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IDENTIFIERS	Virginia

ABSTRACT

The course of study represents the fourth of six modules in advanced crop and soil science and introduces the agriculture student to the topic of soil water. Upon completing the three day module, the student will be able to classify water as to its presence in the soil, outline the hydrological cycle, list the ways water is lost from the soil, define leaching and its measurement, list means of controlling evaporation, and apply the basic principles concerning soil water to management situations. The course outline suggests teaching procedures, behavioral objectives, teaching aids and references, problems, summary, and evaluation. Following the lesson plans, pages are coded for use as handouts and overhead transparencies. A materials source list for the complete soil module is included. (MW)

Agdex 550

SOIL WATER

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

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ADVANCED CROP AND SOIL SCIENCE
A COURSE OF STUDY

Prepared by
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Division of Vocational and Technical Education
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ACKNOWLEDGEMENTS

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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,
example 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:

*Profitable Soil Management, Knuti, Korpi and Hide, Prentice-Hall, Englewood Cliffs, New Jersey 07632, 1969, $8.36.

*Introductory Soils, Berger, K.C., 1965, Macmillan Company, 866 3rd. Avenue, New York, N.Y. 10022, $8.50.

*Soils: An Introduction to Soils and Plant Growth, 2nd Ed., Donahue, Prentice-Hall, 1964, $9.75.

*Approved Practices in Soil Conservation, Foster, Interstate, 1964, $3.80.

*Our Soils and Their Management, Donahue, Interstate, $5.00.

**Farm Soils, Worthen and Aldrich, Wiley & Sons.

**Fundamentals of Soil Science, Millar, Turk.

**The Nature and Properties of Soils, Buckman and Brady, Macmillan, 1969, $10.95.

**Soils and Soil Fertility, Thompson, McGraw-Hill.

**Soil Fertility and Fertilizers, Tisdale and Nelson, Macmillan, 2nd Ed. 1966, $12.95.

**Soil Use and Improvement, Stallings, J.H., Prentice-Hall, $8.36.

**Soil Management for Conservation and Production, Cook, J.W. Wiley and Sons, 1962.

**Soil Physics, Kehnke, McGraw-Hill.

**Using Commercial Fertilizers, McVicker, Interstate, 1961, $4 Good.

**Our Natural Resources, McNall, Interstate, 1964.

**Soil Science Simplified, Kohnke & Helmut, Bolt, 1962. Good.

**Soil Conservation, Stallings, Prentice-Hall, 1957, $11.75.

*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.

**"Water Intake by Soil Experiements for High School Students" Misc. Publ. No. 925, U.S.D.A.

**Soils Yearbook, U.S.D.A.

**Land Capability Classification, Agriculture Handbook No. 210, U.S.D.A.

**Soil Survey Manual, U.S.D.A."

*"Sampling the Soil", National Fertilizer Association, Washington, D.C.

*"Soil Testing" Purdue University Extension Circular, 488.

**"The Fertilizer Handbook:, National Plant Food Institute (NPFI) 1700 K. Street N.W., Washington, D.C. 20006

*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.
"Soil Structure" Vo-Ag. Service, Illinois.
"How and Why Soils Differ", Vo-Ag. Service, Illinois.

Slides:

"How to Take a Soil Sample", N. P. F. I.
"Soils, Plant Nutrition and Fertilizers", 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

"Understanding the Nature and Importance of Soil", AP-1, C. E. Richard, VPI & SU, Blacksburg.

"Preparing the Soil for Planting", AP-3, C. E. Richard, VPI & SU, Blacksburg.

"Developing a Soil and Water Conservation Plan", AP-4, C. E. Richard, VPI & SU, Blacksburg.

"Testing Soils", AP-8, C. E. Richard, VPI & SU, Blacksburg.

"Determining Land Capability Classes", AP-2, C. E. Richard, VPI & SU, Blacksburg.

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

NO.	PUBLICATION
342	"No-tillage Corn - Current Virginia Recommendations"
429	"Soil Fertility Guides for the Piedmont"
97	"Agronomy Handbook"
136	"How Soil Reaction Affects the Supply of Plant Nutrients"
297	"Soil Fertility Guides - for the Coastal Plains Region of Virginia"
299	"Soil Fertility Guides - for the Appalachian Region of Virginia"
684	"Liming for Efficient Crop Production"
36	"Your Fertilizer Use and Crop Record"
106	"Lime Use Guides - for the Coastal Plains Region of Virginia"
107	"Lime Use Guides - for the Appalachian Region of Virginia"
108	"Lime Use Guides - for the Piedmont Region of Virginia"
405	"Lime for Acid Soils"
34	"Soil and Water Conservation Record Book"
CS45	"Soil Sterilization"
47	"Know Your Soils, Unit 2, Major Soil Differences"
25	"The Story of Land"
226	"Working Together for a Liveable Land"

USDA Bulletins (1 each of 100 publications, free)
Publications Division, Office of Information,
U.S.D.A., Washington, D.C. 20250. *FOR SALE ONLY

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

*"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.

