With the introduction of specialized courses of study in the third and fourth year of high school, it has become necessary to do more specialized work in the area of livestock production. The course is designed to provide a guideline to encourage intensified studies in this area, and outlines materials and methods, time allotment, and the use of course materials. The course is divided into three sections and, within each section, into units and jobs. Each job is broken down into five sections: objective, motivation, references, teaching outline, and teaching procedures; in most cases illustrative material is provided. Section A, Livestock Selection, is 27 pages long and reviews herd selection, and the selection of swine, beef animals, sheep, and dairy cattle. Section B, 96 pages, covers the history and present day methods of livestock breeding, trends in Livestock Improvement, and 13 sections covering aspects of reproduction and inheritance. The topics treated in Livestock Nutrition, Section C, 80 pages, are the monogastric and ruminant digestive systems, six sections on nutrients, followed by the digestive process, metabolism and absorption of nutrients, and four sections on rations. (NH)
ADVANCED LIVESTOCK PRODUCTION:
A COURSE OF STUDY

Prepared by
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In Cooperation With

Agricultural Education Service
Division of Vocational Education
State Department of Education
Richmond, Virginia 23216

1973
ACKNOWLEDGEMENTS

Appreciation is expressed to Mr. Julian M. Campbell, State Department of Education, Richmond, Virginia, for sponsoring this curriculum material; and to Dr. Alfred H. Krebs, Professor and Head of Agricultural Education, for his guidance and direction in the preparation of this material.

A Virginia Polytechnic Institute and State University Extension Division Education Field Service Publication
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INTRODUCTION

With the introduction of specialized courses of study in the third and fourth year of high school, it has become necessary to do more specialized work in the area of livestock production. This work has been done in the hope of providing a guideline to encourage intensified studies in this area. This unit should not be considered to be inclusive. Much expansion should be done by the individual instructor to adjust this to his locality and the needs of his students.

The problem of developing a course of study for advanced livestock production has been attacked from the standpoint of this course being fundamentally a science, and that the thorough understanding of that science is the foundation for further study.
MATERIALS AND METHODS

The following source list was developed to allow deliberation upon selection of teaching aids prior to teaching of this course of study. Careful consideration should be given to the selection of these references. The teaching aids listed were selected from the recommended book list, and have definite application to specific areas. In an era when facts are constantly changing, there can be no one best reference for teaching such a broad area as livestock production.

The reference, *Selected References and Aids for Teaching Animal Science to Students of Vocational Agriculture*, has been of valuable assistance in selecting the films and other publications. Without this comprehensive reference, it would have been impossible to select such appropriate teaching aids.

Special attention should be given to the selection of appropriate references and teaching aids before the time arises for their use.

Publishing companies or mailing addresses are given to aid in securing the needed references and teaching aids.
Based on one fifty-minute period per day.

<table>
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</tr>
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</table>

Lost Days
HOW TO USE THIS BOOK

There are three areas within this course: Livestock Selection, Livestock Breeding and Livestock Nutrition. Careful planning should go into the preparation for each area. Careful attention should be given to securing the needed references. Slides, films and other publications should be ordered well in advance. This will necessitate the formulation of a calendarized course of study in order to anticipate the dates for which these materials will be needed. Once the calendar is made, it must be followed closely if one hopes to conclude this course of study within a semester.

Arrangements for field trips, guest speakers and jobs requiring periodical information (Job VIII) should be pre-planned in order to secure the maximum benefit.

Pages containing the letter "H" are recommended as handouts while the pages containing the letter "T" are recommended as transparencies. Some instructors may find it of greater convenience to assemble a "slide-bank" of these materials.
SOURCE LIST

An attempt should be made to keep this source list up to date and comprehensive as new materials become available.

BOOKS

Livestock Selection


Livestock and Poultry Production. Bundy and Diggins Prentice-Hall.


Beef Production. Diggins and Bundy. Prentice-Hall.


Dairy Cattle Judging and Selection. Yapp, John Wiley and Sons.

Livestock Breeding

Breeding and Improvement of Farm Animals. Rice and Andrews. McGraw-Hill

Introduction to Breeding Farm Animals. Winters, John Wiley and Sons.

Genetics of Livestock Improvement. Lagley, Prentice-Hall.
Livestock and Poultry Production, Randy and Diggins,

Prentice-Hall.

Livestock Nutrition


SLIDES

"Animal Science," Iowa State University.

"101 Cuts of Meat", National Livestock and Meat Board.

FILMS


"Tomorrow’s Beef Today," Soil Conservation Service, Film Library, Regional Technological Service Center.

134 South 12th Street, Lincoln, Nebraska 68508.


3201 Frederick Street, St. Joseph, Missouri 64501.


"Culling Sheep", Union Pacific Railroad, 1416 Dodge Street, Omaha, Nebraska 68102.

"Sheep Shape", The Venard Organization.

"Story of Sheep", Texaco, Inc.
"Animal Wonders." American Guernsey Cattle. Promotion Department. 70 Main Street, Peterborough, New Hampshire 03458.

"National Dairy Congress," Purdue Audio Visual Center, Purdue University, Lafayette, Indiana 47907.

"Raising Dairy Calves," Union Pacific Railroad.


"Animal Breeding." Public Relations Department, Indiana Farm Bureau Cooperative Association, Inc., 47 South Pennsylvania Street, Indianapolis, Indiana 46209.

"Heredity," Communication Department, 119 Whitten Hall, Columbia, Missouri 65201.

"The Rumen Story," Ralston Purina Company, St. Louis, Missouri.

"Trip Through a Pig Factory," Ralston Purina.

OTHER PUBLICATIONS


"Animal Science," State Department of Education, Agricultural Education Section and University of Missouri, Agricultural Education Department.


(Handbook)
"101 Cuts of Meat," The Interstate. (Cards)


"Dairy Herd Improvement Association," Alfred Lane, 126 Eckles Hall, Columbia, Missouri 65201.


"Doane's Agricultural Reports," Doane's, St. Louis, Missouri.

"Improvement of Swine Through Breeding," B775, J. F. Lasley, B. N. Day and L. F. Tribble, University of Missouri, Agricultural Experiment Station, Columbia, Missouri 65201.


"Nutrient Requir ements of Horses," No. 6, publication 1401, National Research Council.


LIVESTOCK SELECTION

BEST COPY AVAILABLE
ADVANCED LIVESTOCK PRODUCTION

A Course of Study

Course: Advanced Livestock Production

Area: Livestock Selection

Unit: Basis for Selection of Foundation Stock

Job I: Herd Selection and Improvement

Objectives: To instruct students in the proper method of selecting foundation stock

To teach the student how to improve existing herds

Motivation: Show pictures or slides of livestock of today and those of thirty years ago. Ask the students why these differences have resulted.

References: 1. "Animal Science" unit

2. Animal Science, Ensminger

3. Livestock and Poultry Production, Burdy and Diggins.


5. Films: (a) "The Story of Breeds"

(b) "New Ideas in Livestock Production"

(c) "Tomorrow's Beef Today"
Teaching Outline:  

I. Important factors to consider in the selection of a breed  
   A. Availability of good stock in local community or area  
   B. Prolificy -- ability to produce large litters  
   C. Carcass quality -- ability to produce carcasses  
      that are high in lean meat and low in fat  
   D. Efficient use of feed -- can covert feed into pork  
   E. Growth ability -- are they able to make rapid gains  
   F. Personal likes and dislikes.  

II. Selection of Animals  
   A. Physical traits as a means of selection  
      1. Review "Animal Science" unit (pp. 25-30)  
   B. Genetic traits as a means of selection  
      1. Heritability estimates  
   C. Other important traits  
      1. Weaning weight  
      2. Rate of gain  
      3. Efficiency of gain  
      4. Carcass quality
D. Records, health, pedigrees, and selection

1. Pedigree important, but commercial producer more concerned with production records
   a. Consider record of sire, dam, and to a lesser degree that of grandsire and granddam
   b. Check for certification, pacesetter or superior meat sire on sire side
   c. Check for production registry information on the dam side.

2. Production and performance records
   a. Swine
      (1) Production registry requirements
         (a) A mature sow must farrow and raise eight or more pigs to a 56-day weight of at least 320 pounds.
         (b) A first litter gilt must raise the same number of pigs to a 56-day weight of at least 275 pounds.
         (c) A sow qualifies for production registry after producing two production registry litters.
(d) To qualify as production registry sires, boars must sire five qualified daughters or fifteen daughters that have produced one production registry litter.

(2) Meat certification requirements

(a) Litter must qualify for production registry

(b) Two pigs from the litter must be slaughtered and meet the following requirements:

(1) Weigh 200 pounds at 180 days

(2) Weigh less than 220 pounds at slaughter

(3) Meet these carcass measurements:

- Length -- 29 inches
- Maximum back fat -- 1.6 inches
- Minimum loin eye -- 4 square inches

(4) Litter mates have about 50% of their genes in common and carcass traits are highly heritable

(3) Testing stations

(a) Boars and gilts are tested for

(1) Daily rate of gain

(2) Pounds of feed per pound of gain

(3) Inches of back fat
(b) Litter mate barrows are tested for

(1) Carcass length
(2) Back fat thickness
(3) Per cent of ham and loin in carcass
(4) Size of loin eye area
(5) Carcass grade

(4) Health

(a) Animals large for age are usually in good health. Know herd that animal came from and purchase from disease-free herd.

(b) Negative blood tests for brucellosis and leptospirosis are a must. Vaccination for erysipelas is a must. Animal should be free from internal and external parasites.
Teaching Procedure:

I. Introduce Unit.

II. Show films on livestock selection.

III. Discuss performance testing, production, registry, certified meat sires, etc.

IV. If possible, tour a testing station and obtain testing information, illustrating to students how they can use this information in selecting new and replacement animals.

V. Discuss places to purchase boars and gilts and factors to consider in purchasing.

VI. If possible, attend area purebred or testing station sales.

VII. Summarize and evaluate trips and other learning activities.
Course: Advanced Livestock Production

Area: Livestock Selection

Unit: Basis for Selection of Foundation Stock

Job II: Selection of Swine

Objectives: To instruct students in the proper method of selecting breeding and feeding stock and to tell the reasons

To be able to recognize the cuts of meat as taken from swine

Motivation: "How much can you afford to pay for a herd sire?"

"Is a boar really half a herd?"

References: 1. "101 Cuts of Meat" Cards, The Interstate


3. "101 Cuts of Meat" Slides, National Livestock and Meat Board

4. Livestock and Poultry Production, Bunded Diggins

5. Livestock Judging Handbook, Nordby, Beeson and Fourt


7. Swine Science 3rd Edition, Ensminger (pp. 67-81)


Teaching Outline:

I. Parts of a hog
II. Wholesale cuts of a hog
III. Ideal conformation of a hog
IV. Common Faults of conformation
V. Student judging of a class of hogs
VI. Important breed characteristics
VII. Identification of pork meat slides

Teaching Procedures:

I. Introduce unit.
II. Discuss common faults and judging a class of hogs.
III. Take a pre-arranged field trip and require oral or written reasons for the students' selections.
IV. Discuss the characteristics of each breed.
V. Review slides of cuts of meat from swine and their value as related to selection.
VI. Summarize and evaluate the learning activities.
PARTS OF A HOG

1. SNOUT
2. EYE
3. EAR
4. CHEEK
5. JOWL
6. POLL
7. NECK
8. SHOULDER
9. FORELEG
10. ELBOW
11. KNEE
12. SHANK
13. ANKLE
14. DEW CLAW
15. PASTERN
16. TOE
17. FOREFLANK
18. BACK
19. LOIN
20. SIDE
21. BELLY
22. TEATS
23. SHEATH
24. HIND FLANK
25. RUMP
26. TAIL
27. HAM
28. HOCK
WHOLESALE CUTS OF A PORK CARCASS
-major parts of a hog

- uniform width of back
- full loin
- thick loin
- long, full rump
- high tail setting
- uniform arch
- long, smooth side
- smooth shoulder
- trim underline
- deep flanks
- straight strong pasterns
- deep thick ham
- deep flank
Course: Advanced Livestock Production

Area: Livestock Selection

Unit: Baisis for Selection of Foundation Stock

Job III: Selection of Beef Animals

Objectives: To acquaint the students with the proper method of selecting breeding and feeding stock

To teach students to identify beef meat cuts

Motivation: "Do you own a good bull?" "Why is he good?"

References:
2. "101 Cuts of Meat" Slides, National Livestock and Meat Board
3. "101 Cuts of Meat" Cards, The Interstate
4. Livestock and Poultry Production, Bundy and Diggins
5. Livestock Judging Handbook, Nordby, Beeson, and Fourt
6. Beef Production, Diggins and Bundy (pp. 20-87)
8. Selection, Fitting, Showing Beef Cattle, Nordby and Lattig
10. Film: "Modern Beef Cattle", American Angus Association
II. "Selection of Beef Breeding Animals" Filmstrip

Teaching Outline:

I. Parts of a beef animal

II. Wholesale cuts of a beef animal

III. Ideal conformation of a beef animal

IV. Common faults in conformation

V. Important breed characteristics

VI. Identification of beef meat cuts

VII. Student judging of a class of beef animals

Teaching Procedure:

I. Introduce unit.

II. Present and discuss the cuts of meat as they pertain to economic importance.

III. Arrange a sufficient number of field trips to study breeding and feeding stock for both market and feeder stock.

IV. Require oral or written reasons for students' selections as well as placing of animals.

V. Show films relating to beef selection.

VI. Summarize and evaluate the learning activities.
PARTS OF A PIGEON ANIMAL

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WHOLESALE CUTS OF A BEEF CARCASS

1. Loin
2. Rump
3. Round
4. Rib
5. Chuck
6. Plate
7. Flank
8. Brisket
9. Shank
Major parts of a beef animal:

- Long square level rump
- Broad back
- Strong straight top
- Smooth shoulder
- Deep full quarter
- Deep flanks
- Deep chest
- Wide front
- Wide loin
- Strong bone
- Straight legs
Course: Advanced Livestock Production  
Area: Livestock Selection  
Unit: Basis for Selection of Foundation Stock  
Job IV: Selection of Sheep  
Objective: To teach students to recognize the ideal mutton type and to identify the meat cuts of lamb  
Motivation: "Is there a place for sheep on your farm?"  
"Can you tell an ideal sheep from a cull?"  
"What makes sheep judging so deceptive?"  
2. "101 Cuts of Meat" Slides, National Livestock and Meat Board  
3. "101 Cuts of Meat" Cards, The Interstate  
4. Livestock and Poultry Production, Bundy and Diggins (pp. 440-446)  
5. Livestock Judging Handbook, Nordby, Beeson, and Fourt  
7. Films:  
(a) "Culling Sheep". Union Pacific Railroad  
(b) "Sheep Shape", The Venard Organization  
(c) "Story of Sheep." Texaco, Inc.
Teaching Outline:

I. Parts of a sheep
II. Wholesale cuts of a sheep carcass
III. Ideal conformation of sheep
IV. Common faults in conformation
V. Important breed characteristics
VI. Identification of the cuts of meat of sheep
VII. Student judging of a class of sheep

Teaching Procedures:

I. Introduce unit.
II. Arrange a sufficient number of field trips to study breeding stock and apply classroom information.
III. Require oral or written reasons for students' selections as well as for placing of animals.
IV. Present and discuss the cuts of meat as they pertain to economic importance.
V. Show films relating to selection of sheep.
VI. Summarize and evaluate the learning activities.
1 MOUTH
2 NOSTRIL
3 SUBORBITAL GLAND
4 FACE
5 EYE
6 FOREHEAD
7 HORN PIT
8 EAR
9 NECK
10 THROAT
11 TOP OF SHOULDER
12 BACK
13 LOIN
14 HIP
15 RUMP
16 DOCK
17 LEG OF LAMB
18 HOCK
19 SHANK
20 PASTERN JOINT OR ANKLE
21 DEW CLAW
22 PASTERN
23 TOE
24 HIND FLANK
25 RIBS
26 HEART GIRTH
27 SHOULDER
28 BREAST
29 BRISKET
30 FOREARM
31 KNEE
32 FOREFLANK
33 BELLY
34 PENIS
Wholesale Cuts of a Lamb Carcass.

