issue. One of the strategies to ensuring sustainability of CBBP is integration of CBBP in the curriculum. The integration of CBBP in a curriculum has also added advantages that, graduating students will implement the program right away in their assignment as extension and research staff. Graduates can create knowledge based jobs. International Center for Agricultural Research in Dry Areas (ICARDA) took the initiative and consulted Ethiopian Universities in the integration of CBBP in the undergraduate Animal Science Program. The first workshop was organized on July, 20, 2021 and the second workshop was organized on July 27, 2021 with theme '' **Scaling up Community Based Breeding Programs through Ethiopian Universities''.** Representatives from ten federal Universities were involved in the first workshop. In the second workshop, 11 federal state Universities were involved. The representatives were Animal Breeders and University community service directors, which can implement CBBP in their respective Universities. The workshop formed a committee to amend a curriculum with CBBP practices in Animal Breeding course. Based on the recommendations of the workshop, amendment of the curriculum was made as described below and highlighted by yellow colour for a wider circulation and comments. Universities are expected to implement the CBBP initiatives.

What is required to enter into action and report the integration of CBBP in the curriculum?

- Course Team of Animal breeding and genetics review the proposed curriculum amendment and submit to the head of department with recommendations.
- The department council, chaired by the head of department approves the amendment supported by a minutes
- A cover letter and the approved course amendment (Course description, course outline and later on course material) with University logo passed to Animal breeding and genetics course team for implementation. The same cover letter and course amendment with stamped copy and logo sent to ICARDA.
- Documentation of the amendment and minutes in head department office and make a follow up of the implementation
- Final date of submission End of August 2021.

Course clusters: Animal Breeding and Breed Improvement

- Animal Genetics
- Reproductive physiology and Artificial Insemination
- **Animal Breeding and breed improvement**
- Animal Biotechnology

Table 1: List of core courses

Sr/N	Course Name	Cr.HR	ECTS
1	Anatomy and Physiology of Farm Animals	3	5
2	Fishery and Aquaculture	3	5
3	Swine Production and Management	2	3
4	**Principle of Genetics**	**3**	**5**
5	Principle of Animal Nutrition	3	5
6	Sheep and Goat Production and Management	3	5
7	Forage and Pasture Production and Management	3	5
8	Camel Production and Management	2	3
9	**Animal Breeding**	**3**	**5**
10	Reproductive Physiology and Artificial Insemination	2	3
11	Applied Animal Nutrition	4	6
12	Poultry Production and Hatchery Management	4	6
13	Dairy Cattle Production and Management	3	5
14	Practical in Animal Science I	1	2
15	Beef Cattle Production and Management	3	5
16	Equine Production and Draft Animals Management	3	5
17	Biometry	3	5
18	Research Methods in Animal Sciences	2	3
19	**Animal Biotechnology**	**3**	**5**
20	Range Ecology and Management	3	5
21	Veterinary Parasitology	2	3
22	Practical in Animal Science II	1	2
23	Practical Attachment	2	3
24	Apiculture	3	5
25	Sericulture	2	3
26	Animal Behavior and Welfare	2	3
27	Hide and Skin Processing	2	3
28	Animal Health and Disease Control	3	5
29	Senior Seminar	1	2
30	Food Hygiene and Veterinary Public Health	2	3
31	Livestock Products Processing Technology	3	5
32	Senior Research Project	2	3

Course Title: Animal Breeding

Course Code: AnSc 311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of Genetics

Course Category: Core

Course Description:

This course deals with the Introduction and history of Animal breeding genetics; basic concepts of Animal breeding; characterization of indigenous livestock/poultry/and Animal identification, data collection and recording; alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, Development of a genetic evaluation and breeding structures and its organization, Creation of an enabling environment, Monitoring and evaluation of the program, developed Breeding objectives for the CBBP through participatory and identification of economically important traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; estimating breeding values and genetic parameters including heritability, genetic correlation and repeatability; the bases of establishing breeding programs, types of selection, Mating systems (inbreeding and crossbreeding); hybrid vigor and inbreeding depression and principles and methods of conservation of animal genetic resources;

Learning Outcomes: Upon successful completion of this course, students should be able to:

- Developed Breeding objectives through participatory
- Understand selection theory and breeding methods;
- Understand tools available to maximize response to genetic selection;
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation;
- Optimize selection and mating decisions;
- Estimate genetic parameters and breeding values; and
- Understanding the concept of alternative breeding programs.

Mode of Delivery:

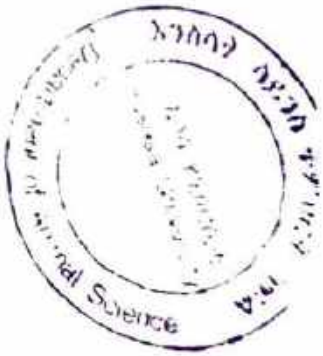
Lecture, discussions, assignment, practical sessions based on filed data and field visits to livestock farms including livestock research centers and villages -based community breeding program.

Teaching Aids:

Reference books, handouts, animal farms, teaching videos.

Course Contents:

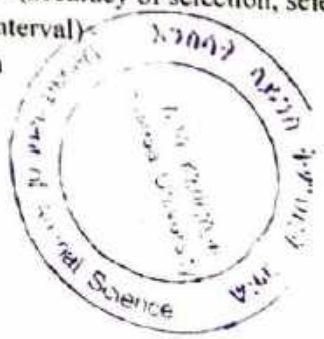
1. Introduction
   - 1.1. Definition and history of animal breeding
   - 1.2. Goals of animal breeding
   - 1.3. Overview of animal breeding industries
     - 1.3.1. Value of improvement
     - 1.3.2. Role of the government
   - 1.4. Contribution of animal breeding to livestock and poultry improvement
   - 1.5. Genetic vs. environmental improvement
2. Categories of Traits in Livestock and Poultry
   - 2.1. Qualitative traits



2.2. Quantitative traits
2.3. Threshold traits
2.4. Component traits
2.5. Economically important traits: description, measurement and inheritance
    2.5.1. Growth, feed efficiency and carcass traits
    2.5.2. Milk production and composition traits
    2.5.3. Reproduction and survival traits
    2.5.4. Type and conformation traits
    2.5.5. Egg production traits (quantitative and qualitative)
    2.5.6. Other Traits (wool, pelt, …)

3. Quantitative Effects of Genes in Populations
    3.1. Genetic and environmental effects
    3.2. Genetic components of variance
    3.3. Additive variance
    3.4. Dominance variance
        3.4.1. Epistatic variance
    3.5. Environmental components of variance
    3.6. Resemblance between relatives
        3.6.1. Phenotypic resemblance
        3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)
    3.7. Heritability and repeatability
        3.7.1. Concepts and usefulness of heritability
        3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)
        3.7.3. Repeatability
        3.7.4. Basic concepts
        3.7.5. Heritability vs repeatability
    3.8. Correlations (phenotypic, genetic and environmental correlations)

4. Selection
    4.1. Natural vs. artificial selection
    4.2. Classification of selection
        4.2.1. Individual (mass / phenotypic) selection
        4.2.2. Selection based on performance of relatives
        4.2.3. Family selection
        4.2.4. Sib selection
        4.2.5. Selection on progeny performance
    4.3. Methods of selection
        4.3.1. Tandom method of selection
        4.3.2. Independent culling level
        4.3.3. Total score or selection index method
    4.4. Response to selection and prediction of genetic gain
        4.4.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)
        4.4.2. Correlated response to selection



5. Mating Systems
    5.1. Inbreeding and line breeding
        5.1.1. Classification of mating systems
            5.1.1.1. Random mating (panmixia)
            5.1.1.2. Non-random mating
            5.1.1.3. Mating based on phenotypic relationship
            5.1.1.4. Mating based on degree of genetic/pedigree relationship
        5.1.2. Inbreeding
        5.1.3. Genetic consequences of inbreeding
        5.1.4. Measurement of inbreeding and relationship coefficients
    5.2. Line breeding
    5.3. Outbreeding and heterosis
        5.3.1. Genetic effects of outbreeding
        5.3.2. Phenotypic effects of outbreeding: hybrid vigor
        5.3.3. Types and measurements of heterosis
    5.4. Systems of crossbreeding
        5.4.1. Uses of crossbreeding
        5.4.2. Two-, three-, four-breed crossing
        5.4.3. Terminal crossbreeding
        5.4.4. Rotational crossbreeding
        5.4.5. Grading-up
        5.4.6. Species hybridization
6. Genotype by Environment Interaction
    6.1. Classification of G x E interaction
    6.2. Extent of G x E interactions
    6.3. Examples of G x E interaction
7. Animal Evaluation and Computation of Breeding Values (BVs)
    7.1. Station vs field test/evaluation
    7.2. Performance testing
    7.3. Progeny testing
    7.4. Why compute BV?
    7.5. Different criteria used for predicting BV
        7.5.1. Individual's own performance (single and repeated records)
        7.5.2. Pedigree performance
        7.5.3. Family performance
        7.5.4. Performance of sibs
        7.5.5. Performance of progeny
8. Breeding Structures and schemes
    8.1. Centralized nucleus schemes
        8.1.1. Closed nucleus breeding scheme
        8.1.2. Open nucleus breeding scheme
    8.2. Village-Based cooperative/Community-based Breeding Program
        8.2.1. Thought of CBBP and Scaling up Community Based Breeding Programs Applications