3. Land Capability Maps - Local S. C. S. Office.

4. Soil Auger: Nasco, price range $4.79 - $13.50.

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

6. Transparencies.

7. Samples of soil structure.

PREPARING FOR SOILS MODULE

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 compentencies 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)

Lesson		Minutes
I:	What is soil?	110
II:	Physical Features of Soil	110
III:	Biological Features of Soil	110
IV:	Soil Water	165
V:	Chemical Features of Soil	220
VI:	Soil Erosion	110
	TOTAL (15-55 min. days)	825

Course: Advanced Crop and Soil Science

Module: Soils

Lesson IV: Soil Water

Suggested teaching time. 3 days

Suggested teaching procedure:

1. Introduce lesson by relating objectives and suitable motivational technique, such as one of demonstrations or films.

2. Make assignment and supervise study period.

3. Discuss results using teaching aids:

   a) Show transparencies "Classification of Soil Water", and "Soil Water Representation" with overlays, and discuss how water in the soil is classified. Use of demonstrations can be used to supplement the discussion.
   b) Show transparency "Water Losses" and "The Water Cycle" and discuss how water is lost from the soil. One acre-inch of water represents 27, 154 gallons. One acre-foot of water is 326,000 gallons. The average annual rainfall at Lafayette is 35 inches which is 950,390 gallons per acre. Our annual rainfall is __________ inches, times 27, 154 gallons, means that on the average __________ gallons of water falls on each acre per year. Many appropriate demonstrations can be found in "Water Intake by Soil, Experiments for High School Students", USDA. Also, film "Water Movement in the Soil", Purdue, may be shown and other ideas gained from "Experiments in Soil Science", pp 57-86. Many appropriate films available from S.C.S. Film Library.
   c) Show transparencies "Nutrient Loss Measurement", "Methods of Measuring Amount of Water in the Soil", and "Tensiometer" to illustrate and discuss these questions.
   d) Show transparency "Controlling Evaporation" and discuss. Supplement with demonstrations on runoff and erosion with mulches, and appropriate S.C.S. film.
   e) Show transparency "Water Requirement of Plants" and discuss, emphasizing the tremendous amount of water required to produce a crop. To illustrate 100 bushel of corn per acre at 70# per bushel and 20% moisture would be 5600 lbs. Dry Matter per acre. 5600 lbs. DM/acre x 368 lbs. H_2O/pound of corn (DM basis) would equal 2,060,800 pounds of water required just to produce the corn, not taking into account the plant.

f) To discuss practical management problems show the transparencies "Conserving Water on a Field", "Make Best Use of Water You Have", "Getting by the Water Problem", "Getting Rid of Excess Water", and "Improvements Through Drainage" and select appropriate demonstrations to supplement the discussion.

4. Summarize and evaluate lesson.

Objectives:

1. Students be able to classify water as to its presence in the soil.

2. Students be able to outline the water, or hydrological, cycle.

3. Students be able to list the ways water is lost from the soil.

4. Students be able to define leaching, how it is measured, and how much water is in the soil.

5. Students be able to list means of controlling evaporation.

6. Students be able to apply the basic principles of soil water through management situations.

Introduction:

Did you know that almost a million gallons of water fall on each acre each year.

References:

Text: Selected reference

Bulletins: "Water Intake by Soil, Experiments for High School Students:, USDA
"Experiments in Soil Science", pp 57-86, VEP

Films: "Water Movement in the Soil", Purdue
Film Bulletin: (Many listings)
"Films to Tell the Soil and Water Conservation Story", S. C. S.

Problems:

1. How is water in the soil classified?

2. How is water lost from the soil? What is the water cycle?

3. How do you measure the nutrients lost in water? How can you measure how much water is in the soil?

4. How can a farmer control evaporation of water?

5. How much water do plants require?

6. How can a farmer conserve the water on a field?

7. How can a farmer make the best use of the water he receives?

8. What can he do to get by the problem of water?

9. How can he get rid of excess water?

10. Why would he want to get rid of excess water?

Summary:

A tremendous amount of water falls on each acre every year. It is the farmers responsibility to make as good a use of the water he receives as practical.

