The course of study represents the third of six modules in advanced crop and soil science and introduces the agriculture student to biological features of soil. Upon completing the two day lesson, the student will: (1) realize the vast amount of life present in the soil, (2) be able to list representative animal and plant life in the soil by size, and (3) be able to list some of the detrimental processes of soil organisms. The course outline suggests teaching procedures, behavioral objectives, teaching aids and references, problems, a summary, and evaluation. Following the lesson plan, pages are coded for use as handouts and overhead transparencies. A materials source list for the complete soil module is included. (MW)
BIOLOGICAL FEATURES OF SOIL

Agricultural Education, College of Education
Virginia Polytechnic Institute and State University, Blacksburg, VA 24061

In Cooperation With

Agricultural Education Service, Division of Vocational Education
State Department of Education, Richmond, VA 23216
Prepared by Larry E. Miller

Publication AP-11
1974
ADVANCED CROP AND SOIL SCIENCE
A COURSE OF STUDY

Prepared by
Larry E. Miller

Agricultural Education Program
Division of Vocational and Technical Education
College of Education
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

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1974
ACKNOWLEDGEMENTS

Appreciation is expressed to Julian M. Campbell, State Supervisor of Agricultural Education, State Department of Education, Richmond, Virginia, for sponsoring these curriculum materials; to James P. Clouse, Professor and Head of Agricultural Education, for his guidance and direction in the preparation of these curriculum materials.

A Virginia Polytechnic Institute and State University
Extension Division
Education Field Service Publication
How to Use This Book

This course of study is divided into six modules, as enumerated in the index. Each lesson plan contains the title of the:

course,
module,
a suggested time allotment,
a suggested teaching procedure,
objectives of the lesson,
extample introduction techniques,
suggested references and teaching aids,
problems,
summary,
and example evaluatory statements.

Space is provided for individual evaluation.

Modules are lettered consecutively, with numbered pages within each module. A small letter following the number denotes its position within the numbered sequence. Following the lesson plans, pages are also denoted with the letter "H", recommended as a handout; and the letter "T", recommended as an overhead transparency.

Some instructors may find it of greater convenience to assemble a "slide-bank" of these teaching aids.
Materials Source List
(Soil Module Only)
SELECTED REFERENCES:

Books:

* Our Soils and Their Management, Donahue, Interstate, $5.00.
* Farm Soils, Worthen and Aldrich, Wiley & Sons.
* Soils and Soil Fertility, Thompson, McGraw-Hill.
* Soil Use and Improvement, Stallings, J. H., Prentice-Hall, $8.36.
* Soil Physics, Kohnke, McGraw-Hill.
* Using Commercial Fertilizers, McVicker, Interstate, 1961, $4.00 Good.
* Our Natural Resources, McNall, Interstate, 1964.
* Experiments in Soil Science, California State Polytechnic College, San Luis Obispo, California 93401, $4.00.
* Factors of Soil Formation, Jenny.

Bulletins:

* "Soil Judging in Indiana" Purdue Mimeo I.D. 72.
* "Soil Color" Voc. Ag. Service, 434 Mumford Hall, Urbana, Illinois 61801
* "Soil Texture" - Illinois V. A. S.
* "Teaching Soil and Water Conservation, A Classroom and Field Guide" PA 341 U.S. D.A.
* "Soils Yearbook, U.S.D.A.
* "Land Capability Classification, Agriculture Handbook No. 210, U.S.D.A.
* "Sampling the Soil", National Fertilizer Association, Washington, D.C.
* "Soil Testing" Purdue University Extension Circular, 488.