Key:
1. Leg
2. Loin
3. Hotel rack
4. Shoulder
5. Breast
6. Flank
Major Parts of a Sheep

- Short Blocky Head
- Long Square Rump
- Deep Chest
- Wide Front
- Wide Deep Flanks
- Well Sprung Ribs
- Deep Twist
- Straight Legs
- Strong Bone
- Strong Straight Top
- Wide Loin
- STRAIGHT LEGS
- STRONG BONE
Course: Advanced Livestock Production

Area: Livestock Selection

Unit: Basis for Selection of Foundation Stock

Job V: Selection of Dairy Cattle

Objectives: To understand the importance of type in dairy selection

To practice using judgment in selecting dairy individuals

Motivation: "Which breed of dairy cattle is best?" "Why?"

References:
1. Livestock and Poultry Production (pp. 299-320)
2. Dairy Cattle Judging and Selection, Yapp, John Wiley and Sons
3. Livestock Judging Handbook, Nordby, Beeson, and Fourt
4. "Dairy Cow Unified Score Card"
5. "Dairy Bull Unified Score Card"
6. "Dairy Herd Improvement Association" Records
7. "Annual Missouri D. H. I. A. Summary"

Films:
(a) "Animal Wonders", American Guernsey Cattle
(b) "National Dairy Cattle Congress," Purdue Audio Visual Center
(a) "Raising Dairy Calves," Union Pacific Railroad
(d) Selecting and Judging Guernseys. " American Guernsey Cattle

13. Breed association information

14. Hoard's judging units

Teaching Outline:

I. Importance of breed character and dairy type

II. Dairy herd improvement associations

III. Use of unified score cards

IV. Placement of classes

Teaching Procedure:

I. Introduce unit.

II. Show films and review breed information concerning the selection of dairy animals.

III. Discuss unified score cards.

IV. Review judging materials.

V. Arrange for field trips to make application of learned materials.

VI. Require written or oral reasons on classes placed.

VII. Summarize and evaluate the learning activities.
LIVESTOCK BREEDING
Course: Advanced Livestock Production
Area: Livestock Breeding
Unit: Improvement of Livestock
Job VI: History of Livestock Breeding

Objectives: To develop an appreciation of past work accomplished in the breeding of animals.
To understand how livestock breeders have used genetic principles to improve livestock.

Motivation: "What improvements have been made in the methods of breeding livestock over the past five centuries?"
Show a picture of a crossbred animal and ask students to identify the breeds of its parents.

References:
1. Breeding and Improvement of Farm Animals. Rice and Andrews, 1951 (Chapters 1 and 2)
2. Introduction to Breeding Farm Animals, Winters (pp. 1-18)
5. Slides (AS 65), Iowa State University
6. Genetics of Livestock Improvements, Lasley
Teaching Outline:

I. Early breeders and their breeding principles

II. Origins of present day breeds of livestock

III. Implications of early breeding practices on present day livestock

Teaching Procedure:

I. Introduce unit.

II. Discuss who early breeders of livestock were and what advancements they made.

III. Present information concerning origins of breeds of livestock and discuss implications of origins of these breeds.

IV. Show film relating to history of animal breeding.

V. Show pictures of present day and past types of livestock and discuss how these improvements were brought about.

VI. Summarize and evaluate the learning activities.
Course: Advanced Livestock Production

Area: Livestock Breeding

Unit: Improvement of Livestock

Job VII: Present day Livestock Breeding

Objective: To instruct students in proper methods of livestock improvement

Motivation: "If you had a dairy cow producing 10,000 pounds of milk per year and you wanted 15,000 pounds, how would you go about attaining your goal?"

References: 1. Introduction to Breeding Farm Animals, Winters

2. Livestock and Poultry Production (pp. 55-60)

3. Swine Production, Bundy

4. "Improvement of Swine Through Breeding," Lasley (Bulletin)

5. Iowa State Slides

6. "Animal Science" Slides (numbers 76-112) Iowa State

7. Doanes Agricultural Report, "Advances in Beef Cattle Crossbreeding" (p. 267)

8. Doanes Agricultural Report, "Principles of Beef Production Testing" (p. 269)

Teaching Outline:

I. Students should understand the systems of breeding and their place in livestock production.

A. Upgrading

B. Purebred breeding
C. Cross breeding
D. Inbreeding
E. Crisscross breeding
F. Rotation breeding
G. Line breeding
H. Crossline breeding

Teaching Procedure:

I. Introduce unit.

II. Give handouts from the unit.

III. Have students plan a hypothetical breeding program for a given kind of livestock.

IV. Discuss how breeding systems can be applied to the home situation.

V. Summarize and evaluate the learning activities.
| TABLE I |
| SAMPLE RECORD KEEPING FORM |
| LITTER RECORD |

<table>
<thead>
<tr>
<th>SOW NUMBER</th>
<th>DATE FARROWED</th>
<th>SIRE</th>
<th>NO. FARROWED</th>
<th>NO. BORN ALIVE</th>
<th>NO. MARKETED</th>
<th>NO. WEANED</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>LITTER NUMBER</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>PIG NO.</th>
<th>SEX</th>
<th>WT.</th>
<th>WT.</th>
<th>BIRTH</th>
<th>WEANING</th>
<th>AGE AT 200</th>
<th>B. F. PROBE</th>
<th>COMMENTS</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>45/46</th>
<th>200 LBS.</th>
</tr>
</thead>
</table>
### TABLE II
**BOAR INFORMATION SHEET**

<table>
<thead>
<tr>
<th>Breeder</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breed</strong></td>
<td><strong>Ear Marks or No.</strong></td>
</tr>
</tbody>
</table>

#### A. HEALTH INFORMATION:
- **Double Treated for Cholera (Yes or No):** [Date]
- **Erysipelas (Yes or No):** [Date]
- Other: [Date]

**Blood Test**
- Brucellosis, date and results
- Leptospirosis, date and results

**Parasite Control:**
- External, date and material used
- Internal, date and material used

#### B. RATIONS FED:
- Complete ration (Yes or No)
- Antibiotic (Yes or No)
- Per cent protein

#### C. PERFORMANCE TESTING DATA:
- Date farrowed
- No. farrowed
- No. weaned
- Pr. weight
- Certified litter
AV. DA. GAIN ___________ ADG ON LITTERMATES

FEED EFFICIENCY ____________________________

ADJ. BACK FAT PROBE _______________________

BACK FAT PROBE ON LITTERMATES ____________

CARCASS DATA LITTERMATES:

LENGTH __________________________
BACK FAT _________________________
LOIN AREA _______________________
% LEAN CUTS _______________________

TESTED ON FARMS _________________________
TESTED STATION _________________________
Course: Advanced Production
Area: Livestock Breeding
Unit: Improvement of Livestock
Job VIII: Trends in Livestock Improvement
Objective: To foster a knowledge of current happenings in the science of livestock breeding.
Motivation: "Would it be possible for one proven sow to furnish the embryos for an entire herd?"
References: 1. Current magazine articles
2. "Beef Cattle Breeding" Bulletin
3. Film: "Animal Wonders"
4. "Improvement of Swine Through Breeding"
   Lasley, Day, Tribble, University of Missouri Bulletin
Teaching Outline:
I. Embryo transplant
II. Hormonal usage
III. Inheritable docking of lambs
IV. Multi-gestational births (superfetation)
V. Influencing multibirths with hormones
Teaching Procedure:
I. Discuss innovations in the field of animal breeding to enlighten the students upon the scope of the field.
II. Assign each student a report to be obtained from current publications concerning new aspects of the animal breeding area.
III. Discuss the reports plus previously acquired material concerning new advancements in animal breeding.

IV. Summarize and evaluate activities.
Course: Advanced Livestock Production
Area: Livestock Breeding
Unit: Reproductive Physiology
Job IX: Male Reproductive System

Objective: To develop an understanding of the vocabulary, parts and function of the male reproductive system

Motivation: "Is it possible that a male animal can produce between two and three million live, viable sperm?"

References: 1. Livestock and Poultry Production, Bundy and Diggins.
   2. Introduction to Breeding Farm Animals, Winters (pp. 32-35)
   3. Breeding and Improvement of Farm Animals, Rice and Andrews
   5. "Animal Science" Slides

Teaching Outline:
I. Parts of male animal's reproductive system
II. Function of parts
III. Comparison among animals
IV. Major defects of the male reproductive system

Teaching Procedure:
I. Introduce unit.
II. Hand out and discuss sheets relating to male reproductive parts.
III. Hand out sheets relating to function of parts of the male reproductive system and discuss the function of each part.

IV. Compare and contrast the reproductive parts of farm animals.

V. Secure the reproductive system of a male animal for students to study.

VI. Discuss what malfunctions of the reproductive system can occur.

VII. Summarize and evaluate the learning activities.
Course: Advanced Livestock Production

Area: Livestock Breeding

Unit: Reproductive Physiology

Job X: Female Reproductive System

Objective: To develop an understanding of the vocabulary, parts and function of the female reproductive system.

Motivation: "Why is it that cows generally have only one calf and sows have multiple births?"

Reference:
1. Livestock and Poultry Production, Bundy and Diggins
2. Introduction to Breeding Farm Animals, Winters
3. Breeding and Improvement of Farm Animals, Rice and Andrews
5. "Animal Science" Slides (numbers 59-60)

Teaching Outline:

I. Parts of female system of reproduction
II. Functions of parts of female system
III. Comparisons among farm animals
IV. Defects likely to occur in the female system

Teaching Procedure:

I. Introduce unit.
II. Use handout sheet as a basis for a discussion of the parts of the female reproductive system.
III. Hand out sheet concerning the function of the female reproductive system and discuss the role of the system's parts in the overall scheme of the female reproductive system.

IV. Secure the reproductive system of a female animal for students to study.

V. Hand out sheet showing comparison of the female reproductive systems of animals.

VI. Discuss what malfunctions of the reproductive system can occur.

VII. Summarize and evaluate learning activities.
FIGURE 1
TYPES OF UTERI

DUPLEX
RAT
OPPOSUM

BICORNUATE
PIG

BIPARTITE
EWE
COW
MARE

SIMPLEX
HUMAN
REPRODUCTIVE ORGANS OF A COW
REPRODUCTIVE ORGANS OF A COW

- Fallopian Tube
- Ovary
- Infundibulum
- Cervix
- Uterus
- Horns of Uterus
- Vagina
- Vulva
- Clitoris
REPRODUCTIVE ORGANS OF A BULL
REPRODUCTIVE ORGANS OF A BULL

- Prostate
- Accessory vesicles
- Bladder
- Vas deferens
- Glans penis
- Testis
- Tail of epididymis
- Cowper's gland
- Retractor muscle
- Sigmoid flexor
- Head of epididymis
- Scrotum
FIGURE 2
FEMALE REPRODUCTIVE TRACT
BROAD LIGAMENT

MESOMETRIUM
(UTERUS)

MESOSALPINX
(FALLOPIAN TUBE)

MESOVARVARIUM
(OVARY)
Course: Advanced Livestock Production

Area: Livestock Breeding

Unit: Reproductive Physiology

Job XI: Physiology of Reproduction

Objectives: To develop an understanding of how a testicle functions
To develop an understanding of how an ovary functions.

Motivation: "How are sperm produced?" "How is an ovum produced?"

References: 1. Introduction to Breeding Farm Animals, Winters
2. Breeding and Improvement of Farm Animals, Rice and Andrews

Teaching Outline:

I. Parts and function of the testicle

II. Parts and function of the ovary
Teaching Procedure:

I. Discuss the parts of the testicle and their functions.

II. Discuss the parts and functions of the ovary.

III. Discuss complexity and variability within reproductive systems.

IV. Relate sperm mortality rate within the female reproductive system to conditions within the system.

V. Summarize and evaluate the learning activities.
"From Breeding and Improvement of Farm Animals by Rice et al. Copyright (c) 1957 by McGraw-Hill, Inc. Used with permission of McGraw-Hill Book Company."
FIGURE 4
SECTIONAL OF TESTIS

- TUNICA ABORGINIA
- PYRIMIDICAL
- SEMIMEFEROUS TUBES
- RETE TESTIS
- EPIDIDYMIS
- HEAD
- BODY
- TAIL
- VAS EFFERENS
- TUBLI RECTI
- SEPTA
"From Breeding and Improvement of Farm Animals by Rice et al. Copyright (c) 1957 by McGraw-Hill, Inc. Used with permission of McGraw-Hill Book Company."
FIGURE 6
GRAAFIAN FOLLICLE

STIGMA
BASEMENT MEMBRANE
THECA EXTERNA
THECA IDIerna

GRANULOSA CELLS
ANTHRUM

Egg
COMPLUS OOPHORUS
FIGURE 8

OVUM

CORONA RADIATA

PRONUCLE
TABLE III

FOLLICLE TERMS

Primary Follicle—During the first stage there are many primary follicles within a female at birth.

Secondary Follicle—Antrum begins to form in the follicle.

Graafian Follicle—Estrus begins when this stage is reached.

Ovulation—The causes of ovulation are not known.

Corpus Hemorrhagicum—The condition of the follicle after ovulation is known as corpus hemorrhagicum.

Corpus Luteum—The condition of the follicle two to three days after corpus hemorrhagicum, which prepares uterus for estrus and will maintain the pregnancy, is known as corpus luteum.