Evaluation:

A. Can the students meet the objectives of the lesson?

B. Do they grasp the significance of the soil water study?

Student evaluation:

CLASSIFICATION OF SOIL WATER

1. FREE WATER - ABOVE FIELD CAPACITY
   - PLANTS DIE FROM LACK OF AIR

(FIELD CAPACITY: WHEN WATER WILL NO LONGER DRAIN OUT BY GRAVITY)
- .5 TO 31 ATMS.

2. CAPILLARY WATER - BETWEEN FIELD CAPACITY AND HYDROSCOPIC COEFFICIENT
   - .5 TO 31 ATMS.

3. HYGROSCOPIC WATER - HELD BY COLLOIDS
   - NON-LIQUID
   - MOVES BY VAPOR
   - 31 TO 10,000 ATMS.

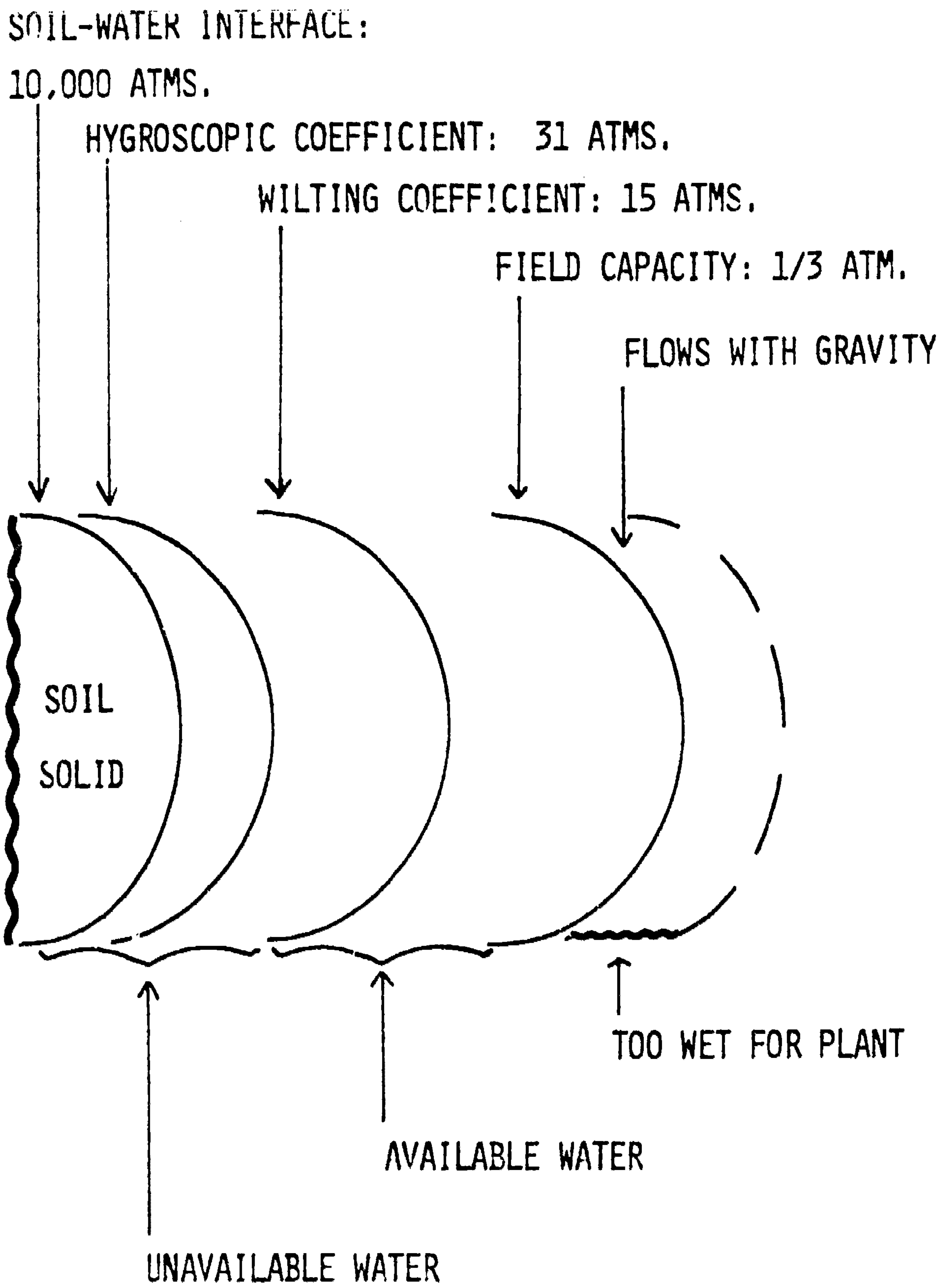
BIOLOGICAL CLASSIFICATION

1. SUPERFLUOUS WATER - FREE WATER

2. AVAILABLE WATER - BETWEEN FIELD CAPACITY AND WILTING POINT
   - WATER AVAILABLE TO PLANT