* Student Reference
** Instructor or Classroom reference
*"Our Land and Its Care", N. P. F. I.
*"What is Fertilizer?" N. P. F. I.
*"How to Take a Soil Sample", N. P. F. I. (Leaflets** and Poster*)
*"Lime Means More Money for You", N. P. F. I. (leaflets** and Poster*)
**"How Soil pH Affects Plant Food Availability", N. P. F. I. (Poster)
**"Hunger Signs in Crops", Illinois V. A. S., VAS 4011a
*"Soil and Plant Tissue Tests", Purdue Station Bulletin 635
*"Soil Science Simplified", Kohnke, Published by Author

Films:
"The Depth of Our Roots", New Holland, C-18 Min.
"Making the Most of a Miracle" (Plant Nutrition), N. P. F. I.
"The Big Test" (Importance of Soil Testing), N. P. F. I.
"What's in the Bag" (Fertilizer) N. P. F. I.

Film Bulletin:
"Films to Tell the Soil and Water Conservation Story" 1970 Soil Conservation Service, Film Library, Rm. 503-134 So. 12th St., Lincoln, Nebraska 68508.

Film Strips:
"Soil Color" Vo-Ag. Service, 434 Mumford Hall, Urbana, Illinois.

Slides:
"How to Take a Soil Sample", N. P. F. I.
"Deficiency Symptoms" (Choice by crop, 25¢ ea.) N. P. F. I. (Send for Catalog.)
"Soil Profile Slides", 16 slides, $6.00. (Send for Catalog.)

Periodicals:
"Plant Food Review", N. P. F. I. (Free to Schools.)
TEACHER'S CURRICULUM GUIDES FOR SOILS


Extension Division Bulletins, VPI & SU, Blacksburg, Virginia 24061.

<table>
<thead>
<tr>
<th>NO.</th>
<th>PUBLICATION</th>
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<tbody>
<tr>
<td>342</td>
<td>&quot;No-tillage Corn - Current Virginia Recommendations&quot;</td>
</tr>
<tr>
<td>429</td>
<td>&quot;Soil Fertility Guides for the Piedmont&quot;</td>
</tr>
<tr>
<td>97</td>
<td>&quot;Agronomy Handbook&quot;</td>
</tr>
<tr>
<td>136</td>
<td>&quot;How Soil Reaction Affects the Supply of Plant Nutrients&quot;</td>
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<tr>
<td>297</td>
<td>&quot;Soil Fertility Guides - for the Coastal Plains Region of Virginia&quot;</td>
</tr>
<tr>
<td>299</td>
<td>&quot;Soil Fertility Guides - for the Appalachian Region of Virginia&quot;</td>
</tr>
<tr>
<td>684</td>
<td>&quot;Liming for Efficient Crop Production&quot;</td>
</tr>
<tr>
<td>36</td>
<td>&quot;Your Fertilizer Use and Crop Record&quot;</td>
</tr>
<tr>
<td>106</td>
<td>&quot;Lime Use Guides - for the Coastal Plains Region of Virginia&quot;</td>
</tr>
<tr>
<td>107</td>
<td>&quot;Lime Use Guides - for the Appalachian Region of Virginia&quot;</td>
</tr>
<tr>
<td>108</td>
<td>&quot;Lime Use Guides - for the Piedmont Region of Virginia&quot;</td>
</tr>
<tr>
<td>405</td>
<td>&quot;Lime for Acid Soils&quot;</td>
</tr>
<tr>
<td>34</td>
<td>&quot;Soil and Water Conservation Record Book&quot;</td>
</tr>
<tr>
<td>CS48</td>
<td>&quot;Soil Sterilization&quot;</td>
</tr>
<tr>
<td>47</td>
<td>&quot;Know Your Soils, Unit 2, Major Soil Differences&quot;</td>
</tr>
<tr>
<td>23</td>
<td>&quot;The Story of Land&quot;</td>
</tr>
<tr>
<td>228</td>
<td>&quot;Working Together for a Liveable Land&quot;</td>
</tr>
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</table>
USDA Bulletins (1 each of 100 publications, free)
Publications Division, Office of Information,
U.S.D.A., Washington, D.C. 20250.  *FOR SALE ONLY*