8.2.2. Designing CBBP operating system and implementation strategy

8.2.2.1. Components and steps in setting and organization of CBBPs in villages

8.3. Group breeding scheme

8.4. Sire referencing scheme

8.5. Comparison of CBBP and conventional Breeding program

9. Animal Genetic Resources (AnGR) and Conservation

9.1. Characterization of Indigenous livestock

9.2. Breed and species diversity

9.3. Global breed risk status

9.4. Causes of loss of AnGR

9.5. Why conserve genetic diversity: rational for conservation

9.6. Methods of conservation

9.6.1. ex situ conservation

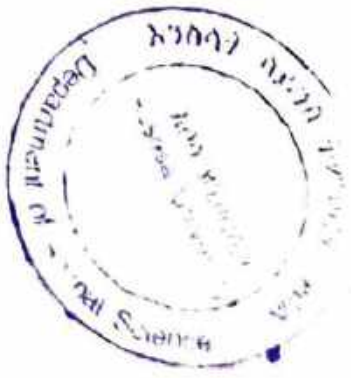
9.6.2. In situ conservation

Practical:

- performance and phenotypic recording and record keeping data [production , reproduction and linear body measurement data collection] generation and analyses from CBBP villages
- Participatory breeding objective definition data collection (group ranking, own flock ranking and participatory definition of breeding objective)
- Estimation and analysis of variance components
  - Phenotypic
  - genetic and
  - environmental
- Heritability and repeatability
- Coefficient of inbreeding and relationship •
- Practical application of methods for genetic evaluation
- Estimation of breeding value

Assessment:

- Practical/lab/field report work and report 25%
- Quizzes and assignment 20%
- Mid exam 20%
- Final exam 35%



References

1. Bourdon, Richard M. (2000) Understanding Animal Breeding
2. Daniel L. Hart and Andrew G. Clark (1997). Principles of Population Genetics

3. Falconer D.S. (1989). Introduction to Quantitative Genetics. 3rd ed.
4. FAO. 2010. Breeding Strategies for Sustainable Management of Animal Genetic Resources. FAO Animal Production and Health Guidelines. No 3. Rome, Italy: FAO.
5. Gerald Wiener (1994). Animal Breeding
6. Malcolm, B. W. (1991). Dalton's Introduction to Practical Animal Breeding.
7. Michael L. and Bruce W. (1998). Genetics and Analysis of Quantitative Traits
8. Haile A., Wurzinger M., Mueller J., Mirkena T., Duguma G., Rekik M., Mwacharo J., Mwai O., Sölkner J. and Rischkowsky B. 2018. Guidelines for Setting Up community-based small ruminants breeding programs in Ethiopia. ICARDA—Tools and guidelines No.1. Beirut, Lebanon: ICARDA.

Date Oct 07/2021

Time 9:00-10:30 AM

Place AC Meeting Room

Attendees Signature

1. Mr. Aregaw Abera----------Chair person
2. Mr. Metekia Tamiru----------secretary
3. Miss Eyerus Muleta----------member
4. Mr. Ahmed Seid----------member
5. Mr. Melaku Mulugeta----------member
6. Mr. Sebseb A/Bor----------member
7. Miss Lishan Takele----------member
8. Mr. Arse Gebeyehu----------member
9. Mr. Milkessa Tadesse----------member
10. Mr.Tagasse Tadaess----------member
11. Mr.Wasihun Hasen ----------member

Agenda: Integrating Community Based Breeding Program (CBBP) in Undergraduate Curriculum: Animal Sciences

Chairperson, Mr.Aregaw Abera distributed the agenda which had been presented via email. In addition, the chairperson also presented background of CBBP and how it can be integrated into the course, mainly at which chapter and topics included in the course outline. Then, all attendees reflected on presented agenda and came up to make decision with the following grounds:

1. Integrating community based breeding program in to Animal Breeding course would help to teach the course in more practical approach since our department is also lunching community based breeding program in Dedo district, Jimma Zone.
2. Integrating community based breeding program in to Animal Breeding course and teaching undergraduate as well as graduate students also in line with the philosophy of the university "**we are community**"

Given the above points, the DC members have endorsed integrating community based breeding program in to Animal Breeding course as it is presented below in the course line.

Background

Community Based Breeding Program is an alternative Breeding Strategy in small holder and resource poor farmers' flock. The program was initiated in 2010 in four sites and now extended to more than 100 sites. The increase in farmers' income has reached up to 20% that has triggered to upscale and out scale CBBP initiatives. Ensuring sustainability of CBBP is a critical issue. One of the strategies to ensuring sustainability of CBBP is integration of CBBP in the curriculum. The integration of CBBP in a curriculum has also added advantages that, graduating students will implement the program right away in their assignment as extension and research staff. Graduates can create knowledge based jobs. International Center for Agricultural Research in Dry Areas (ICARDA) took the initiative and consulted Ethiopian Universities in the integration of CBBP in the undergraduate Animal Science Program. The first workshop was organized on July, 20, 2021 and the second workshop was organized on July 27, 2021 with theme '' **Scaling up Community Based Breeding Programs through Ethiopian Universities''.** Representatives from ten federal Universities were involved in the first workshop. In the second workshop, 11 federal state Universities were involved. The representatives were Animal Breeders and University community service directors, which can implement CBBP in their respective Universities. The workshop formed a committee to amend a curriculum with CBBP practices in Animal Breeding course. Based on the recommendations of the workshop, amendment of the curriculum was made as described below and highlighted by yellow colour for a wider circulation and comments. Universities are expected to implement the CBBP initiatives.

What is required to enter into action and report the integration of CBBP in the curriculum?

- Course Team of Animal breeding and genetics review the proposed curriculum amendment and submit to the head of department with recommendations.
- The department council, chaired by the head of department approves the amendment supported by a minutes
- A cover letter and the approved course amendment (Course description, course outline and later on course material) with University logo passed to Animal breeding and genetics course team for implementation. The same cover letter and course amendment with stamped copy and logo sent to ICARDA.
- Documentation of the amendment and minutes in head department office and make a follow up of the implementation
- Final date of submission End of August 2021.

Course clusters: Animal Breeding and Breed Improvement

- Animal Genetics
- Reproductive physiology and Artificial Insemination
- **Animal Breeding**
- Animal Biotechnology

Table 1: List of core courses

Sr/N	Course Name	Cr.HR	ECTS
1	Anatomy and Physiology of Farm Animals	3	5
2	Fishery and Aquaculture	3	5
3	Swine Production and Management	2	3
4	**Principle of Genetics**	**3**	**5**
5	Principle of Animal Nutrition	3	5
6	Sheep and Goat Production and Management	3	5
7	Forage and Pasture Production and Management	3	5

8	Camel Production and Management	2	3
9	**Animal Breeding**	**3**	**5**
10	Reproductive Physiology and Artificial Insemination	2	3
11	Applied Animal Nutrition	4	6
12	Poultry Production and Hatchery Management	4	6
13	Dairy Cattle Production and Management	3	5
14	Practical in Animal Science I	1	2
15	Beef Cattle Production and Management	3	5
16	Equine Production and Draft Animals Management	3	5
17	Biometry	3	5
18	Research Methods in Animal Sciences	2	3
19	**Animal Biotechnology**	**3**	**5**
20	Range Ecology and Management	3	5
21	Veterinary Parasitology	2	3
22	Practical in Animal Science II	1	2
23	Practical Attachment	2	3
24	Apiculture	3	5
25	Sericulture	2	3
26	Animal Behavior and Welfare	2	3
27	Hide and Skin Processing	2	3
28	Animal Health and Disease Control	3	5
29	Senior Seminar	1	2
30	Food Hygiene and Veterinary Public Health	2	3
31	Livestock Products Processing Technology	3	5
32	Senior Research Project	2	3

Course Title: Animal Breeding

Course Code: AnSc 311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of Genetics

Course Category: Core

Course Description:

This course deals with the historical back ground of animal breeding; characterization of indigenous livestock/poultry/, alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, definition of breeding objectives and identification of economically important traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; estimating breeding values and genetic parameters including heritability, genetic correlation and repeatability; the bases of establishing breeding programs, types of selection, Mating systems (inbreeding and crossbreeding); hybrid vigor and inbreeding depression and principles and methods of conservation of animal genetic resources;

Learning Outcomes: Upon successful completion of this course, students should be able to:

- Participatory definition of breeding objectives
- Understand selection theory and breeding methods;
- Understand tools available to maximize response to genetic selection;
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation;
- Optimize selection and mating decisions;
- Estimate genetic parameters and breeding values; and
- Understanding the concept of alternative breeding programs.