Corpus Albicans—Corpus albicans, the condition of the follicle after corpus luteum if pregnancy hasn’t resulted, is generally absorbed by the body. In cow, sow, and mare, it takes 21 days to regress. While in ewes, it takes 16 days.
### TABLE IV
FACTORS RELATED TO SPERM PRODUCTION

1. **SPECIES**

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>SEMEN/ EJACULATION</th>
<th>SEMEN/ MMM</th>
<th>VOLUME IN CC</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOAR</td>
<td>20 BILLION</td>
<td>100,000</td>
<td>200</td>
</tr>
<tr>
<td>BULL</td>
<td>4 BILLION</td>
<td>1 MILLION</td>
<td>4-6</td>
</tr>
<tr>
<td>RAM</td>
<td>2 BILLION</td>
<td>2 MILLION</td>
<td>.8</td>
</tr>
<tr>
<td>STUD</td>
<td>6 BILLION</td>
<td>100,000</td>
<td>100</td>
</tr>
<tr>
<td>CHICKEN</td>
<td>4 BILLION</td>
<td>4 MILLION</td>
<td>.2-1.5</td>
</tr>
</tbody>
</table>

2. **AGE**

3. **GENETIC -- HYBRIDS**

   (A) CATTALO -- MALE STERILE (SMALL SCROTUM)

   (B) MULE OR HINNEY

   1. HORSE -- 60 CHROMOSOMES
   2. JACK -- 64 CHROMOSOMES
   3. MULE -- 62 CHROMOSOMES -- MALE
      STERILE, A FEW FEMALES FERTILE

4. **NUTRITION**

   (A) VITAMIN E -- RATS ONLY

   (B) VITAMIN A -- HEALTHY MUCOUS MEMBRANES

   (C) OVERFITTING DETRIMENTAL TO FERTILITY

5. **SEASON**

   (A) RAM

   (B) BIRDS -- LIGHT
6. FREQUENCY OF USE - RECOMMENDED

(A) BOAR --

<table>
<thead>
<tr>
<th>AGE IN MONTHS</th>
<th>PASTURE</th>
<th>HAND MATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 OR LESS</td>
<td>NONE</td>
<td>NONE</td>
</tr>
<tr>
<td>7-9</td>
<td>6-8</td>
<td>10-15</td>
</tr>
<tr>
<td>9-12</td>
<td>8-10</td>
<td>15-20</td>
</tr>
<tr>
<td>18 OR OVER</td>
<td>12-15</td>
<td>25-30</td>
</tr>
</tbody>
</table>

(B) RAM LAMB -- SPARINGLY

RAM -- 40-50 EWES

(C) STALLION -- SPARINGLY UNTIL 3 YEARS OLD

MATURE -- 1 PER DAY

(D) BULL -- PER YEAR

<table>
<thead>
<tr>
<th>HAND</th>
<th>PASTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>YEARLING</td>
<td>25</td>
</tr>
<tr>
<td>MATURE</td>
<td>50-75</td>
</tr>
</tbody>
</table>

7. DISEASE AND DEFECTS

(A) INFLAMMATION OF TESTICLE

(B) ACCIDENTAL INJURY

(C) LACK OF LIBIDO -- INHERITABLE

(D) DEFECTIVE RETRACTOR MUSCLE -- INHERITABLE

(E) SCROTAL HERNIAS -- MONORCHIDS CRYPTORCHIDS.

(F) INBREEDING DECREASES FERTILITY
Course: Advanced Livestock Production

Area: Livestock Breeding

Unit: Hormonal Influences on Reproduction

Job XII: Endocrine System

Objective: To develop an understanding of the function of the endocrine system and its role in reproduction

Motivation: "Why is such emphasis being placed upon the study of hormones today?" "Where are hormones produced?"

References: 1. Introduction to Breeding Farm Animals, Winter

2. Breeding and Improvement of Farm Animals, Rice and Andrews

Teaching Outline:

I. The endocrine system

II. The glands and their functions

Teaching Procedure:

I. Introduce unit.

II. Review the endocrine system and assign students appropriate reading or questions from the references.

III. Construct a chart of glands and their functions.

IV. Summarize activities.
FIGURE 9

DRAWING OF THE PIG INDICATING THE LOCATIONS OF THE PRINCIPAL GLANDS OF INTERNAL SECRETION

Course: Advanced Livestock Production
Area: Livestock Breeding
Unit: Hormonal Influences on Reproduction
Job XIII: Male Hormones

Objective: To teach an understanding of the influences of the hormones upon the male

Motivation: "Why does a bull develop a crest, a boar, tusks and a rooster, brilliant feathers?"

References: 1. Introduction to Breeding Farm Animals, Winters
2. Breeding and Improvement of Farm Animals, Rice and Andrews

Teaching Outline:

I. Male hormones production
II. Function of male hormones
III. Target of hormones

Teaching Procedure:

I. Introduce unit.
II. Discuss male hormones—where they are produced and their target organ.
III. Discuss what the secondary sex characteristics are for various animals.
IV. Discuss the role of social dominance within herds, flocks, etc.
V. Discuss and explain puberty and the function of hormones.
VI. Relate puberty to breeding age, etc.
VII. Summarize and evaluate the learning activities.
### TABLE V
MALE HORMONES

<table>
<thead>
<tr>
<th>HORMONE</th>
<th>PRODUCED</th>
<th>FUNCTION OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTH</td>
<td>PITUITARY</td>
<td>ADRENAL GLAND</td>
</tr>
<tr>
<td>FSH</td>
<td>PITUITARY</td>
<td>TESTICLE</td>
</tr>
<tr>
<td>LH OR ICHTH</td>
<td>PITUITARY</td>
<td>TESTICLE</td>
</tr>
<tr>
<td>TESTOSTERONE</td>
<td>TESTICLE</td>
<td></td>
</tr>
</tbody>
</table>

1. SEXUAL BEHAVIOR
2. ACCESSORY SEX GLAND
3. SECONDARY SEX CHARACTERISTICS
   (A) FEATHER PATTERNS
   (B) VOICE
   (C) TUSKS
   (D) ANTLERS
4. SOCIAL DOMINANCE
5. INFLUENCE SPERMATOGENESIS
6. INFLUENCE PITUITARY FUNCTION
ANDROSTERONE
SAME AS TESTOSTERONE: ONLY 1/6 AS POTENT

ANDROGEN
COLLECTIVE TERM FOR MALE HORMONES
Course: Advanced Livestock Production
Area: Livestock Breeding
Unit: Hormonal Influences on Reproduction
Job XIV: Female Hormones

Objective: To teach an understanding of the influences of hormones upon the female

Motivation: "Why does a cow come in heat?" "Why doesn't she when she is settled?"

References: 1. Introduction to Breeding Farm Animals. Winters
2. Breeding and Improvement of Farm Animals. Rice and Andrews

Teaching Outline:
I. Hormonal interrelationship
II. Female hormones and their functions

Teaching Procedure:
I. Introduce unit.
II. Discuss the interrelationships of hormones upon other body processes and upon their own production.
III. Discuss the female hormones and their functions.
IV. Discuss the female hormones and their relationship to puberty and breeding age.
V. Discuss the female role in sperm life and the interrelationship between sperm motility and uterine functions.
<table>
<thead>
<tr>
<th>TABLE VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>PITUITARY GLAND (ANTERIOR)</td>
</tr>
<tr>
<td>SECRETES</td>
</tr>
</tbody>
</table>

**GONADOTROPHIC HORMONES**

**FOLLICLE STIMULATING HORMONE (FSH)**

**CAUSES**

GRAAFIAN FOLLICLE TO GROW

GRAAFIAN FOLLICLE PRODUCES ESTROGEN

ESTROGEN CAUSES DECREASE IN FSH PRODUCTION AND INCREASE IN LH, WHICH IS SECRETED BY THE PITUITARY

**GONADOTROPHIC HORMONES**

**LUTEINIZING HORMONE (LH)**

**CAUSES**

OVULATION OF GRAAFIAN FOLLICLE
GROWTH OF CORPUS LUTEUM

CORPUS LUTEUM PRODUCES PROGESTERONE

PROGESTERONE CAUSES DECREASE IN LH PRODUCTION AND INCREASE IN FSH WHICH IS SECRETED BY THE PITUITARY
TABLE VII
HORMONAL INTERRELATIONSHIPS

PITUITARY \[\text{NUTRITION} \rightarrow \text{FSH} \rightarrow \text{CLIMATE}\]

OVARY

GRAAFIAN FOLLICLE

ESTROGEN \[\text{ESTRUS (SEC. SEX CHARACTERISTICS)}\]

SEX BEHAVIOR

UTERUS

PLACENTAL MEMBRANE

PREPARATION FOR EMBRYO

NEURAL LH \[\rightarrow \text{OVULATION} \rightarrow \text{CORPUS LUTEUM} \rightarrow \text{PROGESTERONE} \rightarrow \text{SUPPRESS ESTRUS}\]

LTH \[\rightarrow \text{PREGNANCY}\]
<table>
<thead>
<tr>
<th>HORMONE</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESTROGEN</td>
<td>1. Initiates development of uterus</td>
</tr>
<tr>
<td></td>
<td>2. Induces estrus</td>
</tr>
<tr>
<td></td>
<td>3. Regulates gonadotrophin</td>
</tr>
<tr>
<td></td>
<td>4. Increases uterine motility</td>
</tr>
<tr>
<td></td>
<td>5. Affects growth</td>
</tr>
<tr>
<td></td>
<td>6. Directs growth of mammary gland</td>
</tr>
<tr>
<td></td>
<td>7. Stimulates implantation</td>
</tr>
<tr>
<td>PROGESTERONE</td>
<td>1. Completes uterine growth</td>
</tr>
<tr>
<td></td>
<td>2. Maintains pregnancy</td>
</tr>
<tr>
<td></td>
<td>3. Growth of mammary gland duct</td>
</tr>
<tr>
<td></td>
<td>4. Affects growth</td>
</tr>
<tr>
<td></td>
<td>5. Forms cervical plug</td>
</tr>
<tr>
<td></td>
<td>6. Used as human medicine</td>
</tr>
<tr>
<td>FSH</td>
<td>1. Stimulates Graafian follicle</td>
</tr>
<tr>
<td></td>
<td>2. Regulates LH production</td>
</tr>
<tr>
<td></td>
<td>3. Affects estrus</td>
</tr>
<tr>
<td></td>
<td>4. Affects secondary sex characteristics</td>
</tr>
<tr>
<td></td>
<td>5. Influences estrogen</td>
</tr>
<tr>
<td>LH</td>
<td>1. Affects ovulation</td>
</tr>
<tr>
<td></td>
<td>2. Suppresses estrus</td>
</tr>
<tr>
<td></td>
<td>3. Affects progesterone production</td>
</tr>
</tbody>
</table>
LTH
OXYTOCIN
ADRENYLIN
RELAXIN

1. Maintains pregnancy
2. Causes egg movement
3. Stimulates cervix
1. Overrides oxytocin
2. Relaxes birth canal
3. Produced by placenta
3. It is a protein
Course: Advanced Livestock Production

Area: Livestock Breeding

Unit: Reproductive Processes

Job XV: Fertilization

Objective: To develop an understanding of how fertilization takes place within an animal.

Motivation: "Why are so many sperm deposited if only one sperm is needed for fertilization?"

References: 1. Introduction to Breeding Farm Animals, Winters

2. Breeding and Improvement of Farm Animals, Rice and Andrews


Teaching Outline:

I. Introduction

II. Ovulation

III. Sperm motility

IV. Fertilization

V. Sperm survival in genital tract

Teaching Procedure:

I. Discuss the types of ovulation.

II. Discuss sperm motility.

III. Discuss the steps in fertilization.

IV. Discuss how sperm survive in the genital tract, including the detrimental aspects of survival.
V. Discuss the function of the cervical plug.

VI. Relate this discussion to the last lesson concerning how, hormonally, pregnancy is maintained.

VII. Summarize and evaluate the learning activities.
TABLE IX

**TYPES OF OVULATION**

1. **SPONTANEOUS** - OVA RELEASED WITHOUT MATING.
2. **INDUCED** - OVULATION OCCURS WHEN MATING OCCURS. SWINE WON'T OVULATE ALL EGGS AT SAME TIME.
TABLE X
SPERM EVALUATIONS

1. HOW SPERM ARE SCORED

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>80-100 PER CENT PROGRESSIVE MOTILITY, SWIRLING MOTION OF THE DROP AS A WHOLE.</td>
</tr>
<tr>
<td>4</td>
<td>60-80 PER CENT PROGRESSIVE MOTILITY, SWIRLING MOTION INDEFINITE OR ABSENT</td>
</tr>
<tr>
<td>3</td>
<td>40-60 PER CENT PROGRESSIVE MOTILITY, MOVEMENT LIMITED TO INDIVIDUAL SPERMATOZOA.</td>
</tr>
<tr>
<td>2</td>
<td>20-40 PER CENT OF SPERMATOZOA SHOWING UNDULATORY MOVEMENT.</td>
</tr>
<tr>
<td>1</td>
<td>20 PER CENT OR LESS OF SPERMATOZOA EXHIBITING UNDULATORY MOVEMENT</td>
</tr>
<tr>
<td>0</td>
<td>NO MOTILITY</td>
</tr>
</tbody>
</table>

2. CONCENTRATION OF SPERM
A. COUNTED LIKE RED BLOOD CELLS

3. LIVE-DEAD PER CENT
A. STAINING OF DEAD CELLS

4. PER CENT ABNORMAL CELLS
A. COILED TAILS
B. BEADS ON TAILS
C. HEADLESS OR TAILLESS SPERM

5. VOLUME OF SEMEN
6. PH OF SEMEN (MOST 6.3 TO 6.8)

7. PURITY -- FREE OF DEBRIS AND URINE

8. METABOLIC MEASUREMENT WITH METHYLENE BLUE -- MOST ACTIVE ARE LIGHTEST BLUE
TABLE XI

<table>
<thead>
<tr>
<th>STEPS IN FERTILIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. INSINUATION -- NATURAL OR ARTIFICIAL DEPOSITING OF SPERM</td>
</tr>
<tr>
<td>2. TRANSPORTATION -- MOVEMENT OF SPERM FROM POINT OF INSINUATION TO OVARIAN END OF FALLOPIAN TUBE</td>
</tr>
<tr>
<td>3. OVULATION</td>
</tr>
<tr>
<td>4. PENETRATION OF OVUM BY SPERM</td>
</tr>
<tr>
<td>5. UNION OF MALE AND FEMALE PRONUCLEI</td>
</tr>
</tbody>
</table>
### TABLE XII

**SPERM SURVIVAL**

1. Useful life generally is not greater than 36-48 hours.

2. Fertilizing capacity of mammal sperm is:
   - A. Bull -- 24-30 hours
   - B. Ram -- 24-36 hours

3. Chickens and turkeys have a 43-day average.

4. Only one sperm functions in fertilization.

5. Some sperm must undergo capacitation, which means they must be in the reproductive tract and must develop somewhat before fertilization.
## COMPARISON OF ONE AND TWO SERVICES

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Per Cent</th>
<th>Pigs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Service</td>
<td>149</td>
<td>61</td>
<td>7.9</td>
</tr>
<tr>
<td>2 Services</td>
<td>124</td>
<td>94</td>
<td>8.9</td>
</tr>
</tbody>
</table>
Course: Advanced Livestock Production
Area: Livestock Breeding
Unit: Reproductive Processes
Job XVI: Gestation

Objective: To develop an understanding of how the fetus is implanted and the processes it undergoes during gestation.

Motivation: "How is it possible for an animal to have a different blood type than its parent?"

References: 1. Introduction to Breeding Farm Animals, Winters
2. Breeding and Improvement of Farm Animals, Rice and Andrews
3. "Animal Science" Slides (numbers 63-65)

Teaching Outline:
I. Implantation
II. Placenta
III. Gestation

Teaching Procedure:
I. Introduce unit.
II. Discuss how implantation occurs.
III. Discuss the functions of the placenta.
IV. Include the nourishing of the fetus.
V. Discuss gestation, gestation periods, gestation variability, and birth weight determinants.
VI. Summarize and evaluate.
1. Embryo is nourished from ovum yolk and uterine milk, from the gland in uterus, until it is implanted.