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<tr>
<th>NO.</th>
<th>PUBLICATION</th>
<th>PRICE</th>
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<tbody>
<tr>
<td>AH210</td>
<td>Land Capability Classification. 1961</td>
<td>.15¢</td>
</tr>
<tr>
<td>AH18</td>
<td>Soil Survey Manual. 1951.</td>
<td>$3.50*</td>
</tr>
<tr>
<td>AB320</td>
<td>Know the Soil You Build On. 1967.</td>
<td>--</td>
</tr>
<tr>
<td>L539</td>
<td>Land Forming, A Means of Controlling Surface Water on Level Fields. 1967</td>
<td>.05*</td>
</tr>
<tr>
<td>L512</td>
<td>Mulch Tillage in the Southeast</td>
<td>--</td>
</tr>
<tr>
<td>YB1957</td>
<td>Soil (Yearbook)</td>
<td>$4.00*</td>
</tr>
<tr>
<td>L307</td>
<td>How Much Fertilizer Shall I Use? 1963.</td>
<td>--</td>
</tr>
<tr>
<td>G89</td>
<td>Selecting Fertilizers for Lawns and Gardens. 1971.</td>
<td>--</td>
</tr>
<tr>
<td>TITLE</td>
<td>Superphosphate: Its History, Chemistry, and Manufacture. 1964.</td>
<td>$3.25*</td>
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</table>

*"Maintaining Organic Matter in Soils" VAS, Illinois
*"Soil Structure" VAS, Illinois

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*Student Reference
**Instructor or Classroom Reference
TEACHING AIDS:

1. Samples of Soil separates. Purdue Agronomy Club
   Life Science Building
   Purdue University
   Lafayette, Indiana 47907

2. Soil Profiles
   Information and directions necessary to make soil profiles.


5. Tissue Test Kit V. A. S. $4.00/kit.

6. Transparencies.

7. Samples of soil structure.
Proper preparation, as in all things, is one of the best assurances of success. Therefore, it is imperative that prior planning be completed before teaching each lesson.

Plans should be made several weeks or months preceding the need for much of the material. Films should be booked as soon as possible to assure their arrival when needed. This will necessitate careful thought in the preparation of your teaching calendar for this module. An inventory of present equipment should yield information necessary to securing needed teaching aids, equipment, and replenishing supplies.

Many other teaching aids can be compiled on shorter notice. Handouts and overhead transparencies can be supplied on rather short notice in most schools. Adjustments will be necessary according to the instructor's and school's clerical assistance in this area.

Short range planning varies considerably with individual instructor's competencies in the teaching area and with previous teaching experience. One may generalize, however, and conclude from good teaching methods that films should be previewed; experiments and demonstrations "pre-run". Subject matter should be reviewed, and adapted and updated lesson plans will be of benefit for each lesson.

The author has attempted to exclude materials that were presumably taught in previous vo-ag. offerings. It will be necessary for each instructor to discern if a review of previous material is necessary. The author has attempted to provide several teaching techniques for each lesson. It is not assumed that all would be used within the time allotment, but that you may have as many alternatives as possible from which to select.
### Soil Module Time Allotment

Allotted days: 15 (at 55 minutes period per day)

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Minutes</th>
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<tbody>
<tr>
<td>I: What is soil?</td>
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<tr>
<td>II: Physical Features of Soil</td>
<td>110</td>
</tr>
<tr>
<td>III: Biological Features of Soil</td>
<td>110</td>
</tr>
<tr>
<td>IV: Soil Water</td>
<td>165</td>
</tr>
<tr>
<td>V: Chemical Features of Soil</td>
<td>220</td>
</tr>
<tr>
<td>VI: Soil Erosion</td>
<td>110</td>
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</tbody>
</table>

**TOTAL (15-55 min. days)** 825
Course: Advanced Crop and Soil Science

Module: Soils

Lesson III: Biological Features of Soil

Suggested teaching time: 2 days

Suggested teaching procedure:

1. Introduce lesson by relating objectives and motivational statements and/or using other teaching aids to stimulate interest.

2. Make assignment and supervise study period.

3. Discuss results using teaching aids:

   a) Show transparencies "Breakdown of Animal Life in the Soil" and discuss life present and benefits received by the soil. Use "Earthworms and Soil" demonstration to inspire interest.

   b) Show transparency "Detrimental Processes of Organisms" and "Conditions Necessary for Optimum Growth of Organisms" and discuss.