Mode of Delivery:

Lecture, discussions, assignment, practical sessions based on filed data and field visits to livestock farms including livestock research centers and community-based breeding program villages.

Teaching Aids:

Reference books, handouts, animal farms, teaching videos.

Course Contents:

1. Introduction
    - 1.1.Definition and history of animal breeding
    - 1.2.Goals of animal breeding
    - 1.3.Overview of animal breeding industries
        - 1.3.1. Value of improvement
        - 1.3.2. Role of the government
    - 1.4. Contribution of animal breeding to livestock and poultry improvement
    - 1.5. Genetic vs. environmental improvement
2. Categories of Traits in Livestock and Poultry
    - 2.1.Qualitative traits
    - 2.2. Quantitative traits
    - 2.3. Threshold traits
    - 2.4.Component traits
    - 2.5. Economically important traits: description, measurement and inheritance
        - 2.5.1. Growth, feed efficiency and carcass traits
        - 2.5.2. Milk production and composition traits
        - 2.5.3. Reproduction and survival traits
        - 2.5.4. Type and conformation traits
        - 2.5.5. Egg production traits (quantitative and qualitative)
        - 2.5.6. Other Traits (wool, pelt, …)
3. Quantitative Effects of Genes in Populations
    - 3.1.Genetic and environmental effects
    - 3.2. Genetic components of variance
    - 3.3.Additive variance
    - 3.4.Dominance variance
        - 3.4.1. Epistatic variance
    - 3.5.Environmental components of variance
    - 3.6.Resemblance between relatives
        - 3.6.1. Phenotypic resemblance
        - 3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)

3.7. Heritability and repeatability

3.7.1. Concepts and usefulness of heritability

3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)

3.7.3. Repeatability

3.7.4. Basic concepts

3.7.5. Heritability vs repeatability

3.8.Correlations (phenotypic, genetic and environmental correlations)

4. Selection

4.1.Natural vs. artificial selection

4.2.Classification of selection

4.2.1. Individual (mass / phenotypic) selection

4.2.2. Selection based on performance of relatives

4.2.3. Family selection

4.2.4. Sib selection

4.2.5. Selection on progeny performance

4.3.Methods of selection

4.3.1. Tandom method of selection

4.3.2. Independent culling level

4.3.3. Total score or selection index method

4.4.Response to selection and prediction of genetic gain

4.4.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)

4.4.2. Correlated response to selection

5. Mating Systems

5.1.Inbreeding and line breeding

5.1.1. Classification of mating systems

5.1.1.1.Random mating (panmixia)

5.1.1.2.Non-random mating

5.1.1.3.Mating based on phenotypic relationship

5.1.1.4.Mating based on degree of genetic/pedigree relationship

5.1.2. Inbreeding

5.1.3. Genetic consequences of inbreeding

5.1.4. Measurement of inbreeding and relationship coefficients

5.2. Line breeding

5.3.Outbreeding and heterosis

5.3.1. Genetic effects of outbreeding

5.3.2. Phenotypic effects of outbreeding: hybrid vigor

5.3.3. Types and measurements of heterosis

5.4. Systems of crossbreeding

5.4.1. Uses of crossbreeding

5.4.2. Two-, three-, four-breed crossing

5.4.3. Terminal crossbreeding

5.4.4. Rotational crossbreeding

5.4.5. Grading-up

5.4.6. Species hybridization

6. Genotype by Environment Interaction

6.1.Classification of G x E interaction

6.2.Extent of G x E interactions

6.3.Examples of G x E interaction

7. Animal Evaluation and Computation of Breeding Values (BVs)

7.1. Station vs field test/evaluation

7.2.Performance testing

7.3.Progeny testing

7.4.Why compute BV?

7.5.Different criteria used for predicting BV

7.5.1. Individual's own performance (single and repeated records)

7.5.2. Pedigree performance

7.5.3. Family performance

7.5.4. Performance of sibs

7.5.5. Performance of progeny

8. Breeding Structures and schemes

8.1.Closed nucleus breeding scheme

8.2. Open nucleus breeding scheme

8.3.Community Based Breeding Program

8.3.1. Concepts of CBBP and Applications

8.3.2. Components and steps in setting CBBPs in villages

8.4.Group breeding scheme

8.5.Sire referencing scheme

8.6.Comparison of CBBP and Hierarchical Breeding program

9. Animal Genetic Resources (AnGR) and Conservation

9.1.Characterization of Indigenous livestock

9.2.Breed and species diversity

9.3.Global breed risk status

9.4.Causes of loss of AnGR

9.5.Why conserve genetic diversity: rational for conservation

9.6.Methods of conservation

Practical:

- **Pedigreed and phenotypic data [performance and linear body measurement data collection] generation and analyses from CBBP villages**
- Estimation of variance components
  - Phenotypic
  - genetic and
  - environmental
- Heritability and repeatability
- Coefficient of inbreeding and relationship •
- Practical application of methods for genetic evaluation
- Estimation of breeding value

Assessment:

- Practical/lab/field report work and report 25%
- Quizzes and assignment 20%
- Mid exam 20%

- Final exam 35%

References

1. Bourdon, Richard M. (2000) Understanding Animal Breeding
2. Daniel L. Hart and Andrew G. Clark (1997). Principles of Population Genetics
3. Falconer D.S. (1989). Introduction to Quantitative Genetics. 3rd ed.
4. Gerald Wiener (1994). Animal Breeding
5. Malcolm, B. W. (1991). Dalton's Introduction to Practical Animal Breeding,
6. Michael L. and Bruce W. (1998). Genetics and Analysis of Quantitative Traits
7. Haile A., Wurzinger M., Mueller J., Mirkena T., Duguma G., Rekik M., Mwacharo J., Mwai O., Sölkner J. and Rischkowsky B. 2018. Guidelines for Setting Up community-based small ruminants breeding programs in Ethiopia

Course Chair Meeting Minute

Date: 28/04/2021

Place: CAES

Participants

- Mr. Damitie Kebede — Chairperson
- Professor Kefyalew — Member
- Dr. Wossenie Shibabaw — Member
- Mr. Esubalew Admasu — Member
- Dr. Mengistie Taye — Secretary

Agenda

- Integrating Community Based Breeding Program (CBBP) to the undergraduate Animal Breeding course

Based on a workshop held on July 20, 2021 by ICARDA in Bahir Dar to discuss on integrating CBBP in the Animal Breeding course of the undergraduate Animal Production and Technology program and Establishing CBBP for important livestock species in the vicinity of Universities, all the universities in Amhara region agreed on integrating CBBP into the curriculum as a course chapter to benefit the graduates of the program.

Accordingly, updated course content of the Animal Breeding course was sent to us to include the course content and update the curriculum. This is, therefore, to assure ICARDA that we have included the course content in the curriculum.

Chairperson

Secretary

Course Title: Animal Breeding
Course Code: AnSc 311
Course Credit Hours: 3 (2+1)
Course Pre-requites: Principles of Genetics
Course Category: Core

Course Description:

This course deals with the historical back ground of animal breeding; characterization of indigenous livestock/poultry/, alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, definition of breeding objectives and identification of economically important traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; estimating breeding values and genetic parameters including heritability, genetic correlation and repeatability; the bases of establishing breeding programs, types of selection, Mating systems (inbreeding and crossbreeding); hybrid vigor and inbreeding depression and principles and methods of conservation of animal genetic resources;

Learning Outcomes:

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

- Participatory definition of breeding objectives
- Understand selection theory and breeding methods.
- Understand tools available to maximize response to genetic selection.
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation.
- Optimize selection and mating decisions.
- Estimate genetic parameters and breeding values; and
- Understanding the concept of alternative breeding programs.

Mode of Delivery:

Lecture, discussions, assignment, practical sessions based on filed data and field visits to livestock farms including livestock research centers and community-based breeding program villages.

Teaching Aids:

Reference books, handouts, animal farms, teaching videos.