2. Time of implantation varies:
   A. Mare -- 36-40 days
   B. Cow -- 30-36 days
   C. Ewe -- 17-18 days
   D. Sow -- 10-12 days
   E. Human -- 6-8 days

3. Abnormal implantation (ectopic) occurs:
   A. In body cavity
   B. In Fallopian tubes
   C. On ovary.

4. Delayed implantation can cause lengthened gestation period.

5. In swine, it takes six to eight inches of space per pig in the uterus.
TABLE XIV.

FUNCTIONS OF PLACENIA

1. TRANSMISSION OF NUTRIENTS
   A. PROTEINS MUST BE BROKEN DOWN TO AMINO ACIDS.
   B. BACTERIA ARE TOO LARGE; VIRUSES AREN'T.
   C. GERMAN MEASLES ARE ESPECIALLY BAD.

2. TRANSMISSION OF WASTE PRODUCTS

3. PROTECTION FROM SHOCK AND BACTERIA

4. PRODUCTION OF SOME HORMONES
   A. ESTROGEN IS PRODUCED.
   B. PROGESTERONE IS PRODUCED.
   C. TWO GONADOTROPIC -- LIKE HORMONES -- ARE PRODUCED:
      (1) HUMAN CHORONIC GONADOTROPIC (HCG) -- WILL INDUCE
          OVULATION IN RABBIT.
      (2) PREGNANT MARE SERUM (PMS).
FIGURE 10
THE PLACENTA

CHORIONALLONTOIS

EMBRYO

AMNIONC AVITY

AMNION

ALLONTOIS

ALLENTOIC CAVITY
FIGURE 11
TYPES OF PLACENTA

1. DIFFUSE -- MARE AND SOW
   TRANSFERS ANYWHERE IT IS IN CONTACT

2. COTYLEDONARY -- COW AND EWE
   LOCALIZED -- 100 TO 120 COTYLEDONS

3. ZONARY -- DOG

4. DISCOIDAL -- HUMAN AND RABBIT
TABLE XV
VARIATION IN GESTATION

1. BREEDS
   A. HEREFORD -- 286 DAYS
   B. SHORTHORN -- 282 DAYS
   C. ANGUS -- 279 DAYS

2. SEX -- MALES GENERALLY CARRIED A DAY LONGER.


4. GENOTYPE OF CALF

5. MULTIPLE BIRTHS -- TWINS CARRIED SHORTER PERIODS OF TIME

6. TIME OF IMPLANTATION
TABLE XVI
PREGNANCY DIAGNOSIS

1. CESSATION OF HEAT
   A. 5% OF PREGNANT CATTLE SHOWING ESTRUS

2. MANUAL MANIPULATION OF UTERUS
   A. 35 DAYS IS EARLIEST POSSIBLE.
   B. VERY EASY AT 60-90 DAYS
   C. BUMPING -- IN LATE STAGES OF GESTATION

3. BIOLOGICAL TEST
   A. PMS AND HCG

4. FALSE PREGNANCY (PSEUDOPREGNANCY)
   A. 2/3 TO 3/4 AS LONG AS USUAL GESTATION PERIOD
   B. MAMMARY GLAND DEVELOPMENT
   C. MAINTAINS CORPUS LUTEUM
   D. MAKE NEST AND HAVE MOTHERING INSTINCT
   E. NOT PREGNANT
   F. WON'T SHOW HEAT
TABLE XVII
BIRTH WEIGHT

1. BIRTH WEIGHT WILL NOT VARY SIGNIFICANTLY WITH FEED RECEIVED.
2. MOTHER'S BEING OVERWEIGHT WILL CAUSE MORE DAMAGE THAN BEING UNDERWEIGHT.
3. A STARVED MOTHER WILL ALWAYS PROTECT HER YOUNG. (FAT, MUSCLE, BONE, NERVE, ETC. WILL BE SACRIFICED BEFORE THE FETUS WILL BE HARMED.)
4. THE LARGER THE UTERUS, THE LARGER THE FETUS IS LIKELY TO BE.
   A. IN HORSES, A SHIRE FEMALE MATED WITH A SHETLAND MALE WILL YIELD A LARGER COLT THAN VICE VERSA.
Course: Advanced Livestock Production
Area: Livestock Breeding
Unit: Reproductive Processes
Job XVII: Parturition
Objective: To investigate the processes involved in parturition
Motivation: "What determines when a calf will be born?"

"How can one tell when an animal is about to give birth?"

References: 1. Introduction to Breeding Farm Animals, Winters
2. Breeding and Improvement of Farm Animals, Rice and Andrews
3. Film: "Trip Through a Pig Factory", Ralston Purina Company

Teaching Outline:
I. Parturition detection
II. Types of births
III. Parturition and hormones

Teaching Procedure:
I. Introduce unit.
II. Show film "Trip Through a Pig Factory" and discuss its implication.
III. Discuss what to look for in telling parturition.
IV. Discuss the types of births and how to care for abnormal births.

V. Discuss the role of hormones in parturition—when hormones can be used to aid parturition.

VI. Invite a veterinarian to talk to the class about how to help at parturition and to discuss use of hormones with the class.

VII. Summarize the discussion.

VIII. Evaluate.
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>GENERAL NERVOUSNESS</td>
</tr>
<tr>
<td>2.</td>
<td>DROOPING TAIL AND HEAD</td>
</tr>
<tr>
<td>3.</td>
<td>LOSS OF APPETITE</td>
</tr>
<tr>
<td>4.</td>
<td>SOW'S PRODUCTION OF MILK 12-24 HOURS BEFORE PARTURITION</td>
</tr>
<tr>
<td>5.</td>
<td>SEEKING OF SECLUSION</td>
</tr>
<tr>
<td>6.</td>
<td>NESTING INSTINCT</td>
</tr>
<tr>
<td>7.</td>
<td>UTERINE DISTENSION</td>
</tr>
</tbody>
</table>
TABLE XIX
TYPES OF BIRTHS

I. NORMAL
   A. FRONT FEET FIRST -- HEAD ON FEET
   B. HIND FEET FIRST -- NORMAL

II. ABNORMAL
   A. HEAD . LEG FOLDED BACK
      (1) WAIT 2 HOURS BEFORE DOING ANYTHING.
      (2) AVOID INFECTING UTERUS
      (3) DON'T PULL WITH ROPES, ETC.
   B. DYSTOCIA (DIFFICULT LABOR)
      (1) SIZE AND SHAPE OF FEET
      (2) BREEDING FEMALES TO YOUNG
      (3) PIGS -- FEMALE TOO FAT
### TABLE XX

**PARTURITION AND HORMONES**

1. **RELAXIN** — RELAXES PELVIC LIGAMENTS
2. **PROGESTERONE** (-----)
3. **ESTROGEN** (——)
4. **OXYTOCIN** — AIDS PARTURITION

* PARTURITION
Course: Advanced Livestock Production
Area: Livestock Breeding
Unit: Handling Breeding Animals
Job XVIII: Improvement of Breeding Efficiency

Objective: To instruct students in some of the reasons for low breeding efficiency among farm animals

Motivation: "Why would you think judges are going away from the overfitted heifers in the show ring?"

References:
1. Introduction to Breeding Farm Animals", Winters
2. Breeding and Improvement of Farm Animals, Rice and Andrews

Teaching Outline:
I. Breeding efficiency to be expected from farm animals
II. Common causes of low breeding efficiency
III. Disease-breeding efficiency relationship
IV. Purchase of healthy animals
V. Nutrition-breeding efficiency relationship

Teaching Procedure:
I. Introduce unit.
II. Assign and discuss reading from references as applied to teaching outline.
III. Discuss causes of low breeding efficiency.

IV. Include freemartins and monor chidism in discussion.

V. Relate and discuss diseases that relate to breeding efficiency.

VI. Relate feeding prior to breeding, during gestation and parturition.

VII. Discuss health papers and how one can increase herd breeding efficiency through the sound purchasing of animals.

VIII. Include semen testing and pregnancy checking.

IX. Summarize and evaluate.
Course: Advanced Livestock Production
Area: Livestock Breeding
Unit: Handling Breeding Animals
Job XIX: Artificial Insimination

Objective: To acquaint students with the procedures, techniques, and wise use of artificial insimination

Motivation: "Why does Denmark breed 100% of its cows artificially?" "Is A.I. practiced on your farm?"

3. Introduction to Breeding Farm Animals, Winters, (pp. 327-360)
4. Breeding and Improvement of Farm Animals, Rice and Andrews (p. 160)

Teaching Outline:

I. History of A.I.
II. Advantages and disadvantages of A.I.
III. Semen collection, dilution, storage, and costs
IV. Insimination process
V. Use on different animals
Teaching Procedure:

I. Introduce unit.

II. Assign the students to do a study of the history of artificial insemination and discuss their findings.

III. Review the advantages and disadvantages of artificial insemination and discuss them.

IV. Discuss the process of insemination.

V. Invite an inseminator to visit the class or take a field trip to see the actual service.

VI. Discuss use of A.I. on different farm animals.

VII. Assign reading in Winters and discuss any current information available.

VIII. Summarize and evaluate.
TABLE XXI
A. I.

ADVANTAGES:

1. The manager can increase use of superior sires.
2. The manager has a better control over diseases.
3. He doesn't have to maintain a bull.
4. He can collect from good bulls that can't serve naturally.
5. He can mate two animals of different sizes.
6. He will probably become more interested in technological advancements.

DISADVANTAGES:

1. If the breeding service should get an inferior sire, the off-spring would be widespread.
2. Artificial insemination will hurt the sale of purebred sires.
3. THE LABOR REQUIREMENTS WILL BE INCREASED.

4. THE COST OF EQUIPMENT WILL INCREASE.
TABLE XXII
SEmen COLLECTION

1. ARTIFICIAL VAGINA -- BEST WAY IN MOST SPECIES (USES WARM WATER)

2. ELECTRO-EJACULATOR
   ADVANTAGES:
   A. CAN BE USED ON IMPOTENT BULLS
   B. CAN BE USED ON INJURED BULLS
   DISADVANTAGES:
   A. CAN GET URINE
   B. GENERALLY NOT AS CLEAN
   C. DOESN'T WORK WELL IN BOARS

3. RECOVERY OF SEMEN FROM FEMALE REPRODUCTIVE TRACT
   A. HAS A LOT OF DEBRIS, MUCUS, AND ACID

4. MASSAGE AMPULLA

<table>
<thead>
<tr>
<th>ANIMAL</th>
<th>NUMBER OF FEMALES PER EJACULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOAR</td>
<td>8-12</td>
</tr>
<tr>
<td>BULL</td>
<td>300-500</td>
</tr>
<tr>
<td>ROOSTER</td>
<td>8-12</td>
</tr>
<tr>
<td>RAM</td>
<td>40-100</td>
</tr>
<tr>
<td>STALLION</td>
<td>8-12</td>
</tr>
</tbody>
</table>
FIGURE 12
ARTIFICIAL VAGINA

"From Breeding and Improvement of Farm Animals by Rice et al. Copyright (c) 1957 by McGraw-Hill, Inc. Used with permission of McGraw-Hill Book Company."
TABLE XXIII
SEmen Dilution

Dilutors:

1. Egg Yolk -- Primary one -- Cheap
   A. Egg Yolk Citrate
   B. Egg Yolk Phosphate

2. Milk

3. Coconut Milk

4. Blood Plasma

5. Glycerol -- Prevents Ice Crystal Formation

How Stored:

1. Ampule
2. Pipette
3. Pellet

Freezing Semen:

1. Dry Ice: -79°C (-110°F)

2. Liquid Nitrogen: -196°C (-320°F)
   A. Cheapest Method
<table>
<thead>
<tr>
<th>HERD SIZE</th>
<th>TOTAL YEARLY COST PER COW</th>
</tr>
</thead>
<tbody>
<tr>
<td>26-35</td>
<td>11.04</td>
</tr>
<tr>
<td>36-45</td>
<td>9.61</td>
</tr>
<tr>
<td>46-55</td>
<td>9.29</td>
</tr>
<tr>
<td>56-65</td>
<td>9.10</td>
</tr>
<tr>
<td>66-75</td>
<td>7.71</td>
</tr>
<tr>
<td>76-85</td>
<td>6.09</td>
</tr>
<tr>
<td>86-95</td>
<td>7.40</td>
</tr>
<tr>
<td>96-OVER</td>
<td>6.93</td>
</tr>
<tr>
<td>ALL (27-220)</td>
<td>8.69</td>
</tr>
</tbody>
</table>
TABLE XXV
A. I. AND HERD LEVEL

<table>
<thead>
<tr>
<th>HERDMATE AVERAGE GROUPING (BUTTERFAT)</th>
<th>A. I. DAUGHTERS OVER HERDMATES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MILK</td>
</tr>
<tr>
<td>600 OR OVER</td>
<td>+811</td>
</tr>
<tr>
<td>HIGH HERDS 500-599</td>
<td>+841</td>
</tr>
<tr>
<td>GOOD HERDS 400-499</td>
<td>+438</td>
</tr>
<tr>
<td>FAIR HERDS 300-399</td>
<td>+1980</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>+645</td>
</tr>
</tbody>
</table>
EXAMPLE: HOLSTEINS

Experimentalists picked a sire that averaged 900 lbs. of milk. Actual increase with the breed average test (3.5%) at $5 per cwt. of milk. This would be $45 more gross income per year. Following a program like this for five years would mean $2,000 more gross income for a 50-cow herd per year.
FIGURE 13
METHOD OF ARTIFICIAL INSIMINATION
Course: Advanced Livestock Production

Area: Livestock Breeding

Unit: Genetics

Job XX: Inheritance of Traits

Objective: To develop an understanding of the principles of genetics

Motivation: "If I dock the sheep in my flock year after year, will I soon have naturally docked lambs?"