   - BETWEEN 1/3 AND 15 ATMS

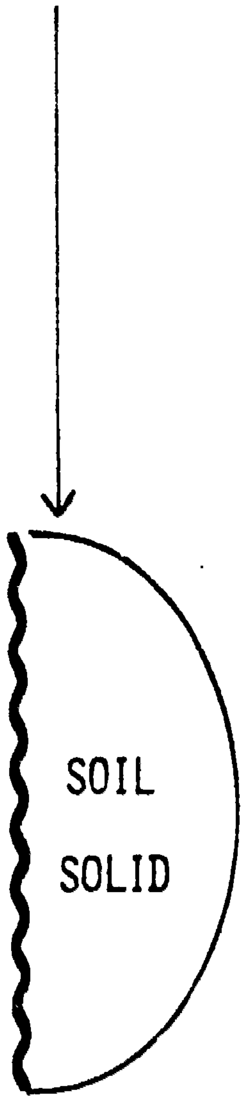
3. UNAVAILABLE WATER - BETWEEN WILTING POINT AND OVEN-DRY

SOIL-WATER REPRESENTATION

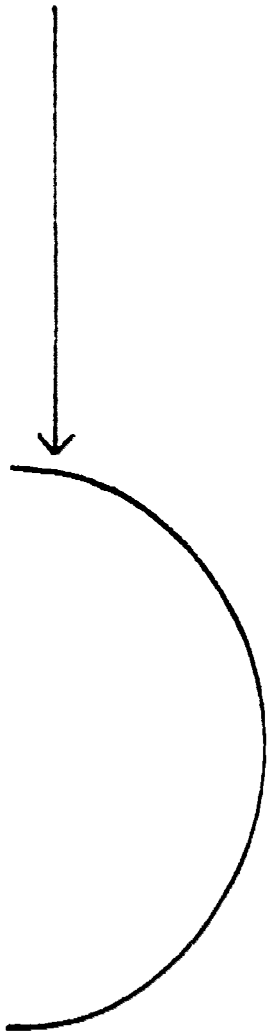


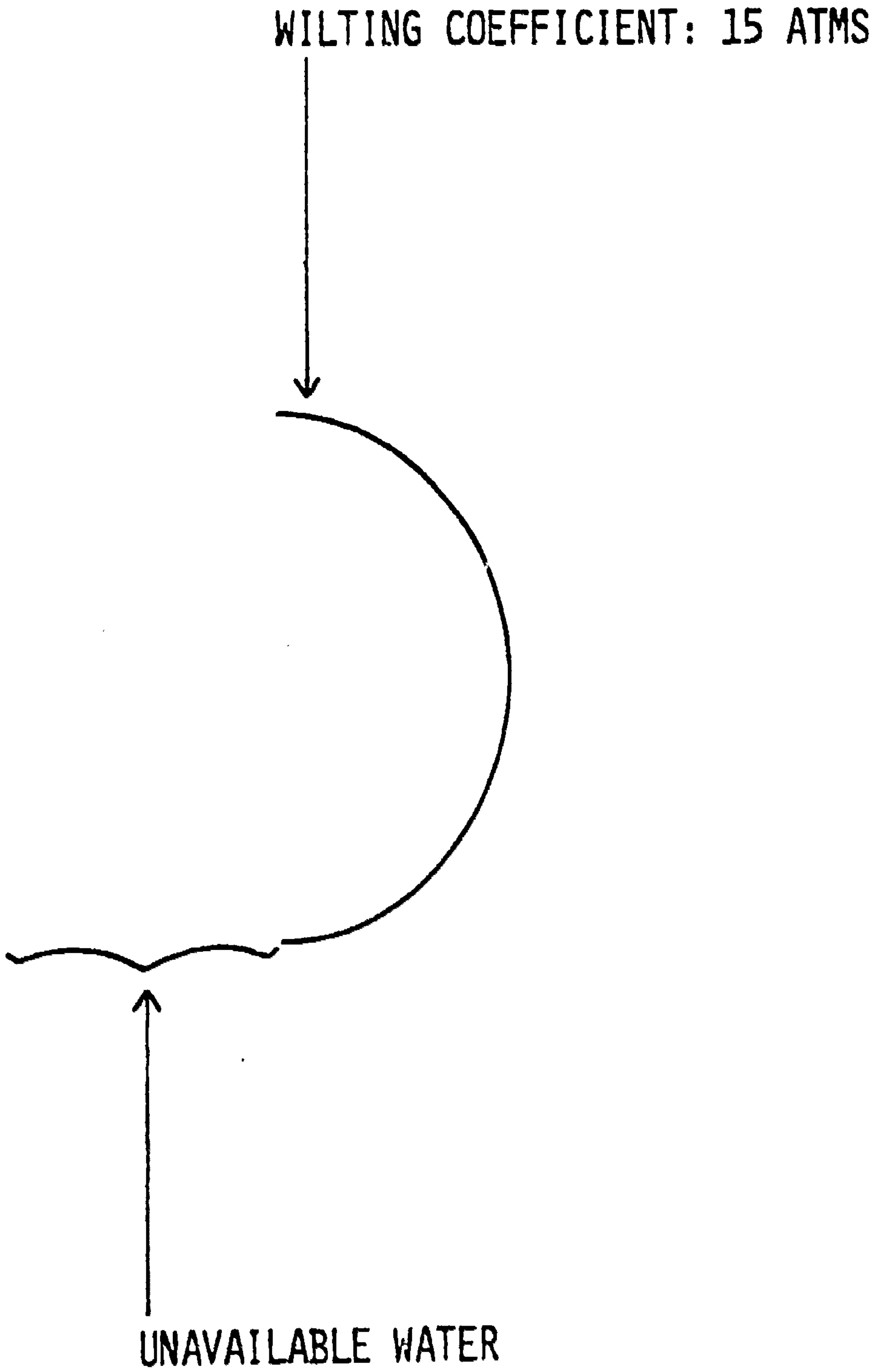
SOIL-WATER REPRESENTATION

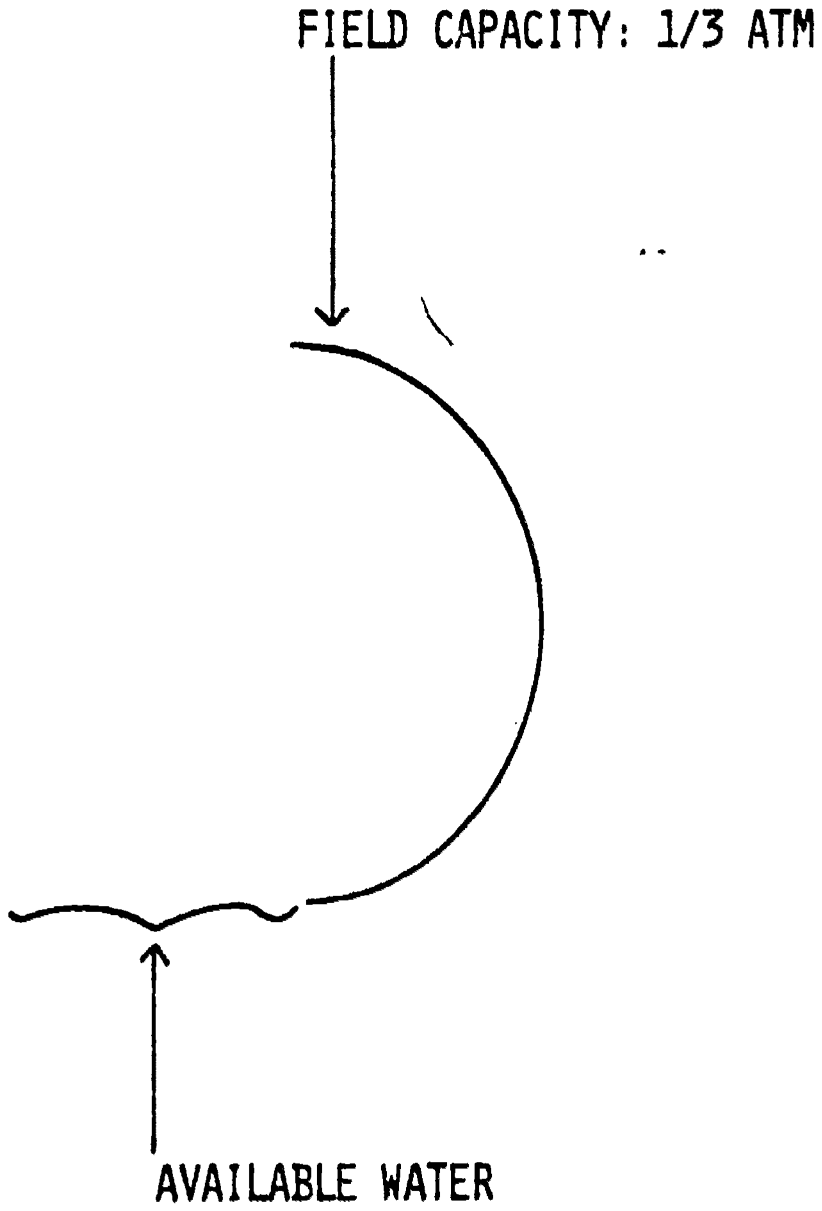
SOIL-WATER INTERFACE:
10,000 ATMOSPHERES