Course Contents:

Chapter 1. Introduction
- 1.1. Definition and history of animal breeding
- 1.2. Goals of animal breeding
- 1.3. Overview of animal breeding industries
  - 1.3.1. Value of improvement
  - 1.3.2. Role of the government
- 1.4. Contribution of animal breeding to livestock and poultry improvement
- 1.5. Genetic vs. environmental improvement

Chapter 2. Categories of Traits in Livestock and Poultry
- 2.1. Qualitative traits
- 2.2. Quantitative traits
- 2.3. Threshold traits
- 2.4. Component traits
- 2.5. Economically important traits: description, measurement, and inheritance
  - 2.5.1. Growth, feed efficiency and carcass traits
  - 2.5.2. Milk production and composition traits
  - 2.5.3. Reproduction and survival traits
  - 2.5.4. Type and conformation traits
  - 2.5.5. Egg production traits (quantitative and qualitative)
  - 2.5.6. Other Traits (wool, pelt, …)

Chapter 3. Quantitative Effects of Genes in Populations
- 3.1. Genetic and environmental effects
- 3.2. Genetic components of variance
- 3.3. Additive variance
- 3.4. Dominance variance

3.4.1. Epistatic variance
3.5. Environmental components of variance
3.6. Resemblance between relatives
3.6.1. Phenotypic resemblance
3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)
3.7. Heritability and repeatability
3.7.1. Concepts and usefulness of heritability
3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)
3.7.3. Repeatability
3.7.3.1.Basic concepts
3.7.3.2.Heritability vs repeatability
3.8. Correlations (phenotypic, genetic and environmental correlations)

Chapter 4. Selection
4.1. Natural vs. artificial selection
4.2. Classification of selection
4.2.1. Individual (mass / phenotypic) selection
4.2.2. Selection based on performance of relatives
4.2.3. Family selection
4.2.4. Sib selection
4.2.5. Selection on progeny performance
4.3. Methods of selection
4.3.1. Tandem method of selection
4.3.2. Independent culling level
4.3.3. Total score or selection index method
4.4. Response to selection and prediction of genetic gain
4.4.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)
4.4.2. Correlated response to selection

Chapter 5. Mating Systems
5.1. Inbreeding and line breeding
5.1.1. Classification of mating systems
5.1.1.1. Random mating (panmixia)
5.1.1.2. Non-random mating
5.1.1.3. Mating based on phenotypic relationship
5.1.1.4. Mating based on degree of genetic/pedigree relationship
5.1.2. Inbreeding
5.1.3. Genetic consequences of inbreeding
5.1.4. Measurement of inbreeding and relationship coefficients
5.2. Line breeding
5.3. Outbreeding and heterosis
5.3.1. Genetic effects of outbreeding
5.3.2. Phenotypic effects of outbreeding: hybrid vigor
5.3.3. Types and measurements of heterosis
5.4. Systems of crossbreeding
5.4.1. Uses of crossbreeding
5.4.2. Two-, three-, four-breed crossing
5.4.3. Terminal crossbreeding
5.4.4. Rotational crossbreeding
5.4.5. Grading-up
5.4.6. Species hybridization

Chapter 6. Genotype by Environment Interaction
6.1. Classification of G x E interaction
6.2. Extent of G x E interactions
6.3. Examples of G x E interaction

Chapter 7. Animal Evaluation and Computation of Breeding Values (BVs)

7.1. Station vs field test/evaluation
7.2. Performance testing
7.3. Progeny testing
7.4. Why compute BV?
7.5. Different criteria used for predicting BV
7.5.1. Individual's own performance (single and repeated records)
7.5.2. Pedigree performance
7.5.3. Family performance
7.5.4. Performance of sibs
7.5.5. Performance of progeny

Chapter 8. Breeding **Structure and Scheme**
8.1. Traditional breeding pyramid: closed nucleus breeding scheme
8.2. Open nucleus breeding scheme
8.3. Group breeding scheme
8.4. Community-based breeding program (CBBP)
8.4.1. Concepts of CBBP and Applications
8.4.2. Components and steps in setting CBBPs in villages
8.5. Sire referencing scheme

Chapter 9. Animal Genetic Resources (AnGR) and Conservation
9.1. Vastness of AnGR
9.2. Breed and species diversity
9.3. **Characterization indigenous stock / Methods, analyses/**
9.4. Global breed risk status
9.5. Causes of loss of AnGR
9.6. Why conserve genetic diversity: rational for conservation
9.7. Methods of conservation

Practical:
- Pedigreed and phenotypic data [performance and linear body measurement data collection] generation and analyses from CBBP villages

- Estimation of variance components.
  - ✓ phenotypic, genetic, and environmental
  - ✓ Heritability and repeatability
- Coefficient of inbreeding and relationship
- Practical application of methods for genetic evaluation
- Estimation of breeding value

Assessment:
- Practical/lab/field report work and report 25%.
- Quizzes and assignment 20%.
- Mid exam 20%.
- Final exam 35%.

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SAMARA UNIVERSITY

College of Dryland Agricultures

Department of Animal Sciences

Community Based Breeding Program (CBBP) Integrated Undergraduate Animal Breeding (AnSc 311) Course in the New Revised Curriculum of Animal Sciences for Regular Program

Background

Community Based Breeding Program is an alternative Breeding Strategy in small holder and resource poor farmers' flock. The program was initiated in 2010 in four sites and now extended to more than 100 sites. The increase in farmers' income has reached up to 20% that has triggered to upscale and out scale CBBP initiatives. Ensuring sustainability of CBBP is a critical issue. One of the strategies to ensuring sustainability of CBBP is integration of CBBP in the curriculum. The integration of CBBP in a curriculum has also added advantages that, graduating students will implement the program right away in their assignment as extension and research staff. Graduates can create knowledge based jobs. International Center for Agricultural Research in Dry Areas (ICARDA) took the initiative and consulted Ethiopian Universities in the integration of CBBP in the undergraduate Animal Science Program. The first workshop was organized on July, 20, 2021 and the second workshop was organized on July 27, 2021 with theme " **Scaling up Community Based Breeding Programs through Ethiopian Universities".** Representatives from ten federal Universities were involved in the first workshop. In the second workshop, 11 federal state Universities were involved. The representatives were Animal Breeders and University community service directors, which can implement CBBP in their respective Universities. The workshop formed a committee to amend a curriculum with CBBP practices in Animal Breeding course. Based on the recommendations of the workshop, amendment of the curriculum was made as described below and highlighted by yellow colour for a wider circulation and comments. Universities are expected to implement the CBBP initiatives.

What is required to enter into action and report the integration of CBBP in the curriculum?

- Course Team of Animal breeding and genetics review the proposed curriculum amendment and submit to the head of department with recommendations.
- The department council, chaired by the head of department approves the amendment supported by a minutes
- A cover letter and the approved course amendment (Course description, course outline and later on course material) with University logo passed to Animal breeding and genetics course

team for implementation. The same cover letter and course amendment with stamped copy and logo sent to ICARDA.

- Documentation of the amendment and minutes in head department office and make a follow up of the implementation
- Final date of submission End of August 2021.

Course clusters: Animal Breeding and Breed Improvement

- Animal Genetics
- Reproductive physiology and Artificial Insemination
- **Animal Breeding**
- Animal Biotechnology

Table 1: List of core courses

Sr/N	Course Name	Cr.HR	ECTS
1	Anatomy and Physiology of Farm Animals	3	5
2	Fishery and Aquaculture	3	5
3	Swine Production and Management	2	3
4	**Principle of Genetics**	**3**	**5**
5	Principle of Animal Nutrition	3	5
6	Sheep and Goat Production and Management	3	5
7	Forage and Pasture Production and Management	3	5
8	Camel Production and Management	2	3
9	**Animal Breeding**	**3**	**5**
10	Reproductive Physiology and Artificial Insemination	2	3
11	Applied Animal Nutrition	4	6
12	Poultry Production and Hatchery Management	4	6
13	Dairy Cattle Production and Management	3	5
14	Practical in Animal Science I	1	2
15	Beef Cattle Production and Management	3	5
16	Equine Production and Draft Animals Management	3	5

17	Biometry	3	5
18	Research Methods in Animal Sciences	2	3
19	**Animal Biotechnology**	**3**	**5**
20	Range Ecology and Management	3	5
21	Veterinary Parasitology	2	3
22	Practical in Animal Science II	1	2
23	Practical Attachment	2	3
24	Apiculture	3	5
25	Sericulture	2	3
26	Animal Behavior and Welfare	2	3
27	Hide and Skin Processing	2	3
28	Animal Health and Disease Control	3	5
29	Senior Seminar	1	2
30	Food Hygiene and Veterinary Public Health	2	3
31	Livestock Products Processing Technology	3	5
32	Senior Research Project	2	3

Course Title: Animal Breeding

Course Code: AnSc 311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of Genetics

Course Category: Core

Course Description:

This course deals with the historical back ground of animal breeding; characterization of indigenous livestock/poultry/, alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, definition of breeding objectives and identification of economically important traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their

partitioning; estimating breeding values and genetic parameters including heritability, genetic correlation and repeatability; the bases of establishing breeding programs, types of selection, Mating systems (inbreeding and crossbreeding); hybrid vigor and inbreeding depression and principles and methods of conservation of animal genetic resources;

Learning Outcomes: Upon successful completion of this course, students should be able to:

- Participatory definition of breeding objectives
- Understand selection theory and breeding methods;
- Understand tools available to maximize response to genetic selection;
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation;
- Optimize selection and mating decisions;
- Estimate genetic parameters and breeding values; and
- Understanding the concept of alternative breeding programs.