References: 1. Introduction to Breeding Farm Animals, Winters
2. Breeding and Improvement of Farm Animals, Rice and Andrews
4. Film: "Heredity," Communication Department, 119 Whitten Hall, Columbia, Missouri 65201

Teaching Outline:

I. Basic cell

II. Mitosis and meiosis

III. Genes and chromosomes

IV. Mendel's Laws
V. Sex determination

Teaching Procedure:

I. Introduce unit.

II. Discuss how bodies are made up of cells and the make-up of an individual cell.

III. Explain cell division, both mitosis and meiosis and discuss their implications as related to heredity and genetics.

IV. If possible, obtain a microscope and examine a cell, and compare these with sperm earlier examined.

V. Discuss genes and chromosomes and their function as carriers of traits.

VI. Discuss how cells occur in pairs in body cells and singularly in gametes.

VII. Discuss how cells are divided as by meiosis, above.

VIII. Discuss and explain Mendel's Laws.

IX. Work up sample problems for the students to calculate.

X. Explain how the sex of an individual is determined.

XI. Summarize and evaluate.
FIGURE 14

DIAGRAM OF A CELL

NUCLEUS CONTAINING CHROMOSOMES

CYTOPLASM
FIGURE 15
REPRODUCTION OF ANIMAL CELLS--MITOSIS

X CHROMOSOMES

X CHROMOSOMES

X CHROMOSOMES
FIGURE 16
SCHEMATIC SEMINIFEROUS TUBULE
SHOWING SPERMATOGENESIS -- MEIOSIS

From Breeding and Improvement of Farm Animals by Rice et al. Copyright (c) 1957 by McGraw-Hill, Inc. Used with permission of McGraw-Hill Book Company.
Diagram showing the kind of offspring produced by mating pure mule-footed boar with a pure normal-footed sow.
DIAGRAM SHOWING THE KIND OF OFFSPRING PRODUCED BY MATING AN IMPURE (HETEROZYGOUS) BOAR WITH AN IMPURE (HETEROZYGOUS) SOW.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitosis</td>
<td>Production of two cells identical to the parent cell</td>
</tr>
<tr>
<td>Meiosis</td>
<td>Production of two cells with half the chromosome number of the parent cell</td>
</tr>
<tr>
<td>Spermatogenesis</td>
<td>Production of sperm</td>
</tr>
<tr>
<td>Spermiogenesis</td>
<td>Growth and maturation of sperm to a mature cell</td>
</tr>
<tr>
<td>Genotype</td>
<td>Genetic make-up of the individual</td>
</tr>
<tr>
<td>Phenotype</td>
<td>Physical make-up of the individual</td>
</tr>
<tr>
<td>Homozygous</td>
<td>Identical in genotype and phenotype with reference to chromosomes and individuals</td>
</tr>
<tr>
<td>Heterozygous</td>
<td>Not identical in genotype and phenotype with reference to chromosomes and individuals</td>
</tr>
<tr>
<td>Dominance</td>
<td>The ability of a gene to cover up a recessive gene that is homozygous to it</td>
</tr>
<tr>
<td>Recessive</td>
<td>Nonapparent unless it is homozygous</td>
</tr>
<tr>
<td>Allele</td>
<td>A pair of genes that occur in the same place on a homozygous chromosome but affect the same trait in a different manner</td>
</tr>
<tr>
<td>Prepotency</td>
<td>Ability of an individual to stamp its characteristics on its offspring</td>
</tr>
<tr>
<td>Progeny</td>
<td>Offspring of an individual</td>
</tr>
</tbody>
</table>
Heterosis -- Hybrid vigor resulting from a cross

Fertility -- Degree of reproductive ability an individual possesses

Prolificness -- Ability to produce large numbers of offspring

Fecundity -- Ability to produce large numbers of eggs or sperm
<table>
<thead>
<tr>
<th>ANIMAL</th>
<th>TOTAL</th>
<th>PAIRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DONKEY</td>
<td>66</td>
<td>33</td>
</tr>
<tr>
<td>HORSE</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>MULE</td>
<td>63</td>
<td>30 + 3</td>
</tr>
<tr>
<td>COW</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>SHEEP</td>
<td>54</td>
<td>27</td>
</tr>
<tr>
<td>HOG</td>
<td>38</td>
<td>19</td>
</tr>
<tr>
<td>MAN</td>
<td>46</td>
<td>23</td>
</tr>
</tbody>
</table>
TABLE XXVII!
MENDEL'S LAWS

WHEN TWO DIVISIONS TAKE PLACE INDEPENDENTLY, THE PRODUCT IS THE
PROBABILITY OF EACH INDEPENDENT EVENT.

B = BLACK          B = RED

\[
\begin{array}{c|c c c c}
& BB & Bb & Bb & BB \\
\hline
1 & \frac{1}{4} & \frac{1}{4} & \frac{1}{4} & \frac{1}{4} \\
\end{array}
\]

BLACK          RED

\[
\begin{array}{c|c c c c}
& BB & \text{BLACK} & Bb & \text{RED} \\
\hline
2 & \frac{2}{4} & \frac{1}{4} & \frac{1}{4} & \frac{1}{4} \\
\end{array}
\]

GENOTYPE RATIO: 1:2:1

PHENOTYPE RATIO: 3:1

1. Bb x BB = BB
2. Bb x Bb = 1 BB : 1 Bb
3. BB x bb = Bb
4. Bb x Bb = NEVER BREED TRUE
5. Bb x bb = 1 Bb : 1 BB
6. BB x BB = BB

187/138
TABLE XXIX
MENDEL’S SECOND LAW

INDEPENDENT ASSORTMENT
OF CHARACTERS

\[ P = \text{POLLED} \]
\[ B = \text{BLACK} \]
\[ P = \text{HORNED} \]
\[ B = \text{RED} \]

\[ P_1 -- BBPP \]
BLACK POLLED

\[ F_1 -- BbPp \]
BLACK POLLED

\[ F_2 -- BbPp \times BbPp \]

\[ 1 \text{ PP} -- 1 \text{ BBPP} \]
\[ 1 \text{ BB} -- 2 \text{ Pp} -- 2 \text{ BbPp} \]
\[ 1 \text{ PP} -- 1 \text{ BBPP} \]

\[ 1 \text{ PP} -- 2 \text{ BbPP} \]
\[ 2 \text{ Bb} -- 2 \text{ Pp} -- 4 \text{ BbPp} \]
\[ 1 \text{ PP} -- 2 \text{ BbPP} \]

\[ 1 \text{ PP} -- 1 \text{ BBPP} \]
\[ 1 \text{ BB} -- 2 \text{ Pp} -- 2 \text{ BbPp} \]
\[ 1 \text{ PP} -- 1 \text{ BBPP} \]
PHENOTYPE RATIO:

BLACK POLLED --- 9
BLACK HORNED --- 3
RED POLLED --- 3
RED HORNED --- 1
FIGURE 19
SEX DETERMINATION

MALE
XY
X
Y
Sperm
XY
XX
FEMALE
XX
X
X
Ova
XX
Male offspring
Female offspring
Course: Advanced Livestock Production

Area: Livestock Breeding

Unit: Genetics

Job XXI: Heritability Estimates

Objective: To instruct students in heritability estimation and the practicality of heritability estimate's application to farm use

Motivation: "Which trait in swine can you change the quickest by selective breeding--number of pigs farrowed or rate of gain?"

References: 1. "Improvement of Swine Through Breeding."
               Lasley, Day, Tribble, B775

2. Animal Breeding, Winters (p. 150)

3. Breeding and Improvement of Farm Animals,
   Rice and Andrews (p. 270)

4. "Animal Science" Slide (number 75)

Teaching Outline:

I. Principles of heritability estimation

II. Heritability estimates of livestock

III. Application to farm situation

Teaching Procedure:

I. Introduce unit.
II. Assign reading from one of the references and discuss the principles.

III. Discuss actual heritability estimates that apply to livestock.

IV. Discuss how heritability estimates can be applied to the student's livestock.

V. Summarize and evaluate.
<table>
<thead>
<tr>
<th>PERFORMANCE CHARACTER</th>
<th>PER CENT HERITABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER OF PIGS FARROWED</td>
<td>15</td>
</tr>
<tr>
<td>NUMBER OF PIGS WEANED</td>
<td>20</td>
</tr>
<tr>
<td>WEIGHT OF LITTER AT WEANING</td>
<td>15</td>
</tr>
<tr>
<td>GROWTH RATE, WEANING TO 200 POUNDS</td>
<td>30</td>
</tr>
<tr>
<td>ECONOMY OF GAIN, WEANING TO 200 POUNDS</td>
<td>40</td>
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<table>
<thead>
<tr>
<th>BODY CONFORMATION</th>
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<tr>
<td>NIPPLE NUMBERS</td>
<td>60</td>
</tr>
<tr>
<td>LENGTH OF LEGS</td>
<td>65</td>
</tr>
<tr>
<td>LENGTH OF BODY</td>
<td>60</td>
</tr>
<tr>
<td>SCORE FOR CONFORMATION</td>
<td>30</td>
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<table>
<thead>
<tr>
<th>CARCASS ITEMS</th>
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<tr>
<td>CARCASS LENGTH</td>
<td>60</td>
</tr>
<tr>
<td>LOIN-EYE AREA</td>
<td>50</td>
</tr>
<tr>
<td>BACKFAT THICKNESS</td>
<td>50</td>
</tr>
<tr>
<td>Description</td>
<td>Percentage</td>
</tr>
<tr>
<td>------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>PER CENT OF HAM</td>
<td>60</td>
</tr>
<tr>
<td>PER CENT OF FAT CUTS</td>
<td>60</td>
</tr>
<tr>
<td>PER CENT OF SHOULDER</td>
<td>50</td>
</tr>
<tr>
<td>PER CENT OF LEAN CUTS</td>
<td>50</td>
</tr>
<tr>
<td>BELLY THICKNESS</td>
<td>60</td>
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</tbody>
</table>
TABLE XXXI
EXAMPLE OF HOW SELECTION ON HERITABILITY WORKS

<table>
<thead>
<tr>
<th>HEAD AVERAGE</th>
<th>140 DAY</th>
<th>BACKFAT.</th>
<th>FEED PER 100 LBS.</th>
<th>% LEAN</th>
<th>LEAN EYE AREA</th>
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<tbody>
<tr>
<td>BEST RECORD</td>
<td>235</td>
<td>.80</td>
<td>230</td>
<td>40</td>
<td>6.50</td>
</tr>
<tr>
<td>DIFFERENCE</td>
<td>50</td>
<td>.60</td>
<td>60</td>
<td>3</td>
<td>2.50</td>
</tr>
<tr>
<td>HERITABILITY</td>
<td>30%</td>
<td>50%</td>
<td>40%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>PREDICTED CHANGE</td>
<td>7.5</td>
<td>.15</td>
<td>12.1</td>
<td>.75%</td>
<td>.62 SQ.</td>
</tr>
<tr>
<td></td>
<td>LBS.</td>
<td>INS.</td>
<td>LBS.</td>
<td></td>
<td>INS.</td>
</tr>
<tr>
<td>IRAII</td>
<td>PER CENT HERITABILITY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPEED OF MILKING</td>
<td>27-37</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>MILK PRODUCTION</td>
<td>25-35</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPEED OF FEEDING</td>
<td>12-15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BREEDING PROBLEMS</td>
<td>8-14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MILK LEAK</td>
<td>5-10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LIVESTOCK NUTRITION
Course: Advanced Livestock Production

Area: Livestock Nutrition

Unit: Digestive Systems of Livestock

Job XXII: The Monogastric System

Objective: To develop an understanding of the monogastric digestive system

Motivation: "Why doesn't a pig chew a cud?" "What is different about a hog that allows it to digest food without chewing a cud?"

References: 1. Feeds and Feeding, Morrison

2. "Animal Science" Slides, Iowa State
   (numbers 1-3, 35)

Teaching Outline:

I. Parts of monogastric digestive system

II. Function of parts of digestive system

Teaching Procedure:

I. Introduce unit.

III. Integrate the animal science slides from Iowa State into the discussion.

IV. Obtain the digestive system of a hog and compare pictures to actual system.

V. Summarize and evaluate.
Course: Advanced Livestock Production

Area: Livestock Nutrition

Unit: Digestive Systems of Livestock

Job XXIII: Ruminant Digestive System

Objective: To develop an understanding of the ruminant digestive system

Motivation: "Why do ruminants suffer from 'hardware' disease when other animals don't?"

References: 1. Feeds and Feeding, Morrison
2. Animal Nutrition, Maynard and Loosli
3. Film: "The Rumen Story," Ralston Purina Company
4. 
5. "Animal Science" Slides, Iowa State (numbers 4-10, 32-34)

Teaching Outline:

I. Parts of a ruminant's stomach

II. Function of each portion

III. Pathways of food through ruminant's stomach

IV. Rumination and its implications

Teaching Procedure:

I. Introduce unit.
III. Integrate the Iowa State slides into the discussion of the function, parts, and movement within the ruminant's stomach.

IV. Obtain the digestive system from a cow and examine it in class and point out the various parts.

V. Point out the esophageal groove and the linings within the stomachs and intestines.

VI. Show the movie "The Rumen Story".

VII. Summarize and evaluate.
TABLE XXXIII
COMPARISON OF DIGESTIVE SYSTEMS

1. Ruminants have a relatively large digestive system (large rumen plus other compartments), which enables them to use enormous amounts of roughage-type feeds in comparison with monogastric animals.

2. Ruminant animals have a much greater ability than non-ruminants to digest roughage before it enters the intestinal tract.

3. The alimentary tract in the ruminant animal is far more efficient than that of the monogastric animal in the utilization of crude fiber.
**ALEASE L YA CRUDE FIBER DIGESTION**

<table>
<thead>
<tr>
<th>Animal</th>
<th>Percent Digestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>CATTLE</td>
<td>44</td>
</tr>
<tr>
<td>SHEEP</td>
<td>45</td>
</tr>
<tr>
<td>HORSES</td>
<td>39A</td>
</tr>
<tr>
<td>SWINE</td>
<td>22</td>
</tr>
</tbody>
</table>

Mainly in the caecum

**BEST COPY AVAILABLE**
TABLE XXXIV
RELATIVE CAPACITIES OF DIGESTIVE TRACTS

<table>
<thead>
<tr>
<th>Animal</th>
<th>LG. Intestine</th>
<th>SM. Intestine</th>
<th>Stomach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horse</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Pig</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Cow</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Sheep</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
Course: Advanced Livestock Production

Area: Livestock Nutrition

Unit: Nutrients

Job XXIV: The Basic Nutrients

Objective: To develop a general knowledge on the part of the student of the basics of nutrients

Motivation: "Is it true that livestock need fuel just like a motor?" "What nutrients are required?" "How can they be provided?"

References: 1. Feeds and Feeding, Morrison

2. "Animal Science" Slides (numbers 12-19)

3. "Nutrient Requirements of Beef Cattle," No. 4, publication 1137, National Academy of Sciences

4. "Nutrient Requirements of Horses", No. 6, publication 1401, National Academy of Sciences

5. "Nutrient Requirements of Dairy Cattle," No. 3, publication 1349, National Academy of Sciences

6. "Nutrient Requirements of Swine," No. II, publication 1192, National Academy of Sciences


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Teaching Outline:

I. The kinds of nutrients.

Teaching Procedure:

I. Introduce unit.

II. Assign students to construct a chart of the food nutrients showing the different kinds, compositions, sources, and uses by the animal.

III. Review the unit on feed nutrients, using handout, and integrating the Iowa State slides.

IV. Summarize and evaluate.
Course: Advanced Livestock Production
Area: Livestock Nutrition
Unit: Nutrients
Job XXV: The Proteins

Objective: To develop an understanding of the structure of protein and amino acids and the use of non-proteinous-nitrogen

Motivation: "Why is it that of the proteins we have studied, no two proteins are alike?"