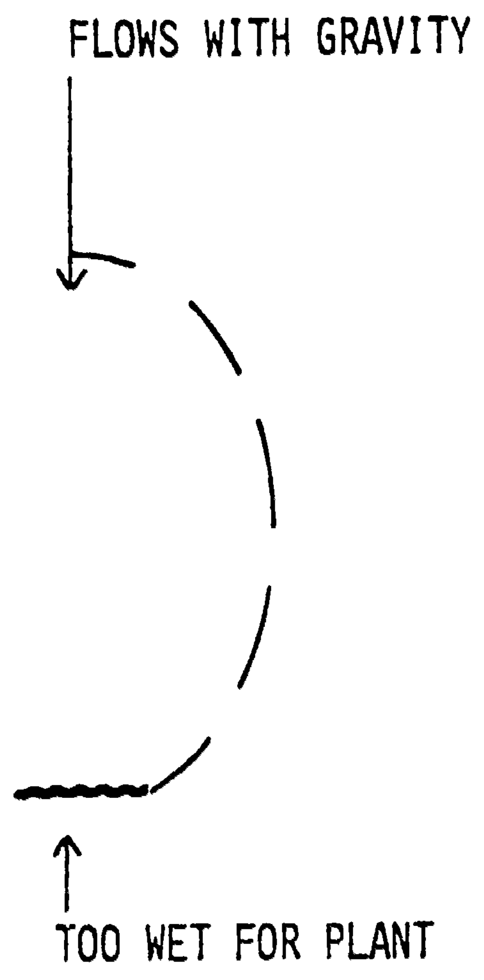


HYDROSCOPIC COEFFICIENT: 31 ATMS.