Mode of Delivery:

Lecture, discussions, assignment, practical sessions based on filed data and field visits to livestock farms including livestock research centers and community-based breeding program villages.

Teaching Aids:

Reference books, handouts, animal farms, teaching videos.

Course Contents:

1. **Introduction**
   - 1.1. Definition and history of animal breeding
   - 1.2. Goals of animal breeding
   - 1.3. Overview of animal breeding industries
     - 1.3.1. Value of improvement
     - 1.3.2. Role of the government
   - 1.4. Contribution of animal breeding to livestock and poultry improvement
   - 1.5. Genetic vs. environmental improvement
2. **Categories of Traits in Livestock and Poultry**
   - 2.1. Qualitative traits
   - 2.2. Quantitative traits
   - 2.3. Threshold traits
   - 2.4. Component traits
   - 2.5. Economically important traits: description, measurement and inheritance
     - 2.5.1. Growth, feed efficiency and carcass traits
     - 2.5.2. Milk production and composition traits
     - 2.5.3. Reproduction and survival traits
     - 2.5.4. Type and conformation traits

2.5.5. Egg production traits (quantitative and qualitative)
2.5.6. Other Traits (wool, pelt, ...)

3. **Quantitative Effects of Genes in Populations**
   3.1. Genetic and environmental effects
   3.2. Genetic components of variance
   3.3. Additive variance
   3.4. Dominance variance
      3.4.1. Epistatic variance
   3.5. Environmental components of variance
   3.6. Resemblance between relatives
      3.6.1. Phenotypic resemblance
      3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)
   3.7. Heritability and repeatability
      3.7.1. Concepts and usefulness of heritability
      3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)
      3.7.3. Repeatability
      3.7.4. Basic concepts
      3.7.5. Heritability vs repeatability
   3.8. Correlations (phenotypic, genetic and environmental correlations)
4. **Selection**
   4.1. Natural vs. artificial selection
   4.2. Classification of selection
      4.2.1. Individual (mass / phenotypic) selection
      4.2.2. Selection based on performance of relatives
      4.2.3. Family selection
      4.2.4. Sib selection
      4.2.5. Selection on progeny performance
   4.3. Methods of selection
      4.3.1. Tandom method of selection
      4.3.2. Independent culling level
      4.3.3. Total score or selection index method
   4.4. Response to selection and prediction of genetic gain
      4.4.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)
      4.4.2. Correlated response to selection
5. **Mating Systems**
   5.1. Inbreeding and line breeding
      5.1.1. Classification of mating systems
         5.1.1.1. Random mating (panmixia)
         5.1.1.2. Non-random mating
         5.1.1.3. Mating based on phenotypic relationship
         5.1.1.4. Mating based on degree of genetic/pedigree relationship

- 5.1.2. Inbreeding
- 5.1.3. Genetic consequences of inbreeding
- 5.1.4. Measurement of inbreeding and relationship coefficients

5.2. Line breeding

5.3. Outbreeding and heterosis

- 5.3.1. Genetic effects of outbreeding
- 5.3.2. Phenotypic effects of outbreeding: hybrid vigor
- 5.3.3. Types and measurements of heterosis

5.4. Systems of crossbreeding

- 5.4.1. Uses of crossbreeding
- 5.4.2. Two-, three-, four-breed crossing
- 5.4.3. Terminal crossbreeding
- 5.4.4. Rotational crossbreeding
- 5.4.5. Grading-up
- 5.4.6. Species hybridization

6. **Genotype by Environment Interaction**
   - 6.1. Classification of G x E interaction
   - 6.2. Extent of G x E interactions
   - 6.3. Examples of G x E interaction
7. **Animal Evaluation and Computation of Breeding Values (BVs)**
   - 7.1. Station vs field test/evaluation
   - 7.2. Performance testing
   - 7.3. Progeny testing
   - 7.4. Why compute BV?
   - 7.5. Different criteria used for predicting BV
     - 7.5.1. Individual's own performance (single and repeated records)
     - 7.5.2. Pedigree performance
     - 7.5.3. Family performance
     - 7.5.4. Performance of sibs
     - 7.5.5. Performance of progeny
8. **Breeding Structures and schemes**
   - 8.1. Closed nucleus breeding scheme
   - 8.2. Open nucleus breeding scheme
   - 8.3. Community Based Breeding Program
     - 8.3.1. Concepts of CBBP and Applications
     - 8.3.2. Components and steps in setting CBBPs in villages
   - 8.4. Group breeding scheme
   - 8.5. Sire referencing scheme
   - 8.6. Comparison of CBBP and Hierarchical Breeding program
9. **Animal Genetic Resources (AnGR) and Conservation**
   - 9.1. Characterization of Indigenous livestock
   - 9.2. Breed and species diversity
   - 9.3. Global breed risk status

9.4. Causes of loss of AnGR
9.5. Why conserve genetic diversity: rational for conservation
9.6. Methods of conservation

Practical Sessions:

- Pedigreed and phenotypic data [performance and linear body measurement data collection] generation and analyses from CBBP villages
- Estimation of variance components
    - Phenotypic
    - genetic and
    - environmental
- Heritability and repeatability
- Coefficient of inbreeding and relationship •
- Practical application of methods for genetic evaluation
- Estimation of breeding value

Assessment:

- Practical/lab/field report work and report 25%
- Quizzes and assignment 20%
- Mid exam 20%
- Final exam 35%

References

1. Bourdon, Richard M. (2000) Understanding Animal Breeding
2. Daniel L. Hart and Andrew G. Clark (1997). Principles of Population Genetics
3. Falconer D.S. (1989). Introduction to Quantitative Genetics. 3rd ed.
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7. Haile A., Wurzinger M., Mueller J., Mirkena T., Duguma G., Rekik M., Mwacharo J., Mwai O., Sölkner J. and Rischkowsky B. 2018. Guidelines for Setting Up community-based small ruminants breeding programs in Ethiopia. ICARDA—Tools and guidelines No.1. Beirut, Lebanon: ICARDA.

UNIVERSITY OF GONDAR

COLLEGE OF VETERINARY MEDICINE AND ANIMAL SCIENCES

NATIONALLY HARMONIZED CURRICULUM FOR B.Sc. DEGREE IN ANIMAL SCIENCES

Gondar, Ethiopia

June, 2021

Course Title: Animal Breeding

Course Code: AnSc311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of Genetics

Course Status: Core

Course Description:

This course deals with the historical back ground of animal breeding; characterization of indigenous livestock/poultry/, alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, definition of breeding objectives and identification of economically important traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; estimating breeding values and genetic parameters including heritability, genetic correlation and repeatability; the bases of establishing breeding programs, types of selection, Mating systems (inbreeding and crossbreeding); hybrid vigor and inbreeding depression and principles and methods of conservation of animal genetic resources;

Learning Outcomes: Upon successful completion of this course, students should be able to:

- Define breeding objectives in participatory way
- Understand selection theory and breeding methods
- Understand tools available to maximize response to genetic selection;
- Predict the rate of genetic improvement
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation
- Optimize selection and mating decisions
- Estimate genetic parameters and breeding values

Mode of Delivery:

Lecture, discussions, assignment, practical sessions based on filed data and field visits to livestock farms including livestock research **centers** and community-based breeding program villages.