References: 1. Feeds and Feeding, Morrison
2. "Buying Protein Supplement," Doanes Agricultural Report (p. 218.1)
4. "Urea and Limestone for Corn Silage," Doanes Agricultural Report (p. 276.1)

Teaching Outline:

I. Structure of proteins

II. Essential and nonessential amino acids
III. Non-proteinous-nitrogen sources

Teaching Procedure:

I. Introduce unit.

II. Described how proteins are made up of amino acids.

III. Discuss which amino acids are essential and which are nonessential.

IV. Discuss the use of non-protein-nitrogen in ruminant rations.

V. Summarize and evaluate.
<table>
<thead>
<tr>
<th>ESSENTIAL</th>
<th>NONESSENTIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHENYLALANINE</td>
<td>ALANINE</td>
</tr>
<tr>
<td>HISTIDINE</td>
<td>ASPARTIC ACID</td>
</tr>
<tr>
<td>ISOLEUCINE</td>
<td>CYSTINE</td>
</tr>
<tr>
<td>LEUCINE</td>
<td>GLUTAMIC ACID</td>
</tr>
<tr>
<td>LYSINE</td>
<td>GLYCINE</td>
</tr>
<tr>
<td>METHIONINE</td>
<td>HYDROXYPROLINE</td>
</tr>
<tr>
<td>TRYPTOPHAN</td>
<td>PROLINE</td>
</tr>
<tr>
<td>VALINE</td>
<td>SERINE</td>
</tr>
<tr>
<td>ARGININE</td>
<td>TYROSINE</td>
</tr>
<tr>
<td>THREONINE</td>
<td></td>
</tr>
</tbody>
</table>
TABLE XXXVI

UREA

| CRUDE PROTEIN = (% NITROGEN) (6.25) |
| CRUDE PROTEIN = (UREA 46% N) (6.25) |
| CRUDE PROTEIN = 262% |

1. USE IN RATIONS LOW IN PROTEIN
2. ENERGY SOURCE
3. NECESSITY OF BEING WELL MIXED
4. POSSIBILITY OF SUPPLYING UP TO 1/3 TOTAL PROTEIN

A. ABOUT 1% OF TOTAL RATION
B. ABOUT 3% OF CONCENTRATE
C. ABOUT 5% OF PROTEIN SUPPLEMENT

\[
\begin{align*}
\text{C} & = 0 \\
\text{NH}_2 & \\
\end{align*}
\]
OTHER UREA SOURCES -- LESS BENEFICIAL THAN UREA

1. AMMONIATED MOLASSES
2. AMMONIATED CONDENSED DISTILLERS MOLASSES SOLUBLES
3. AMMONIATED CITRUS PULP
4. AMMONIATED BEET PULP
5. AMMONIATED FURFURAL RESIDUE
6. BIURET

**Table XXXVII**

**UREA FEEDING RECOMMENDATIONS**

*(BY CLASS OF LIVESTOCK)*

<table>
<thead>
<tr>
<th></th>
<th>LOW QUALITY ROUGHAGE* + PROTEIN SUPPLEMENT</th>
<th>GOOD OR HIGH QUALITY ROUGHAGE** + PROTEIN SUPPLEMENT</th>
<th>HIGH ROUGHAGE + SUPPLEMENTAL GRAIN AND PROTEIN</th>
<th>FULL</th>
<th>HIGH CONCENTRATE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BEEF CATTLE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wintering Cows</td>
<td>1/2 S</td>
<td>1/3 T</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growing Calves 200 + Pounds</td>
<td>1/2 S</td>
<td>1/3 T</td>
<td>1/3 C</td>
<td>1/3 T</td>
<td>1/2 T</td>
</tr>
<tr>
<td>Fattening</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SHEEP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ewes</td>
<td>1/2 S</td>
<td>1/3 T</td>
<td>1/2 C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lambs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DAIRY CATTLE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milking Cows</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Cows</td>
<td>1/2 S</td>
<td>1/3 T</td>
<td>1/3 C</td>
<td>1/3 C</td>
<td></td>
</tr>
<tr>
<td>Growing Stock</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
* LOW QUALITY ROUGHAGE—CONTAINING LESS THAN 6% PROTEIN
** GOOD QUALITY ROUGHAGE—CONTAINING MORE THAN 6% PROTEIN
S AMOUNT OF SUPPLEMENTAL PROTEIN UREA MAY REPLACE
C AMOUNT OF CONCENTRATE PROTEIN UREA MAY REPLACE
T AMOUNT OF TOTAL RATION PROTEIN UREA MAY REPLACE

"Reproduced from DOANE'S Agricultural Report, St. Louis, Missouri."
TABLE XXXVIII

PROTEIN UTILIZATION IN RUMINANTS

Procedure

1. Bacterial breakdown of protein and non-protein-nitrogen in the ration, which produces ammonia

2. Synthesis of this ammonia into bacterial protein

3. Digestion of the bacterial protein in the lower digestive tract of the ruminant, which supplies both the essential and nonessential amino acids required
TABLE XXXIX
NITROGEN METABOLISM IN THE RUMINANT

<table>
<thead>
<tr>
<th>Protein</th>
<th>NPN</th>
<th>Diet</th>
<th>Saliva</th>
<th>Urea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>NPN</td>
<td>Peeptides</td>
<td>Ammonia</td>
<td>Microbial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Amino acids</td>
<td></td>
<td>Protein</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ammonia</td>
<td></td>
<td>Protein</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Urea</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ammonia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Amino acids</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Liver</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rumen</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Urine</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tissue</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Metabolism</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Feces</td>
</tr>
</tbody>
</table>

Protein Ammonia
Amino Acids

Undigested Dietary
Metabolic Fecal
-N

Endogenous
-N
Course: Advanced Livestock Production
Area: Livestock Nutrition
Unit: Nutrients
Job XXVI: The Energy Sources

Objective: To develop a basic understanding of how an animal secures energy

Motivation: "Can a cow actually receive some nutritional value from straw?"

Reference:
1. Feeds and Feeding, Morrison
2. "Animal Science" Slides (number 19)
4. "Nutrient Requirements of Horses," No. 6, publication 1401, National Academy of Sciences
5. "Nutrient Requirements of Dairy Cattle," No. 3, publication 1349, National Academy of Sciences
6. "Nutrient Requirements of Swine," No. II, publication 1192, National Academy of Sciences
Teaching Outline:

I. Sources of energy

II. Supplying of energy through feeds

III. Measures of energy

Teaching Procedure:

I. Introduce unit.

II. Discuss how energy sources are broken down.

III. Assign students to make a list of sources of high energy levels.

IV. Discuss how energy is measured in regard to ration calculation.

V. Summarize and evaluate.
### TABLE XL

#### ENERGY SOURCES

<table>
<thead>
<tr>
<th>YIELD ENERGY:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) FAT</td>
</tr>
<tr>
<td>(2) NITROGEN-FREE EXTRACT</td>
</tr>
<tr>
<td>(3) PROTEIN</td>
</tr>
<tr>
<td>(4) CRUDE FIBER</td>
</tr>
</tbody>
</table>

#### CARBOHYDRATES

**I. MONOSACCHARIDES**

A. PENTOSES

B. HEXTOSES

1. GLUCOSE

2. GALACTOSE

3. FRUCTOSE

**II. DISACCHARIDES**

A. LACTOSE (MILK SUGAR)

B. MALTOSE

C. SUCROSE (TABLE SUGAR)

**III. POLYSACCHARIDES**

A. STARCH

B. CELLULOSE
IV. LIGNIN
   A. NOT DIGESTIBLE

Saturated:

ACETIC  VOLATILE FATTY
PROPIONIC  ACIDS FROM
BUTYRIC  RUMEN
CAPROIC  FOUND IN
CAPRYLIC  BUTTERFAT
CAPRIC

OLEIC -- UNSATURATED:
LINOLEIC*
LINOLENIC*
ARACHADONIC -- UNSATURATED*

* ESSENTIAL FATTY ACIDS TO NUTRITION
REST USED FOR ENERGY SUPPLY
TABLE XLI
MEASUREMENTS OF ENERGY

TDN (TOTAL DIGESTIBLE NUTRIENTS)

1. TDN = (% PROTEIN) (PROTEIN DIGESTIBILITY COEFFICIENT) +
   (% FAT) (FAT DIGESTIBILITY COEFFICIENT) (2.25) +
   (% CRUDE FIBER) (C. F. DIGESTIBILITY COEFFICIENT)
   + (% NITROGEN-FREE EXTRACT) (NFE DIGESTIBILITY
   COEFFICIENT)

2. D. E. (DIGESTIBLE ENERGY)
   ASSUME ONE POUND TDN = 2,000
   KILOCALORIES OF DE
Course: Advanced Livestock Production

Area: Livestock Nutrition

Unit: Nutrients

Job XXVII: Minerals

Objective: To develop an understanding of the functions of minerals, their symptoms of deficiency and when and where a deficiency is likely to occur.

Motivation: "If animals require such small amounts of minerals, why is it essential that we supply any minerals?"

References: 1. Feeds and Feeding, Morrison

2. "Nutrient Requirements of Beef Cattle," No. 4, publication 1137, National Academy of Sciences

3. "Nutrient Requirements of Horses," No. 6, publication 1401, National Academy of Sciences

4. "Nutrient Requirements of Dairy Cattle," No. 3, publication 1349, National Academy of Sciences

5. "Nutrient Requirements of Swine," No. II, publication 1192, National Academy of Sciences


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Teaching Outline:

I. Minerals
II. Function of minerals
III. Deficiency symptoms of minerals
IV. Time and place mineral deficiencies are likely to occur
V. Mineral requirements
VI. Water as a nutrient

Teaching Procedure:

I. Introduce unit.

II. Distribute handouts and discuss the minerals and their functions, deficiencies, and when and where they are likely to occur.

IV. Obtain a guest speaker through a commercial feed company to discuss with the class the feeding of minerals.

V. Show samples of minerals and mineral supplements.

VI. Collect pictures of animals exhibiting mineral deficiencies from various sources and exhibit and discuss them with the class.

VII. Review in Feeds and Feeding or NRC bulletins the nutrients required by the various farm animals.

VIII. Review the amount of minerals in feeds.

IX. Discuss the function, metabolism, and elimination of water.

X. Summarize and evaluate.
TABLE XLII
THE GENERAL FUNCTIONS OF MINERALS

1. STRUCTURAL -- CALCIUM AND PHOSPHORUS IN THE SKELETON

2. OSMOTIC PRESSURE -- SODIUM, POTASSIUM, CHLORINE AND PHOSPHATES

3. pH REGULATION
   A. BUFFERS
   B. BLOOD pH 7.35

4. MUSCLE FUNCTION AND NERVE TRANSMISSION -- CALCIUM, POTASSIUM AND SODIUM

5. ENZYME REACTIONS
<table>
<thead>
<tr>
<th>MINERAL</th>
<th>FUNCTIONS</th>
<th>SYMPTOM OF DEFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>REGULATES OSMOTIC PRESSURE; REGULATES pH; REGULATES ENZYMATIC REACTIONS</td>
<td>LOSS IN WEIGHT, REDUCED FEED INTAKE, POOR WOOL GROWTH, STIFFNESS</td>
</tr>
<tr>
<td>P</td>
<td>AIDS STRUCTURAL GROWTH</td>
<td>LOWERED BLOOD PLASMA P; DEPRAVED APPETITE (PICA), RICKETS, POOR GAINS, ROUGH HAIR COAT</td>
</tr>
<tr>
<td>Ca</td>
<td>AIDS STRUCTURAL GROWTH</td>
<td>RICKETS IN YOUNG ANIMALS, FRAGILE BONES OR OSTEOMALACIA IN MATURE ANIMALS, ESPECIALLY LACTATING</td>
</tr>
</tbody>
</table>
WHEN IS DEFICIENCY LIKELY?

WHEN RUMINANTS ARE FED RATION WITH NO ROUGHAGE

WHEN CATTLE ARE ON LOW GRADE ROUGHAGE OR ON UNFERTILIZED PASTURE; WHEN POULTRY ARE ON PLANT RATIONS; WHEN HOGS ARE ON PASTURE WITH NO PROTEIN SUPPLEMENT

WHEN CATTLE AND SHEEP ARE ON LOW GRADE HAY; WHEN HOGS ARE ON DRY LOT AND VEGETABLE RATIONS; WHEN POULTRY ARE FED UNSUPPLEMENTED RATIONS
<table>
<thead>
<tr>
<th>Element</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mg</td>
<td>Aids structural growth; regulates enzymatic reactions</td>
</tr>
<tr>
<td>Fe</td>
<td>Aids blood formation; regulates enzymatic reactions</td>
</tr>
<tr>
<td>Cu</td>
<td>Aids iron usage; influences hair pigmentation</td>
</tr>
<tr>
<td>Co</td>
<td>Regulates vitamin B12 usage</td>
</tr>
<tr>
<td></td>
<td>Females and laying hens</td>
</tr>
<tr>
<td></td>
<td>Hyperirritability, muscular twitching, weak pasterns, tetany and excess salivation</td>
</tr>
<tr>
<td></td>
<td>Anemia and thumps in pigs</td>
</tr>
<tr>
<td></td>
<td>Diarrhea, bleached hair coat, steely wool, swelling about pasterns, fragile bones, anemia</td>
</tr>
<tr>
<td></td>
<td>Loss of appetite, anemia, poor growth</td>
</tr>
<tr>
<td></td>
<td>Magnesium aids structural growth; regulates enzymatic reactions</td>
</tr>
<tr>
<td></td>
<td>Iron abets blood formation; regulates enzymatic reactions</td>
</tr>
<tr>
<td></td>
<td>Copper aids iron usage; influences hair pigmentation</td>
</tr>
<tr>
<td></td>
<td>Cobalt regulates vitamin B12 usage</td>
</tr>
</tbody>
</table>
When on lush pastures with high nitrogen applications

When baby pigs are on concrete or board floors

Not likely to occur

When corn cobs or low grade roughage are fed with corn
<table>
<thead>
<tr>
<th>Element</th>
<th>Function</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mn (Manganese)</td>
<td>Aids carbohydrate metabolism; aids fertility</td>
<td>Slipped tendons in poultry, lowered hatchability</td>
</tr>
<tr>
<td>Zn (Zinc)</td>
<td>Regulates insulin production; influences skin enzyme production</td>
<td>Parakeratosis, poor growth in poultry</td>
</tr>
<tr>
<td>Se (Selenium)</td>
<td>Regulates vitamin E usage</td>
<td>White muscle disease, stiff lamb disease, chronic alkali disease, acute blind staggars</td>
</tr>
<tr>
<td>S (Sulphur)</td>
<td>Aids formation of proteins</td>
<td>Reduced growth, especially of wool in sheep</td>
</tr>
<tr>
<td>I (Iodine)</td>
<td>Regulates thyroid gland</td>
<td>Goiter, hairless pigs, enlarged necks</td>
</tr>
</tbody>
</table>
If poultry rations are used, never for other farm animals when large amounts of Ca are added to swine rations not likely to occur; easily corrected by large dose of vitamin E when low grade roughage supplemented with urea are used when pregnant animals drink rain or river water in some areas.
NA  Cl
SALT

REGULATES OSMOTIC PRESSURE

SALT HUNGER, REDUCED
APPETITE, ROUGH HAIR,
LOSS OF WEIGHT, DECLINE
IN PRODUCTION
IN ALL ANIMALS, IF NOT ALLOWED SALT
TABLE XLIV
WATER

FUNCTIONS --
1. TAKES UP HEAT -- HIGH SPECIFIC
   HEAT AND HEAT OF VAPORIZATION
2. ABETS NERVE TRANSMISSION -- HIGH
   DIELECTRIC CONSTANT
3. PRODUCES CATALYTIC CHEMICAL
   REACTION IN DIGESTION AND HYDRO-
   LYSIS OF FOODS

METABOLISM --
1. INTAKE
   A. DRINKING WATER
   B. WATER IN THE FEED
   C. METABOLIC WATER
      \[ \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]
2. ELIMINATION
   A. URINE
   B. FECES
   C. PERSPIRATION -- THROUGH PORES
   D. INSENSIBLE PERSPIRATION
      (1) LOST FROM LUNGS
      (2) LOST DIRECTLY THROUGH SKIN
Objective: To develop an understanding of the functions of the various vitamins, the symptoms of their deficiencies, their sources, and their requirements.

Motivation: Show examples of animals with vitamin deficiencies and ask what could have caused these conditions.

References:


2. "Nutrient Requirements of Beef Cattle," No. 4, publication 1137, National Academy of Sciences.