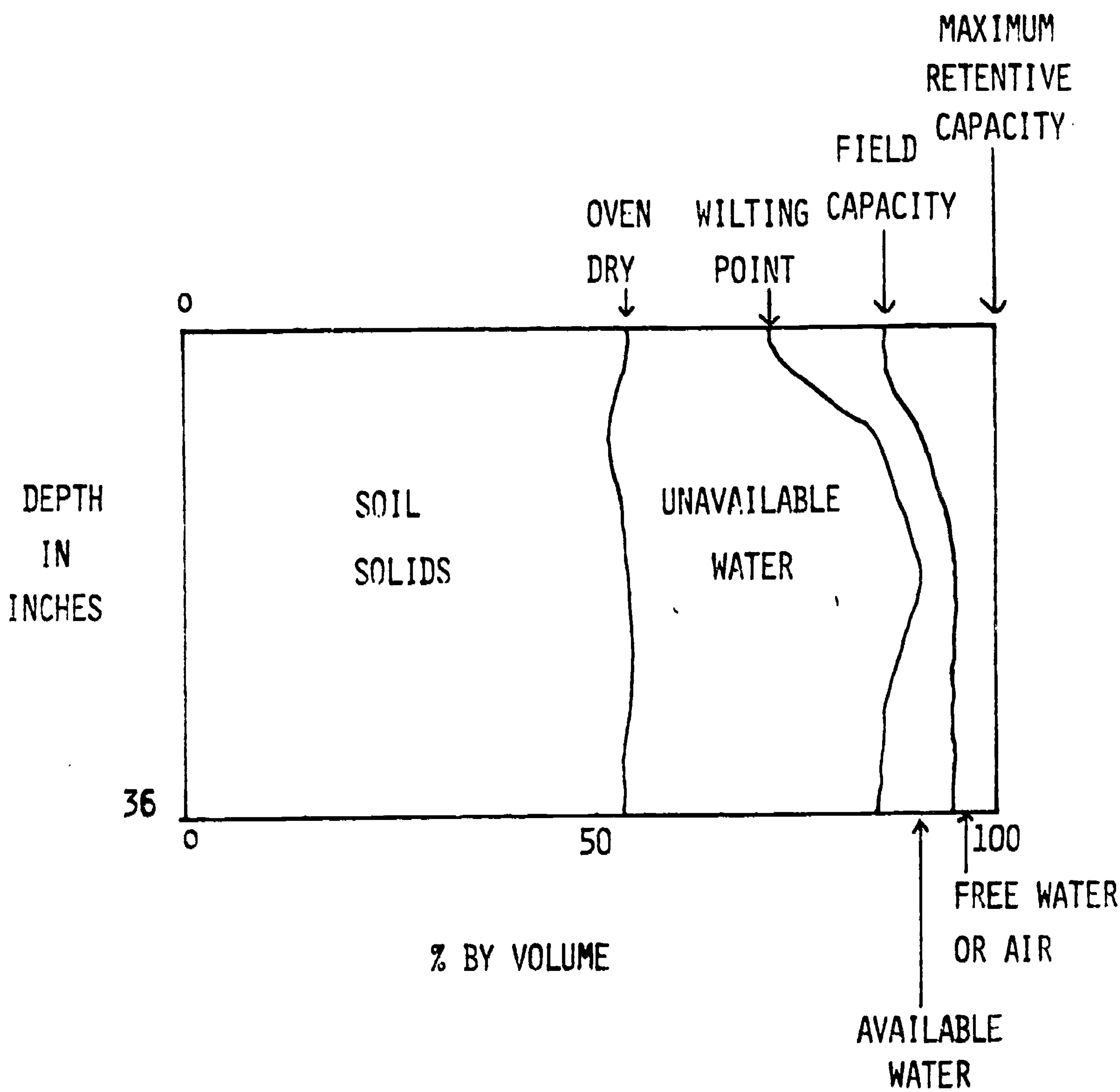



WILTING COEFFICIENT: 15 ATMS
UNAVAILABLE WATER

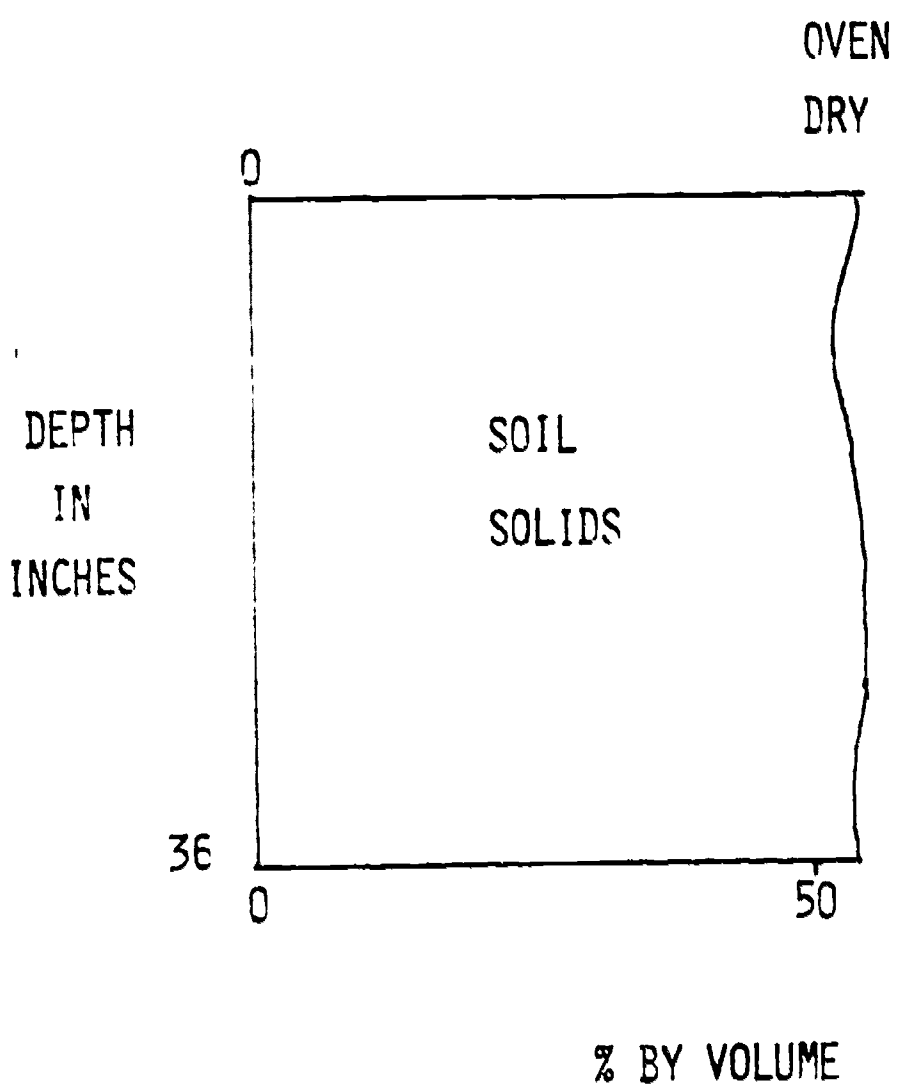

FIELD CAPACITY: 1/3 ATM
AVAILABLE WATER

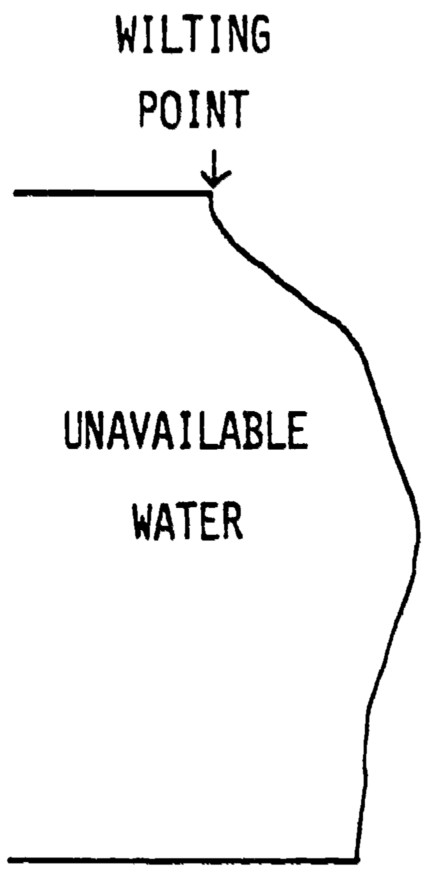

FLOWS WITH GRAVITY
TOO WET FOR PLANT

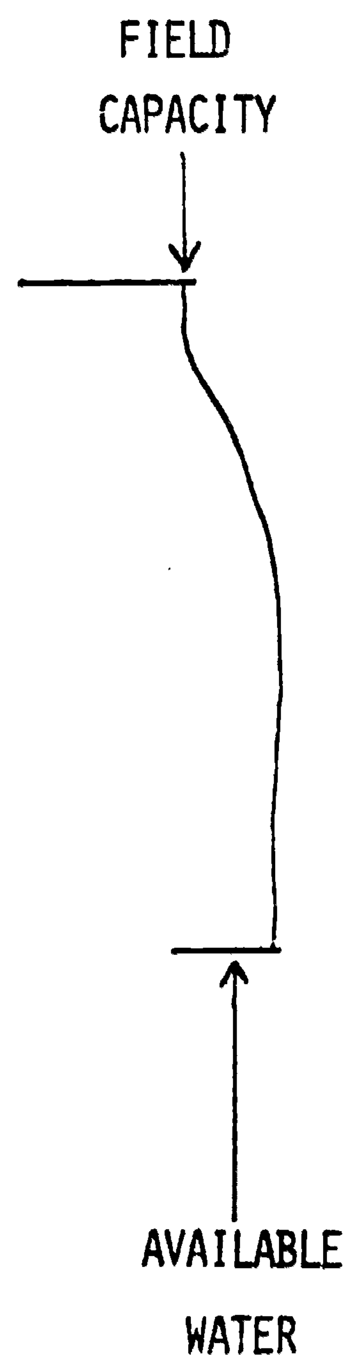