Teaching Aids:

Reference books, handouts, animal farms, teaching videos

Course Contents:

1. Introduction
   - 1.1. Definition and history of animal breeding
   - 1.2. Goals of animal breeding
   - 1.3. Overview of animal breeding industries
     - 1.3.1. Value of improvement
     - 1.3.2. Role of the government
   - 1.4. Contribution of animal breeding to livestock and poultry improvement
   - 1.5. Genetic vs. environmental improvement
2. Categories of Traits in Livestock and Poultry
   - 2.1. Qualitative traits
   - 2.2. Quantitative traits

2.3. Threshold traits
2.4. Component traits
2.5. Economically important traits: description, measurement and inheritance
    2.5.1. Growth, feed efficiency and carcass traits
    2.5.2. Milk production and composition traits
    2.5.3. Reproduction and survival traits
    2.5.4. Type and conformation traits
    2.5.5. Egg production traits (quantitative and qualitative)
    2.5.6. Other Traits (wool, pelt, …)

3. Quantitative Effects of Genes in Populations
    3.1. Genetic and environmental effects
    3.2. Genetic components of variance
    3.3. Additive variance
    3.4. Dominance variance
        3.4.1. Epistatic variance
    3.5. Environmental components of variance
    3.6. Resemblance between relatives
        3.6.1. Phenotypic resemblance
        3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)
    3.7. Heritability and repeatability
        3.7.1. Concepts and usefulness of heritability
        3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)
        3.7.3. Repeatability
        3.7.4. Basic concepts
        3.7.5. Heritability vs repeatability
    3.8. Correlations (phenotypic, genetic and environmental correlations)

4. Selection
    4.1. Natural vs. artificial selection
    4.2. Classification of selection
        4.2.1. Individual (mass / phenotypic) selection
        4.2.2. Selection based on performance of relatives
        4.2.3. Family selection
        4.2.4. Sib selection
        4.2.5. Selection on progeny performance
    4.3. Methods of selection
        4.3.1. Tandem method of selection
        4.3.2. Independent culling level
        4.3.3. Total score or selection index method
    4.4. Nucleus Breeding Schemes
        4.4.1. Open Nucleus breeding scheme
        4.4.2. Closed Nucleus breeding schemes
    4.5. Community-based breeding program (CBBP)
        4.5.1. Concepts of CBBP and Applications
            4.5.1.1. Comparison of CBBP and hierarchical breeding program
            4.5.1.2. **Designing CBBP operating system and implementation strategy**
        4.5.2. Components and steps in setting CBBPs in villages
            4.5.2.1. Characterization of **indigenous livestock /poultry**/population and production systems

4.5.2.2. Participatory definition of breeding objectives and trait identification
4.5.2.3. Development of breeding structures
4.5.2.4. Participatory selection, mating design and culling of inferiors
4.5.2.5. Data recording and management
4.5.2.6. Institutional arrangements
4.5.2.7. Dissemination models for the improved genetics
4.5.2.8. **Monitoring, evaluation, and impact assessment of CBBPs**

4.6. Response to selection and prediction of genetic gain
4.6.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)
4.6.2. Correlated response to selection

5. Mating Systems
5.1. Inbreeding and line breeding
5.1.1. Classification of mating systems
5.1.1.1. Random mating (panmixia)
5.1.1.2. Non-random mating
5.1.1.3. Mating based on phenotypic relationship
5.1.1.4. Mating based on degree of genetic/pedigree relationship
5.1.2. Inbreeding
5.1.3. Genetic consequences of inbreeding
5.1.4. Measurement of inbreeding and relationship coefficients
5.2. Line breeding
5.3. Outbreeding and heterosis
5.3.1. Genetic effects of outbreeding
5.3.2. Phenotypic effects of outbreeding: hybrid vigor
5.3.3. Types and measurements of heterosis
5.4. Systems of crossbreeding
5.4.1. Uses of crossbreeding
5.4.2. Two-, three-, four-breed crossing
5.4.3. Terminal crossbreeding
5.4.4. Rotational crossbreeding
5.4.5. Grading-up
5.4.6. Species hybridization

6. Genotype by Environment Interaction
6.1. Classification of G x E interaction
6.2. Extent of G x E interactions
6.3. Examples of G x E interaction

7. Animal Evaluation and Computation of Breeding Values (BVs)
7.1. Station vs field test/evaluation
7.2. Performance testing
7.3. Progeny testing
7.4. Why compute BV?
7.5. Different criteria used for predicting BV
7.5.1. Individual's own performance (single and repeated records)
7.5.2. Pedigree performance
7.5.3. Family performance
7.5.4. Performance of sibs
7.5.5. Performance of progeny

8. Breeding Industry Structure

8.1. Traditional breeding pyramid: closed nucleus breeding scheme
8.2. Open nucleus breeding scheme
8.3. Group breeding scheme
8.4. Sire referencing scheme

9. Animal Genetic Resources (AnGR) and Conservation
   9.1. Characterization of livestock
   9.2. Breed and species diversity
   9.3. Global breed risk status
   9.4. Causes of loss of AnGR
   9.5. Why conserve genetic diversity: rational for conservation
   9.6. Methods of conservation

Practical:

- Pedigreed and phenotypic data [performance and linear body measurement data collection] generation and analyses from CBBP villages
- Estimation of variance components
  - Phenotypic
  - genetic and
  - environmental
- Heritability and repeatability
- Coefficient of inbreeding and relationship
- Practical application of methods for genetic evaluation
- Estimation of breeding value

Assessment:

- Practical/lab/field report work and report 25%
- Quizzes and assignment 20%
- Mid exam 20%
- Final exam 35%

References

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4. Gerald Wiener (1994) Animal Breeding 5. Malcolm, B. W. (1991)
5. Dalton's Introduction to Practical Animal Breeding
6. Michael L. and Bruce W. (1998). Genetics and Analysis of Quantitative Traits Citation:
7. Haile A., Wurzinger M., Mueller J., Mirkena T., Duguma G., Rekik M., Mwacharo J., Mwai O., Sölkner J. and Rischkowsky B. 2018. Guidelines for Setting Up community-based small ruminants breeding programs in Ethiopia. ICARDA—Tools and guidelines No.1. Beirut, Lebanon: ICARDA.

Course Title: Animal Breeding

Course Code: AnSc 311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of Genetics

Course Category: Core

Course Description:

This course deals with the historical back ground of animal breeding; characterization of indigenous livestock/poultry/, alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, definition of breeding objectives and identification of economically important traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; estimating breeding values and genetic parameters including heritability, genetic correlation and repeatability; the bases of establishing breeding programs, types of selection, Mating systems (inbreeding and crossbreeding); hybrid vigor and inbreeding depression and principles and methods of conservation of animal genetic resources;

Learning Outcomes: Upon successful completion of this course, students should be able to:

- Participatory definition of breeding objectives
- Understand selection theory and breeding methods;
- Understand tools available to maximize response to genetic selection;
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation;
- Optimize selection and mating decisions;
- Estimate genetic parameters and breeding values; and
- Understanding the concept of alternative breeding programs.

Mode of Delivery:

Lecture, discussions, assignment, practical sessions based on filed data and field visits to livestock farms including livestock research centers and community-based breeding program villages.

Teaching Aids:

Reference books, handouts, animal farms, teaching videos.

Course Contents:

1. Introduction
   1.1. Definition and history of animal breeding
   1.2. Goals of animal breeding

1.3. Overview of animal breeding industries
    1.3.1. Value of improvement
    1.3.2. Role of the government
1.4. Contribution of animal breeding to livestock and poultry improvement
1.5. Genetic vs. environmental improvement

2. Categories of Traits in Livestock and Poultry
2.1. Qualitative traits
2.2. Quantitative traits
2.3. Threshold traits
2.4. Component traits
2.5. Economically important traits: description, measurement and inheritance
    2.5.1. Growth, feed efficiency and carcass traits
    2.5.2. Milk production and composition traits
    2.5.3. Reproduction and survival traits
    2.5.4. Type and conformation traits
    2.5.5. Egg production traits (quantitative and qualitative)
    2.5.6. Other Traits (wool, pelt, ...)