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Teaching Outline:

I. The vitamins - fat and water soluble
II. The functions of the vitamins
III. The symptoms of deficiency of vitamins
IV. The sources of vitamins
V. The vitamin requirements

Teaching Procedure:

I. Introduce unit.

III. Distribute handouts and discuss the vitamins, their functions, deficiency symptoms, sources and requirements.

IV. Collect pictures of animals exhibiting vitamin deficiencies and discuss them with the class.

V. Review the NRC and Feeds and Feeding as they apply to the amounts of vitamins needed by the different classes of livestock.

VI. Review the amounts of vitamins found in feedstuffs and have the students compile a list of vitamin contents of commonly used feeds.

VII. Summarize and evaluate.
<table>
<thead>
<tr>
<th>VITAMIN</th>
<th>FUNCTION</th>
<th>SYMPTOM OF DEFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Maintain epithelial tissue and form cartilage</td>
<td>Night blindness; xerophthalmia; reproductive problems; poor growth</td>
</tr>
<tr>
<td>D</td>
<td>Forms bone and activates parathyroid</td>
<td>Rickets in young; osteomalacia in mature; weak egg shells in poultry</td>
</tr>
<tr>
<td>E</td>
<td>Acts as antioxidant, stimulates protein synthesis, aids reproduction</td>
<td>Reproductive failures; encephalomalacia—crazy chicken disease, water on the brain; stiff lamb and white muscle disease of sheep</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>K</td>
<td>COAGULATES BLOOD (PROTHROMBIN)</td>
<td>INTERNAL HEMORRHAGING</td>
</tr>
<tr>
<td></td>
<td>WATER SOLUBLE</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>NONE</td>
<td>NONE</td>
</tr>
<tr>
<td>B₁</td>
<td>THIAMIN</td>
<td>METABOLIZES PYRUVIC ACID</td>
</tr>
<tr>
<td>B₂</td>
<td>RIBOFLAVIN</td>
<td>ENCOURAGES PHOS-PHYRILATION AND AMINO ACID OXIDATION</td>
</tr>
<tr>
<td>B</td>
<td>NIAcin</td>
<td>ENCOURAGES PHOS-PHYRILATION</td>
</tr>
<tr>
<td>SOURCES</td>
<td>MISCELLANEOUS INFORMATION AND REQUIREMENTS</td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>ANIMAL SOURCE -- A; PLANT</td>
<td>MAINTENANCE -- 1,000 IU PER CWT.</td>
<td></td>
</tr>
<tr>
<td>SOURCE -- CAROTENE</td>
<td>GROWTH -- 3,000 IU PER CWT.</td>
<td></td>
</tr>
<tr>
<td>PLANT -- D₂; ANIMAL -- D₃;</td>
<td>400 IU PER CWT.</td>
<td></td>
</tr>
<tr>
<td>SUNLIGHT</td>
<td>UNKNOWN</td>
<td></td>
</tr>
<tr>
<td>GERM OF GRAIN; GREEN FORAGES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ANTIBIOTICS, ALFALFA</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>NONE</td>
<td>NEEDED ONLY BY MAN, MONKEY AND GUINEA PIGS</td>
<td></td>
</tr>
<tr>
<td>SYNTHESIZED IN RUMEN</td>
<td>.5 MG PER DAY</td>
<td></td>
</tr>
<tr>
<td>YEAST, WHEY, GREEN PLANTS</td>
<td>1-2 MG PER POUND FEED, DESTROYED BY LIGHT</td>
<td></td>
</tr>
<tr>
<td>YEAST, MEAT SCRAPs, GRAIN</td>
<td>5-10 MG PER POUND FEED</td>
<td></td>
</tr>
</tbody>
</table>
B12 ENCOURAGES NUCLIC ACID METABOLISM AND RED BLOOD CELL FORMATION; AIDS IN THE CARBOLIC EXCHANGE

POOR GROWTH, ANEMIA
TANKAGE, FISH MEAL, 
FERMENTATION RESIDUES

5 MG PER POUND FEED

OTHER VITAMINS:
1. PYRIDOXINE
2. PANTOTHENIC ACID
3. BIOTIN
4. CHOLIN
5. INISTOL
6. FOLIC ACID
TABLE XLVI
DIGESTION--THE PROCESS
OF PREPARING FOOD FOR ABSORPTION

I. MECHANICAL
   A. MASTICATE (TEETH)
   B. CRUSH (GIZZARD)
   C. EMULSIFY (LIVER)
   D. REGURGETATE (RUMINANT)

II. CHEMICAL
   A. STOMACH -- HYDROCHLORIC ACID
   B. SMALL INTESTINE -- ALKALI
### III. ENZYMATIC -- NEURAL AND HORMONAL SECRETION

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>NAME</th>
<th>ACTS UPON</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOUTH (SALIVA)</td>
<td>PTYALIN</td>
<td>CARBOHYDRATES</td>
</tr>
<tr>
<td>STOMACH (GASTRIC JUICE)</td>
<td>PEPSIN</td>
<td>PROTEIN</td>
</tr>
<tr>
<td>PANCREAS</td>
<td>TRYPSIN</td>
<td>PROTEIN</td>
</tr>
<tr>
<td>(PANCREATIC JUICE)</td>
<td>CHYMOTRYPSIN</td>
<td>PROTEIN</td>
</tr>
<tr>
<td></td>
<td>AMYLASE</td>
<td>CARBOHYDRATES</td>
</tr>
<tr>
<td></td>
<td>LIPASE</td>
<td>FATS</td>
</tr>
<tr>
<td>SMALL INTESTINE (INTESTINAL JUICE)</td>
<td>PEPTIDASE</td>
<td>PROTEIN</td>
</tr>
<tr>
<td></td>
<td>CARBOHYDASES</td>
<td>CARBOHYDRATES</td>
</tr>
</tbody>
</table>
IV. BACTERIAL -- ALL ACTION IN RUMEN BACTERIAL

A. CONDITIONS IN RUMEN DESIRABLE FOR BACTERIA

(1) WARM (39°C)
(2) MOIST
(3) pH CONTROLLED
(4) DARK
(5) CONTINUOUS FEEDING
### TABLE XLVII
CARBOHYDRATE DIGESTION

<table>
<thead>
<tr>
<th>Process</th>
<th>Enzyme/Chemical</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>SALIVA -- PIG SALIVORY-- AMYLASE</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>STOMACH -- HYDROCHLORIC ACID</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>SMALL INTESTINE</td>
<td></td>
</tr>
<tr>
<td>A.</td>
<td>MALTOSE</td>
<td>2 GLUCOSE MOLECULES</td>
</tr>
<tr>
<td>B.</td>
<td>SUCROSE</td>
<td>1 GLUCOSE + 1 FRUCTOSE MOLECULE</td>
</tr>
<tr>
<td>C.</td>
<td>LACTOSE</td>
<td>1 GLUCOSE + 1 GALACTOSE MOLECULE</td>
</tr>
</tbody>
</table>
TABLE XLVIII
FAT DIGESTION

\[
\text{FAT} \xrightarrow{\text{PANCREATIC LIPASE}} \text{GLYCEROL} + \text{FATTY ACIDS}
\]
\[
\text{AIDED BY: BILE SALTS} \quad \text{ALKALI (SM. INTESTINE)}
\]
**TABLE XLIX**

**PROTEIN DIGESTION**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. STOMACH -- PEP SIN (SCI OR HCL)</td>
<td></td>
</tr>
<tr>
<td>2. PANCREAS</td>
<td></td>
</tr>
<tr>
<td>A. TRYSIN</td>
<td></td>
</tr>
<tr>
<td>B. CHYMOTRYSIN</td>
<td></td>
</tr>
<tr>
<td>3. SMALL INTESTINE</td>
<td></td>
</tr>
<tr>
<td>A. CARBOXY PEPTIDASE</td>
<td></td>
</tr>
<tr>
<td>B. AMINO PEPTIDASE</td>
<td></td>
</tr>
<tr>
<td>C. DIPEPTIDASE</td>
<td></td>
</tr>
</tbody>
</table>

**THESE SEPARATE SPECIFIC AMINO ACIDS.**
Course: Advanced Livestock Production

Area: Livestock Nutrition

Unit: Physiology of Digestion

Job XXIX: Digestive Process

Objective: To develop an understanding of the processes, both physically and enzymatically, in digestion

Motivation: "Food taken into the animal must undergo certain changes before it can be used by the animal."

References: 1. Feeds and Feeding, Morrison.

Teaching Outline:

I. Digestive Process
   A. Mechanical
      1. Masticate (teeth)
      2. Crush (gizzard)
      3. Emulsify (liver)
      4. Regurgitate (ruminent)
   B. Chemical
   C. Enzymatic
   D. Bacterial

Teaching Procedure:

I. Introduce unit.
II. Discuss the digestive process and integrate the slides from Iowa State.
III. Summarize and evaluate.
Course: Advanced Livestock Production
Area: Livestock Nutrition
Unit: Physiology of Digestion
Job XXX: Metabolism and Absorption of Nutrients

Objective: To instruct students in how the body takes the nutrients it needs from feedstuff.

Motivation: Liken the body to a pipe which closes around its food and takes out what it needs. "How is this accomplished?"

References: 1. Feeds and Feeding, Morrison

Teaching Outline:
I. Absorption
   A. Carbohydrates
   B. Fats
   C. Proteins
II. Metabolism of nutrients

Teaching Procedure:
I. Introduce unit.
II. Integrate the appropriate slides into the discussion.
III. Discuss how carbohydrates, fats, and proteins are absorbed and metabolized.
IV. Summarize and evaluate.
TABLE L
CARBOHYDRATE ABSORPTION
VILLI OF SMALL INTESTINE

CARBOHYDRATE METABOLISM:

ABSORBED SUGARS

BLOOD SUGARS

LIVER

GLYCOGEN

CARBON DIOXIDE WATER ENERGY

BODY FAT

NH₂

NON-ESSENTIAL AMINO ACIDS

NH₂
TABLE LI
FAT ABSORPTION
VILLI OF SMALL INTESTINE

FAT METABOLISM:

SMALL INTESTINE → LIVER → HEART → LUNGS → BODY TISSUE

LYMPH STREAM

ABSORBED FAT
→ STORED IN ADIPOSE TISSUE
→ CO₂
→ HO₂
→ ENERGY
→ STORED IN LIVER
TABLE LII
PROTEIN ABSORPTION
VILLI OF SMALL INTESTINE.

PROTEIN METABOLISM:

PROTEIN
→ AMINO ACID

BLOOD
ŏ
LIVER

ENERGY

PLASMA

PROTEIN

HORMONES

ENERGY

BLOOD

AMINO ACIDS

TISSUE

PROTEIN

CO₂
H₂O
NH₃
ENERGY
TABLE LIII
METABOLISM

ANY CHANGE THAT Takes PLACE IN AN ANIMAL’S BODY

WASTE REMOVAL

1. LIVER --- REGULATOR --- WATER INSOLUBLE WASTE PRODUCTS
2. KIDNEY --- REGULATOR --- WATER SOLUBLE WASTE PRODUCTS
3. LUNGS --- OXYGEN UPTAKE AND CARBON DIOXIDE REMOVAL
Course: Advanced Livestock Production
Area: Livestock Nutrition
Unit: Rations
Job XXXI: Analysis of Feedstuffs

Objectives: To instruct students in how an analysis of feedstuffs is made and how it can be used
To understand the digestibility of feeds

Motivation: "What is the difference between a concentrate and a roughage?"

References: 1. Feeds and Feeding, Morrison
2. "Nutrient Requirements of Beef Cattle," No. 4, publication 1137, National Academy of Sciences
3. "Nutrient Requirements of Horses," No. 6, publication 1401, National Academy of Sciences
4. "Nutrient Requirements of Dairy Cattle," No. 3, publication 1349, National Academy of Sciences
5. "Nutrient Requirements of Swine," No. II, publication 1192, National Academy of Sciences
Teaching Outline:

I. Proximate analysis

II. Digestibility of feeds

Teaching Procedure:

I. Introduce unit.

II. Review the routine analysis of feedstuffs and discuss how it is made.

III. Burn some dry leaves to illustrate ash content.

IV. Review Table I in the appendix of Feeds and Feeding and illustrate the calculation of the digestibility of feedstuff.

V. Calculate a problem on TDN as illustrated in Table S1 to illustrate the digestibility of feedstuff.

A. Digestibility Coefficient = \frac{\text{Amount of feed digested}}{\text{Amount of feed consumed}}

VI. Summarize and evaluate.
TABLE LIV

ROUTINE ANALYSIS OF FEEDSTUFFS

1. DRY MATTER. HEAT SAMPLE TO A CONSTANT WEIGHT. THIS REMOVES THE WATER, SO LOSS IN WEIGHT EQUALS WATER -- 24 HRS. USUALLY REQUIRED.

2. ETHER EXTRACT (FAT). EXTRACT DRY SAMPLE WITH ANHYDROUS ETHYL ETHER FOR 16 HOURS. THIS REMOVES THE FAT SO AGAIN THE LOSS IN WEIGHT AFTER DRYING (EVAPORATION OF ETHER) EQUALS THE FAT. (WILL CONTAIN PIGMENTS, WAXES, AND OILS.)

3. ASH. BURN SAMPLE BY PLACING A WEIGHED AMOUNT IN A MUFFLE FURNACE FOR 2 HOURS AT 600°C. ASH IS CONSIDERED AT THE DRY RESIDUE REMAINING. THE WATER, FAT, PROTEIN, CARBOHYDRATES HAVE BEEN REMOVED BY THE PROCESS.

4. PROTEIN (KJELDAHL PROCESS). DIGEST SMALL DRIED SAMPLE IN CONCENTRATED SULPHURIC ACID UNTIL ALL ORGANIC MATTER IS DESTROYED. NITROGEN IN FEED IS NOW IN FORM OF AMMONIUM SULPHATE. THE DIGEST IS DISTILLED WITH SODIUM HYDROXIDE AND THE AMMONIA IS DRIVEN OVER INTO STANDARD ACID AND TITRATED. THIS DETERMINES THE AMOUNT OF NITROGEN IN THE SAMPLE.
5. The percentage of nitrogen free extract (N.F.E.) is found by difference -- not by actual analysis. The percentage of water, ash, protein, fiber, and fat are merely added together and subtracted from 100.

6. Crude fiber. After removal of water and E.E. from a sample of feed, the sample is boiled for thirty minutes in weak acid (0.255N.H2SO4), then in weak alkali (0.312 N. NaOH). This removed the proteins, sugars, and starches, which are discarded. Cellulose and mineral matter are left in the feed residue. This material is dried and weighed, then burned in muffle furnace at 600°C. Loss in weight is reported as crude fiber.

7. Carbohydrates (CHO). Not determined by analysis. CHO = N.F.E. plus crude fiber, 100 - H2O + fat + protein + crude fiber + min. = N.F.E.
TABLE LV

ROUTINE ANALYSIS OF FEEDSTUFFS CHART

OUTLINE

FEED SAMPLE

- H₂O
- D.M.

ASH

ORGANIC SUBSTANCES

NITROGENOUS SUBSTANCES

NON-NITROGENOUS SUBSTANCES

E.E.

CARBOHYDRATES

N.F.E.