4. Summarize and evaluate lesson.

Objectives:

1. Students should realize the vast amount of life present in the soil.

2. Students should be able to list representative animal and plant life in the soil by size.

3. Students should be able to list some of the detrimental processes of soil organisms.

Motivation:

If one were to walk into an average field and pick up soil in his cupped hands, there would be more living organisms present than there are people on the face of the earth!

Reference:

Text: Selected reference
Problems:

1. What are some large (macro) animals commonly found in the soil? How does each aid the soil?

2. What small (micro) animals exist in the soil? What benefits do they provide?

3. What plants exist in the soil? What benefits do they provide?

4. Are all plants and animals beneficial to the soil? Give examples of detrimental organisms and their affect.

Summary:

Many types and kinds of organisms exist in the soil. By far, they are beneficial ones and we want to contribute to their well being. Primarily a soil that produces good crops provides an environment conducive to good organism growth.

Evaluation:

A. Did the students grasp the concept of the vastness of the soil organism population?

B. Do the students understand the different animal and plant life present in the soil?

C. Do the students understand that most organisms are beneficial?

Student evaluation:
BREAKDOWN OF ANIMAL LIFE IN THE SOIL

MACRO-ANIMALS:

A. SUBSIST LARGELY ON PLANT MATERIAL
   1. SMALL MAMMALS
   2. INSECTS
   3. MILLIPEDES
   4. SOWBUGS (WOODLICE)
   5. MITES
   6. SLUGS
   7. SNAILS
   8. EARTHWORMS

B. LARGELY PREDATORS
   1. SNAKES
   2. MOLES
   3. INSECTS
   4. MITES
   5. CENTIPEDES
   6. SPIDERS

MICROANIMALS: PREDATORY, PARASITIC AND LIVING ON PLANT TISSUES.
   1. NEMATODES
   2. PROTOZOA
   3. ROTIFERS
PLANT DESTRUCTIVE NEMATODE
BREAKDOWN OF PLANT LIFE IN THE SOIL

A. ROOTS OF HIGHER PLANTS

B. ALGAE
   1. GREEN
   2. BLUE-GREEN
   3. DIATOMES

C. FUNGI
   1. MUSHROOM FUNGI
   2. YEASTS
   3. MOLDS

D. ACTINOMYCETES OF MANY KINDS

E. BACTERIA
   1. AEROBIC
   2. ANAEROBIC
   1. AUTOTROPHIC
   2. HETEROPTROPHIC
DETRIMENTAL PROCESSES OF ORGANISMS

1. PRODUCTION OF PLANT AND ANIMAL DISEASES (PATHOGENS)
   A) WILTS
   B) ROTs
   C) GALLS (NEMATODE INJURY)

2. DENITRIFICATION: REVERSE RELEASE OF NITROGEN FROM SOIL.

3. COMPETITION FOR AVAILABLE NUTRIENTS TIE UP NITROGEN IN THEIR BODIES WHEN A LOT OF CARBON IS PRESENT.

4. PRODUCE TOXIC COMPOUNDS
   A) METHANE
   B) HYDROGEN SULFIDE
   C) PHOSPHINE
   D) OTHER ORGANIC ACIDS
CONDITIONS NECESSARY FOR OPTIMUM GROWTH OF ORGANISMS

1. TEMPERATURE - 80-90°F
2. MOISTURE - AROUND FIELD CAPACITY
3. ACIDITY - pH OF 6.8
4. OXYGEN - AERIATE SOIL
EARTHWORMS AND SOIL

**Purpose:** To show the effect of earthworms on soil

**Materials:** Two transparent plastic containers filled with soil
Earthworms

**Procedure:** Fill the two plastic containers with fairly compact soil and add worms to one. Note differences in volume, compactness and permeability. The mixing of soil can be illustrated best if layers of white sand and dark soil are alternated at the beginning of this demonstration.