3. Quantitative Effects of Genes in Populations
3.1. Genetic and environmental effects
3.2. Genetic components of variance
3.3. Additive variance
3.4. Dominance variance
    3.4.1. Epistatic variance
3.5. Environmental components of variance
3.6. Resemblance between relatives
    3.6.1. Phenotypic resemblance
    3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)
3.7. Heritability and repeatability
    3.7.1. Concepts and usefulness of heritability
    3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)
    3.7.3. Repeatability
    3.7.4. Basic concepts
    3.7.5. Heritability vs repeatability
3.8. Correlations (phenotypic, genetic and environmental correlations)

4. Selection
4.1. Natural vs. artificial selection
4.2. Classification of selection
    4.2.1. Individual (mass / phenotypic) selection
    4.2.2. Selection based on performance of relatives
    4.2.3. Family selection
    4.2.4. Sib selection

4.2.5. Selection on progeny performance

4.3. Methods of selection

4.3.1. Tandom method of selection

4.3.2. Independent culling level

4.3.3. Total score or selection index method

4.4. Response to selection and prediction of genetic gain

4.4.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)

4.4.2. Correlated response to selection

5. Mating Systems

5.1. Inbreeding and line breeding

5.1.1. Classification of mating systems

5.1.1.1. Random mating (panmixia)

5.1.1.2. Non-random mating

5.1.1.3. Mating based on phenotypic relationship

5.1.1.4. Mating based on degree of genetic/pedigree relationship

5.1.2. Inbreeding

5.1.3. Genetic consequences of inbreeding

5.1.4. Measurement of inbreeding and relationship coefficients

5.2. Line breeding

5.3. Outbreeding and heterosis

5.3.1. Genetic effects of outbreeding

5.3.2. Phenotypic effects of outbreeding: hybrid vigor

5.3.3. Types and measurements of heterosis

5.4. Systems of crossbreeding

5.4.1. Uses of crossbreeding

5.4.2. Two-, three-, four-breed crossing

5.4.3. Terminal crossbreeding

5.4.4. Rotational crossbreeding

5.4.5. Grading-up

5.4.6. Species hybridization

6. Genotype by Environment Interaction

6.1. Classification of G x E interaction

6.2. Extent of G x E interactions

6.3. Examples of G x E interaction

7. Animal Evaluation and Computation of Breeding Values (BVs)

7.1. Station vs field test/evaluation

7.2. Performance testing

7.3. Progeny testing

7.4. Why compute BV?

7.5. Different criteria used for predicting BV

7.5.1. Individual's own performance (single and repeated records)

7.5.2. Pedigree performance
7.5.3. Family performance
7.5.4. Performance of sibs
7.5.5. Performance of progeny

8. Breeding Structures and schemes
   8.1. Closed nucleus breeding scheme
   8.2. Open nucleus breeding scheme
   8.3. Community Based Breeding Program
      8.3.1. Concepts of CBBP and Applications
      8.3.2. Components and steps in setting CBBPs in villages
   8.4. Group breeding scheme
   8.5. Sire referencing scheme
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   9.1. Characterization of Indigenous livestock
   9.2. Breed and species diversity
   9.3. Global breed risk status
   9.4. Causes of loss of AnGR
   9.5. Why conserve genetic diversity: rational for conservation
   9.6. Methods of conservation

Practical:

- Pedigreed and phenotypic data [performance and linear body measurement data collection] generation and analyses from CBBP villages
- Estimation of variance components
  - Phenotypic
  - genetic and
  - environmental
- Heritability and repeatability
- Coefficient of inbreeding and relationship •
- Practical application of methods for genetic evaluation
- Estimation of breeding value

Assessment:

- Practical/lab/field report work and report 25%
- Quizzes and assignment 20%
- Mid exam 20%
- Final exam 35%

References

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2. Daniel L. Hart and Andrew G. Clark (1997). Principles of Population Genetics
3. Falconer D.S. (1989). Introduction to Quantitative Genetics. 3rd ed.
4. Gerald Wiener (1994). Animal Breeding
5. Malcolm, B. W. (1991). Dalton's Introduction to Practical Animal Breeding,
6. Michael L. and Bruce W. (1998). Genetics and Analysis of Quantitative Traits
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Animal breeding course book

DebreMarkos University							
Program: Animal science							
Course Guide book							
Course Titles/Codes	**Animal Breeding** (AnSc 3082)						
Module Name/No.	**Animal Genetic & Breed Improvement**						
Course ECTS	5						
Course Information	**Target Group: animal science year II** **Academic Year :** **Semester : I** **Meeting Location/Room :**						
Module Coordinator	**Name:MisganawMammoCell Phone: 0913383832** **: 0983159941** **E-mail: Misganawmammo@rocketmail.com** **Office:- Animal science**						
Instructor (s)	**Name:MisganawMammo** Office : Animal Science Phone :**0913383832** / 0983159941 **Email : misganawmammo@rocketmail.com** **Office hour:**						
ECTS	**5 ECTS**						
Student's Work Load	**Lecture**	**Tutorial**	**Home Study**	**Assessment**	**Practice/field works**	**Group work**	**Total**
	32 hrs	**16**	**23**	**-**	**48**	**16**	**135 hrs**
Course Description	This course deals with the historical back ground of animal breeding; characterization of indigenous livestock/poultry/, alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, definition of breeding objectives and identification of economically important traits in farm animals, variation in quantitative traits and causes of variation, components of variation and their partitioning. Population genetics.The Genetic parameters including heritability, genetic correlation and repeatability of farm animals: Tools in farm animal genetic improvements (selection and mating systems (Cross breeding and Inbreeding)). Hybrid vigor and inbreeding depression. Relationship Characterization of indigenous livestock /poultry/ and principles and methods of conservation of animal genetic resources. Breeding schemes.						
Learning Outcome	**At the end of the course the student should be able to understand:** ➢ Participatory definition of breeding objectives ➢ Understand selection theory and breeding methods; ➢ Concepts of traits and variation in quantitative traits ➢ the concept Population genetics ➢ Genetic parameters and its advantage ➢ Know important Breeds and Breeding system along with different breeding schemes ➢ tools available to maximize response to genetic selection; ➢ the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation; ➢ Optimize selection and mating decisions; ➢ Estimate genetic parameters and breeding values; and						

	➢ Understanding the concept of alternative breeding programs.
Mode of Delivery/ /Teaching and learning methods	Lecture, brain storming questions, group discussions and presentation, assignment (group and individual), practical sessions based on filed data and field visits to livestock farms including livestock research centersand community-based breeding program villages (cooperative learning)
Teaching Aids:	Reference books, handouts, animal farms, teaching videos attached with link in PPT.
Pre-requisites	**Animal Genetics**
Course Status	**Core**

Course Contents (Schedule)

Topics and Subtopics

1. Introduction
   - 1.1. Definition and history of animal breeding
   - 1.2. Goals of animal breeding
   - 1.3. Overview of animal breeding industries
     - 1.3.1. Value of improvement
     - 1.3.2. Role of the government
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   - 2.1. Qualitative traits
   - 2.2. Quantitative traits
   - 2.3. Threshold traits
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     - 2.5.2. Milk production and composition traits
     - 2.5.3. Reproduction and survival traits
     - 2.5.4. Type and conformation traits
     - 2.5.5. Egg production traits (quantitative and qualitative)
   - 2.6. Other Traits (wool, pelt, …)
3. Quantitative Effects of Genes in Populations
   - 3.1. Genetic and environmental effects
   - 3.2. Genetic components of variance
   - 3.3. Additive variance
   - 3.4. Dominance variance
     - 3.4.1. Epistatic variance
   - 3.5. Environmental components of variance
   - 3.6. Resemblance between relatives
     - 3.6.1. Phenotypic resemblance
     - 3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)
   - 3.7. Heritability and repeatability
     - 3.7.1. Concepts and usefulness of heritability
     - 3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)

- 3.7.3. Repeatability
- 3.7.4. Basic concepts
- 3.7.5. Heritability vs repeatability

3.8. Correlations (phenotypic, genetic and environmental correlations)

4. Selection
   - 4.1. Natural vs. artificial selection
   - 4.2. Classification of selection
     - 4.2.1. Individual (mass / phenotypic) selection
     - 4.2.2. Selection based on performance of relatives
     - 4.2.3. Family selection
     - 4.2.4. Sib selection
     - 4.2.5. Selection on progeny performance
   - 4.3. Methods of selection
     - 4.3.1. Tandom method of selection
     - 4.3.2. Independent culling level
     - 4.3.3. Total score or selection index method
   - 4.4. Response to selection and prediction of genetic gain
     - 4.4.1. Improving response to selection: (accuracy of selection, selection differential, genetic variability, generation interval)
     - 4.4.2. Correlated response to selection

5. Mating Systems
   - 5.1. Inbreeding and line breeding
     - 5.1.1. Classification of mating systems
       - 5.1.1.1. Random mating (panmixia)
       - 5.1.1.2. Non-random mating
       - 5.1.1.3. Mating based on phenotypic relationship
       - 5.1.1.4. Mating based on degree of genetic/pedigree relationship
     - 5.1.2. Inbreeding
     - 5.1.3. Genetic consequences of inbreeding
     - 5.1.4. Measurement of inbreeding and relationship coefficients
   - 5.2. Line breeding
   - 5.3. Outbreeding and heterosis
     - 5.3.1. Genetic effects of outbreeding
     - 5.3.2. Phenotypic effects of outbreeding: hybrid vigor
     - 5.3.3. Types and measurements of heterosis
   - 5.4. Systems of crossbreeding
     - 5.4.1. Uses of crossbreeding
     - 5.4.2. Two-, three-, four-breed crossing
     - 5.4.3. Terminal crossbreeding
     - 5.4.4. Rotational crossbreeding
     - 5.4.5. Grading-up
   - 5.5. Species hybridization