CRUDE FIBER

(CELLULOSE, LIGNIN)
Course: Advanced Livestock Production

Area: Livestock Nutrition

Unit: Rations

Job XXXII: Economics of Ration Selection

Objective: To instruct students in the method of feedstuff evaluation for economics purposes

Motivation: "If corn is available for $1.15 per bushel and milo, for $1.05 per 100 pounds, which would be the best buy in terms of TDN?"

References: 1. Feeds and Feeding. Morrison (Table II)

Teaching Outline:

I. Evaluation on TDN basis

II. Evaluation in terms of Peterson Constants

Teaching Procedure:

I. Introduce unit.

II. Illustrate, by use of a problem, how feedstuffs can be evaluated on a TDN basis and discuss the procedure.

III. Assign additional problems.

IV. Illustrate and discuss the use of the Peterson Constants of feed evaluation.

V. Assign additional problems for the students to calculate.

VI. Summarize and evaluate.
TABLE LVI
PROBLEM: EVALUATION ON TDN BASIS

WHICH OF THE FOLLOWING WOULD BE THE BEST BUY? (ON TDN BASIS)

SHELLED CORN AT $1.10 PER BUSHEL
BARLEY AT 1.05 PER BUSHEL
MILO AT 1.95 PER CWT.

CHANGE PRICES TO CWT. BASIS.

SHELLED CORN = $1.96 PER CWT.
BARLEY = 2.18 PER CWT.
MILO = 1.95 PER CWT.

CHANGE TO POUNDS OF TDN (% TDN X 100 LBS.)

SHELLED CORN = $1.96 PER 80.1 LBS. TDN
BARLEY = 2.18 PER 73.2 LBS. TDN
MILO = 1.95 PER 77.8 LBS. TDN

CHANGE TO VALUE PER POUND TDN (PRICE/NO. OF POUNDS)

SHELLED CORN = 2.45¢ PER POUND TDN
BARLEY = 2.98¢ PER POUND TDN
MILO = 2.50¢ PER POUND TDN

THEREFORE, SHELLED CORN IS THE BEST BUY.
TABLE LVII

PROBLEM: PETERSON CONSTANTS

IF THE FOLLOWING PRICES WERE IN EFFECT, WHICH WOULD BE THE
BEST BUY?

44% SOLVENT SOYBEAN MEAL = $82.50 PER TON

41% COTTONSEED MEAL = $80.70 PER TON

36% LINSEED MEAL = $73.80 PER TON

17% DEHYDRATED ALFALFA MEAL = $53.00 PER TON

AND CORN IS SELLING FOR $39.20 PER TON.

PETERSON CONSTANTS

(TABLE II, FEEDS AND FEEDING)

<table>
<thead>
<tr>
<th>Feed</th>
<th>Corn Constant</th>
<th>Soybean Meal Constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOYBEAN MEAL</td>
<td>.000</td>
<td>1.000</td>
</tr>
<tr>
<td>COTTONSEED MEAL</td>
<td>.025</td>
<td>.770</td>
</tr>
<tr>
<td>LINSEED MEAL</td>
<td>.258</td>
<td>.709</td>
</tr>
<tr>
<td>ALFALFA MEAL</td>
<td>.325</td>
<td>.241</td>
</tr>
<tr>
<td>CORN</td>
<td>1.000</td>
<td>.000</td>
</tr>
</tbody>
</table>

313/314
CSM PRICE = (.025) (39.20) + (.770) (82.30)
= .99 + 63.40

LSM PRICE = $64.39_PER_TON
= (.258) (39.20) + (.709) (82.30)
= 10.11 + 58.30

ALFALFA PRICE = $68.41_PER_TON
= (.325) (39.20) + (.241) (82.30)
= 12.71 + 19.80

SBM PRICE = $32.52_PER_TON
= (.000) (39.20) + (1.000) (82.30)
= 0 + 82.30
= $82.30_PER_TON

THEREFORE, BUY SOYBEAN MEAL.
Course: Advanced Livestock Production

Area: Livestock Nutrition

Unit: Rations

Job XXXIII: Balancing Rations

Objective: To instruct students in the methods of ration balancing.

Motivation: "How can a farmer calculate his own rations without getting professional assistance?"

References:
1. *Feeds and Feeding*, Morrison
2. "Nutrient Requirements of Beef Cattle," No. 4, publication 1137, National Academy of Sciences
3. "Nutrient Requirements of Horses," No. 6, publication 1401, National Academy of Sciences
4. "Nutrient Requirements of Dairy Cattle," No. 3, publication 1349, National Academy of Sciences
5. "Nutrient Requirements of Swine," No. II, publication 1192, National Academy of Sciences
Teaching Outline:

I. Methods of balancing rations
   A. Trial and error
   B. Simultaneous equations
   C. Square method

Teaching Procedure:

I. Introduce unit.

II. Illustrate and discuss the use of the square method of calculating rations.

III. Assign additional problems for students to calculate.

IV. Illustrate and discuss the use of simultaneous equations to calculate rations.

V. Assign additional problems for the students to calculate.

VI. After students have worked problems, check and discuss them.

VII. Summarize and evaluate.
TABLE LVIII
SQUARE METHOD

Assume that we require 20% protein (dig.) for our sow's ration and that we have corn (6.7% DP) and linseed meal (30.6% DP) on hand. How much of each would we mix to make a 20% DP ration?

<table>
<thead>
<tr>
<th>CORN</th>
<th>LSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.7</td>
<td>30.6</td>
</tr>
</tbody>
</table>

\[
\begin{align*}
\text{% CORN} &= \frac{10.6}{23.9} = 44.4\% = 44.4 \times 20 = 888\#/\text{TON} \\
\text{% LSM} &= \frac{13.3}{23.9} = 55.6\% = \frac{55.6}{100} = \frac{1112\#}{\text{TON}} 
\end{align*}
\]

\[319/320\]
BY ALGEBRA:

LET $X = \%$ CORN  \hspace{1cm} 100 - $X$ = $\%$ LSM

\[0.067X + 0.306(100 - X) = 20\]

$X = 44.4$

$100 - X = 55.6$
TABLE LIX

SQUARE METHOD PROBLEM

I have a lactating gilt. According to the Iowa State University "Life Cycle Swine Nutrition," she requires 16 per cent protein. Using barley at 12 per cent protein and cottonseed meal at 41 per cent protein, how much of each would you mix, to achieve the 16 per cent protein ration, in a ton of feed?
TABLE LX  
SIMULTANEOUS EQUATION  

USING ALFALFA HAY AND CORN, BALANCE A RATION FOR A 400-POUND DAIRY HEIFER.

RULES:
1. FEEDS THAT INCLUDE ROUGHAGE SATISFY FOR DM AND TDN.
2. FOR MOST CONCENTRATE RATIONS, BALANCE FOR DP AND TDN.

1. OBTAIN THE REQUIREMENTS FOR THE HEIFER:

HEIFER 400#  

<table>
<thead>
<tr>
<th></th>
<th>#DM</th>
<th>#DP</th>
<th>#TDN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9.1</td>
<td>11.4</td>
<td>0.76</td>
</tr>
<tr>
<td>TDN</td>
<td></td>
<td></td>
<td>6.7</td>
</tr>
</tbody>
</table>

USE UPPER LIMITS

2. OBTAIN PER CENT COMPOSITION OF FEEDSTUFFS.

<table>
<thead>
<tr>
<th></th>
<th>#DM</th>
<th>#DP</th>
<th>#TDN</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALFALFA HAY (Y)</td>
<td>90.5</td>
<td>10.9</td>
<td>50.7</td>
</tr>
<tr>
<td>CORN (X)</td>
<td>85</td>
<td>6.7</td>
<td>80.1</td>
</tr>
</tbody>
</table>

CHANGE % TO DECIMAL EQUIVALENTS.
3. SET UP SIMULTANEOUS EQUATIONS.
   IN THIS CASE, FOR DM AND TDN.
   LET X = AMOUNT OF CORN
   LET Y = AMOUNT OF ALFALFA HAY

   DM
   .85X + .905Y = 11.4
   11.4 - .905Y
   X = 13.4 - 1.06Y
   X = 13.4 - 1.06 (10.8) = 13.4 - 11.5
   X = 1.9 POUNDS OF CORN

   4. SUBSTITUTE (X) IN TDN EQUATION
   5. SUBSTITUTE (Y) BACK INTO DM EQUATION.

   TDN
   .801X + .507 = 7.
   .801 (13.4 - 1.06Y) + .507Y = 7
   10.7 - .85Y + .507Y = 7
   -.343Y = -3.7

   Y = \frac{-3.7}{-3.43}

   Y = 10.8 POUNDS OF ALFALFA HAY
6. **SEE IF REQUIREMENTS HAVE BEEN MET.**

<table>
<thead>
<tr>
<th></th>
<th>CM</th>
<th></th>
<th>DP</th>
<th></th>
<th>TDN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>COMP</td>
<td>AMT.</td>
<td>COMP</td>
<td>AMT.</td>
<td>COMP</td>
</tr>
<tr>
<td>ALFALFA HAY</td>
<td>10.8#</td>
<td>.905</td>
<td>9.8</td>
<td>.109</td>
<td>1.17</td>
</tr>
<tr>
<td>CORN</td>
<td>1.9#</td>
<td>.85</td>
<td>1.6</td>
<td>.067</td>
<td>.13</td>
</tr>
</tbody>
</table>

- **TOTAL PRODUCED**
  - XXX 11.4 XXX 1.30 XXX 7.00

- **REQUIRED AMOUNT**
  - 11.4 .37 7.00

- **EXCESS OR DEFICIT**
  - ±0 +.43 ±0

**EXCESS IS PERMISSIBLE.**
<table>
<thead>
<tr>
<th>Feed Stuffs - Percent:</th>
<th>T.D.N.</th>
<th>D.P.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>80.1</td>
<td>6.7</td>
</tr>
<tr>
<td>Soybean Meal:</td>
<td>78.1</td>
<td>42.0</td>
</tr>
</tbody>
</table>

Let $X = \text{Corn}$

Let $Y = \text{S.B.M.}$
TABLE LXII
KEY -- SIMULTANEOUS EQUATION PROBLEM

100- POUND SHOAT
REQUIREMENTS:

FEEDSTUFFS -- PERCENT:

<table>
<thead>
<tr>
<th></th>
<th>TDN LBS.</th>
<th>DP LBS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORN</td>
<td>80.1</td>
<td>6.7</td>
</tr>
<tr>
<td>SOYBEAN MEAL</td>
<td>78.1</td>
<td>42.0</td>
</tr>
</tbody>
</table>

LET X = CORN
LET Y = S.B.M.

\[
\begin{align*}
\text{TDN} & = (0.801)(X) + (0.781)(Y) = 4.4 \\
0.801X + 0.781Y & = 4.4 \\
X & = \frac{4.4 - 0.781Y}{0.801} \\
X & = 5.5 - 0.97Y
\end{align*}
\]

\[
\begin{align*}
\text{DP} & = (0.067)(X) + (0.42)(Y) = 0.65 \\
0.067X + 0.42Y & = 0.65 \\
0.067(5.5 - 0.97Y) + 0.42Y & = 0.65 \\
0.37 - 0.06Y + 0.42Y & = 0.65
\end{align*}
\]
.42Y - .06Y = .65 - .37
.36Y = .28

Y = .28

.36

Y = .77 POUNDS OF S.B.M.

X = 5.5 - .97 (.77)

X = 5.5 - .75

X = 4.75 POUNDS OF CORN
TABLE LXIII
RATION PROBLEM FOR STUDENTS

The basic principles of balancing a ration are illustrated in this problem; however, the problem is made easy because of the limited number of feeds used and the limited nutrient requirements to be satisfied. The ration may or may not be adequate in other nutrients not considered in this problem.

Given:

\[
\% \text{ TDN} = (\% \text{ Protein in feed}) (\text{Protein Digestibility Coefficient}) \\
+ (\% \text{ Fat in feed}) (\text{Fat Digestibility Coefficient})(2.25) \\
+ (\% \text{ Crude Fiber}) (\text{CF Digestibility Coefficient}) \\
+ (\% \text{ NFE}) (\text{NFE Digestibility Coefficient}) \\
\]

\[
\text{NFE} = 100 - (\% \text{ water} + \% \text{ protein} + \% \text{ ash} + \% \text{ fat} + \% \text{ crude fiber})
\]

\[
\% \text{ Protein} = \% \text{ Nitrogen} \times 6.25
\]

A. Using oat hay, how much of this feed would be required to supply enough **dry matter** for a 600-pound dairy heifer?

B. Using the amount of hay calculated in A, determine whether her digestible protein and TDN requirements will be met. (Make calculations and show your results, using upper requirement figures.)

C. Using milo grain and soybean meal (solvent analysis), how much of the feed is required to make up the **deficit** indicated in B?
D. Readjust the amount of the feed in A. Show final ration.

(DM, TDN, and DP should be within the upper requirements range.)
Course: Advanced Livestock Production
Area: Livestock Nutrition
Unit: Rations
Job XXXIV: Feed Additives

Objective: To familiarize the students with compounds added to a ration for non-nutritional purposes

Motivation: "You are all familiar with the tags on feeds. What are the meanings of the other numerous items listed which we haven't studied? What are their functions?"

References: 1. Feeds and Feeding, Morrison

Teaching Outline:
I. Growth stimulants
II. Medicants
III. Adjuncts

Teaching Procedure:
I. Introduce unit.
II. Discuss and describe the feed additives.
III. Obtain current information, with student aid, concerning new developments in the feed additive field such as poloxolene, M. G. A., etc.
IV. Obtain an outside speaker, perhaps a commercial feed salesman or a veterinarian, to further discuss the safe use of feed additives.
V. Summarize and evaluate.
### TABLE LXIV
**FEED ADDITIVES**

#### I. GROWTH STIMULANTS

##### A. HORMONES
1. DIETHYLSTILBESTROL
2. SYNOVEX
3. IODINATED CASEIN -- DAIRY CATTLE
4. DIENESTROLDIACETATE

##### B. ANTIBIOTICS
1. TYLAN
2. AUREA -- SP 250

##### C. ARSONIC ACIDS

##### D. TRANQUILIZERS
1. TRAN-Q
2. SERPASIL -- CAGED LAYERS
3. TRIFLUOMEPRAZINE

##### E. ENZYMES -- LIMITED USE
1. TAKAMINE
2. AGROZYME

#### II. MEDICANTS

##### A. BACTERIOSTATS

##### B. ANTIBIOTICS
C. COCCIDIOSTATS -- POULTRY
D. PARASITICIDES
E. ANTHELMENTICS -- WORMERS
   (1) HYGRAMYCINE
   (2) CADMIUM OXIDE
   (3) PHENOTHIAZINE
   (4) PIPERAZINE
   (5) THIBENZOL
F. SYSTEMICS -- GRUBICIDES
   (1) RONNEL
   (2) CO-RAL
G. SULFACANTS -- PREVENT FEEDLOT BLOAT
   (1) DYNAFAC

III. ADJUNCTS
A. ANTIOXIDANTS -- FOR GUARANTEED VITAMIN CONTENT
   (1) SANTAQUIN
   (2) B. H. T.
   (3) M. H. T.
B. ANTIMYCOTICS -- PREVENT MOLDS
C. HUMECANTS -- ADD MOISTURE
D. FLAVORS
E. PELLET BINDERS
   (1) STAPEL (LIGNIN MATERIAL FROM WOOD)
   (2) SODIUM BENTONITE