6. Genotype by Environment Interaction

6.1.Classification of G x E interaction
6.2.Extent of G x E interactions
6.2.1. Examples of G x E interaction

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- Pedigreed and phenotypic data [performance and linear body measurement data collection] generation and analyses from CBBP villages
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Assessment:

- Practical/lab/field report work and report 25%
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- Mid exam 20%

Final exam 35%

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Approval Section:

Prepared by instructor	**Approved by department head**
Name: Misganaw Mammo	**Name: Yaregal Melak**
Signature	**Signature**
Date 16/03/2014 E.C	**Date 16/03/2014 E.C**

Integrating Community Based Breeding Program (CBBP) in Undergraduate Curriculum: Animal Sciences

Background

Community Based Breeding Program is an alternative Breeding Strategy in small holder and resource poor farmers' flock. The program was initiated in 2010 in four sites and now extended to more than 100 sites. The increase in farmers' income has reached up to 20% that has triggered to upscale and out scale CBBP initiatives. Ensuring sustainability of CBBP is a critical issue. One of the strategies to ensuring sustainability of CBBP is integration of CBBP in the curriculum. The integration of CBBP in a curriculum has also added advantages that, graduating students will implement the program right away in their assignment as extension and research staff. Graduates can create knowledge based jobs. International Center for Agricultural Research in Dry Areas (ICARDA) took the initiative and consulted Ethiopian Universities in the integration of CBBP in the undergraduate Animal Science Program. The first workshop was organized on July, 20, 2021 and the second workshop was organized on July 27, 2021 with theme " **Scaling up Community Based Breeding Programs through Ethiopian Universities".** Representatives from ten federal Universities were involved in the first workshop. In the second workshop, 11 federal state Universities were involved. The representatives were Animal Breeders and University community service directors, which can implement CBBP in their respective Universities. The workshop formed a committee to amend a curriculum with CBBP practices in Animal Breeding course. Based on the recommendations of the workshop, amendment of the curriculum was made as described below and highlighted by yellow colour for a wider circulation and comments. Universities are expected to implement the CBBP initiatives.

What is required to enter into action and report the integration of CBBP in the curriculum?

- Course Team of Animal breeding and genetics review the proposed curriculum amendment and submit to the head of department with recommendations.
- The department council, chaired by the head of department approves the amendment supported by a minutes
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- Documentation of the amendment and minutes in head department office and make a follow up of the implementation
- Final date of submission End of August 2021.

Course clusters: Animal Breeding and Breed Improvement

- Animal Genetics
- Reproductive physiology and Artificial Insemination
- **Animal Breeding**
- Animal Biotechnology

Table 1: List of core courses

Sr/N	Course Name	Cr.HR	ECTS
1	Anatomy and Physiology of Farm Animals	3	5
2	Fishery and Aquaculture	3	5
3	Swine Production and Management	2	3
4	**Principle of Genetics**	**3**	**5**
5	Principle of Animal Nutrition	3	5
6	Sheep and Goat Production and Management	3	5
7	Forage and Pasture Production and Management	3	5
8	Camel Production and Management	2	3
9	**Animal Breeding**	**3**	**5**
10	Reproductive Physiology and Artificial Insemination	2	3
11	Applied Animal Nutrition	4	6
12	Poultry Production and Hatchery Management	4	6
13	Dairy Cattle Production and Management	3	5
14	Practical in Animal Science I	1	2
15	Beef Cattle Production and Management	3	5
16	Equine Production and Draft Animals Management	3	5
17	Biometry	3	5
18	Research Methods in Animal Sciences	2	3
19	**Animal Biotechnology**	**3**	**5**
20	Range Ecology and Management	3	5
21	Veterinary Parasitology	2	3
22	Practical in Animal Science II	1	2
23	Practical Attachment	2	3
24	Apiculture	3	5
25	Sericulture	2	3
26	Animal Behavior and Welfare	2	3
27	Hide and Skin Processing	2	3
28	Animal Health and Disease Control	3	5
29	Senior Seminar	1	2
30	Food Hygiene and Veterinary Public Health	2	3
31	Livestock Products Processing Technology	3	5
32	Senior Research Project	2	3

Course Title: Animal Breeding

Course Code: AnSc 311

Course Credit Hours: 3 (2+1)

Course Pre-requites: Principles of Genetics

Course Category: Core

Course Description:

This course deals with the historical back ground of animal breeding; characterization of indigenous livestock/poultry/, alternative breeding schemes, concepts and procedures in implementation of community-based breeding programs, definition of breeding objectives and identification of economically important traits in farm animals; variation in quantitative traits and causes of variation; components of variation and their partitioning; estimating breeding values and genetic parameters including heritability, genetic correlation and repeatability; the bases of establishing breeding programs, types of selection, Mating systems (inbreeding and crossbreeding); hybrid vigor and inbreeding depression and principles and methods of conservation of animal genetic resources;

Learning Outcomes: Upon successful completion of this course, students should be able to:

- Participatory definition of breeding objectives
- Understand selection theory and breeding methods;
- Understand tools available to maximize response to genetic selection;
- Understand the effects of inbreeding and crossbreeding, heritability and repeatability, and breeding value estimation;
- Optimize selection and mating decisions;
- Estimate genetic parameters and breeding values; and
- Understanding the concept of alternative breeding programs.

Mode of Delivery:

Lecture, discussions, assignment, practical sessions based on filed data and field visits to livestock farms including livestock research centers and community-based breeding program villages.

Teaching Aids:

Reference books, handouts, animal farms, teaching videos.

Course Contents:

1. Introduction
   1.1. Definition and history of animal breeding
   1.2. Goals of animal breeding
   1.3. Overview of animal breeding industries
      1.3.1. Value of improvement

1.3.2. Role of the government

1.4. Contribution of animal breeding to livestock and poultry improvement

1.5. Genetic vs. environmental improvement

2. Categories of Traits in Livestock and Poultry

2.1. Qualitative traits

2.2. Quantitative traits

2.3. Threshold traits

2.4. Component traits

2.5. Economically important traits: description, measurement and inheritance

2.5.1. Growth, feed efficiency and carcass traits

2.5.2. Milk production and composition traits

2.5.3. Reproduction and survival traits

2.5.4. Type and conformation traits

2.5.5. Egg production traits (quantitative and qualitative)

2.5.6. Other Traits (wool, pelt, ...)

3. Quantitative Effects of Genes in Populations

3.1. Genetic and environmental effects

3.2. Genetic components of variance

3.3. Additive variance

3.4. Dominance variance

3.4.1. Epistatic variance

3.5. Environmental components of variance

3.6. Resemblance between relatives

3.6.1. Phenotypic resemblance

3.6.2. Genetic covariance (parent and offspring, half-sibs, full-sibs)

3.7. Heritability and repeatability

3.7.1. Concepts and usefulness of heritability

3.7.2. Estimation of heritability (regression of offspring on parents, sib-analysis (half-sib and full-sib)

3.7.3. Repeatability

3.7.4. Basic concepts

3.7.5. Heritability vs repeatability

3.8. Correlations (phenotypic, genetic and environmental correlations)

4. Selection

4.1. Natural vs. artificial selection

4.2. Classification of selection

4.2.1. Individual (mass / phenotypic) selection

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4.2.5. Selection on progeny performance

4.3. Methods of selection

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- 4.3.2. Independent culling level
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5.1. Inbreeding and line breeding

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  - 5.1.1.2. Non-random mating
  - 5.1.1.3. Mating based on phenotypic relationship
  - 5.1.1.4. Mating based on degree of genetic/pedigree relationship
- 5.1.2. Inbreeding
- 5.1.3. Genetic consequences of inbreeding
- 5.1.4. Measurement of inbreeding and relationship coefficients

5.2. Line breeding

5.3. Outbreeding and heterosis

- 5.3.1. Genetic effects of outbreeding
- 5.3.2. Phenotypic effects of outbreeding: hybrid vigor
- 5.3.3. Types and measurements of heterosis

5.4. Systems of crossbreeding

- 5.4.1. Uses of crossbreeding
- 5.4.2. Two-, three-, four-breed crossing
- 5.4.3. Terminal crossbreeding
- 5.4.4. Rotational crossbreeding
- 5.4.5. Grading-up
- 5.4.6. Species hybridization

6. Genotype by Environment Interaction

6.1. Classification of G x E interaction

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Course Title: Animal Breeding

Course Code: AnSc 311

Course Credit Hours: 3 (2+1)

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Course Category: Core

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