WATER BY VOLUME IN A TYPICAL PROFILE

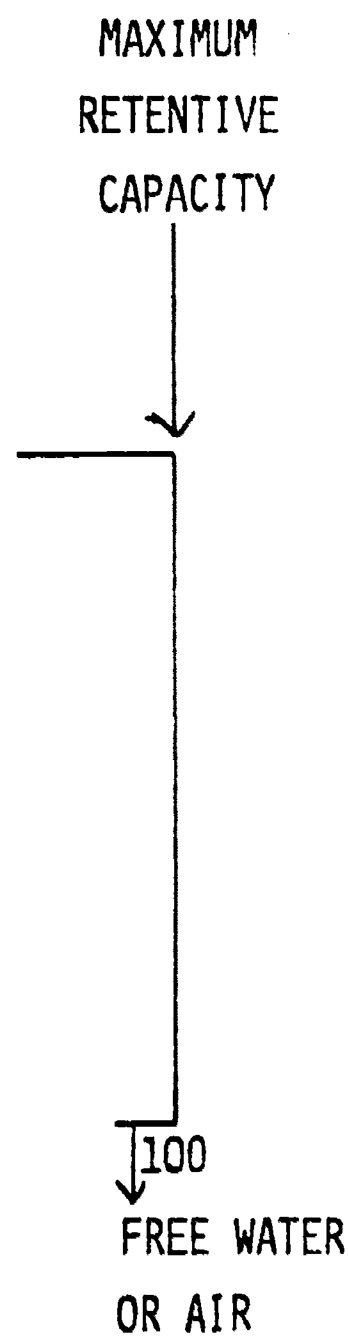


WATER BY VOLUME IN A TYPICAL PROFILE




WILTING
POINT
UNAVAILABLE
WATER


FIELD
CAPACITY
AVAILABLE
WATER


MAXIMUM
RETENTIVE
CAPACITY
100
FREE WATER
OR AIR

H

WATER LOSSES

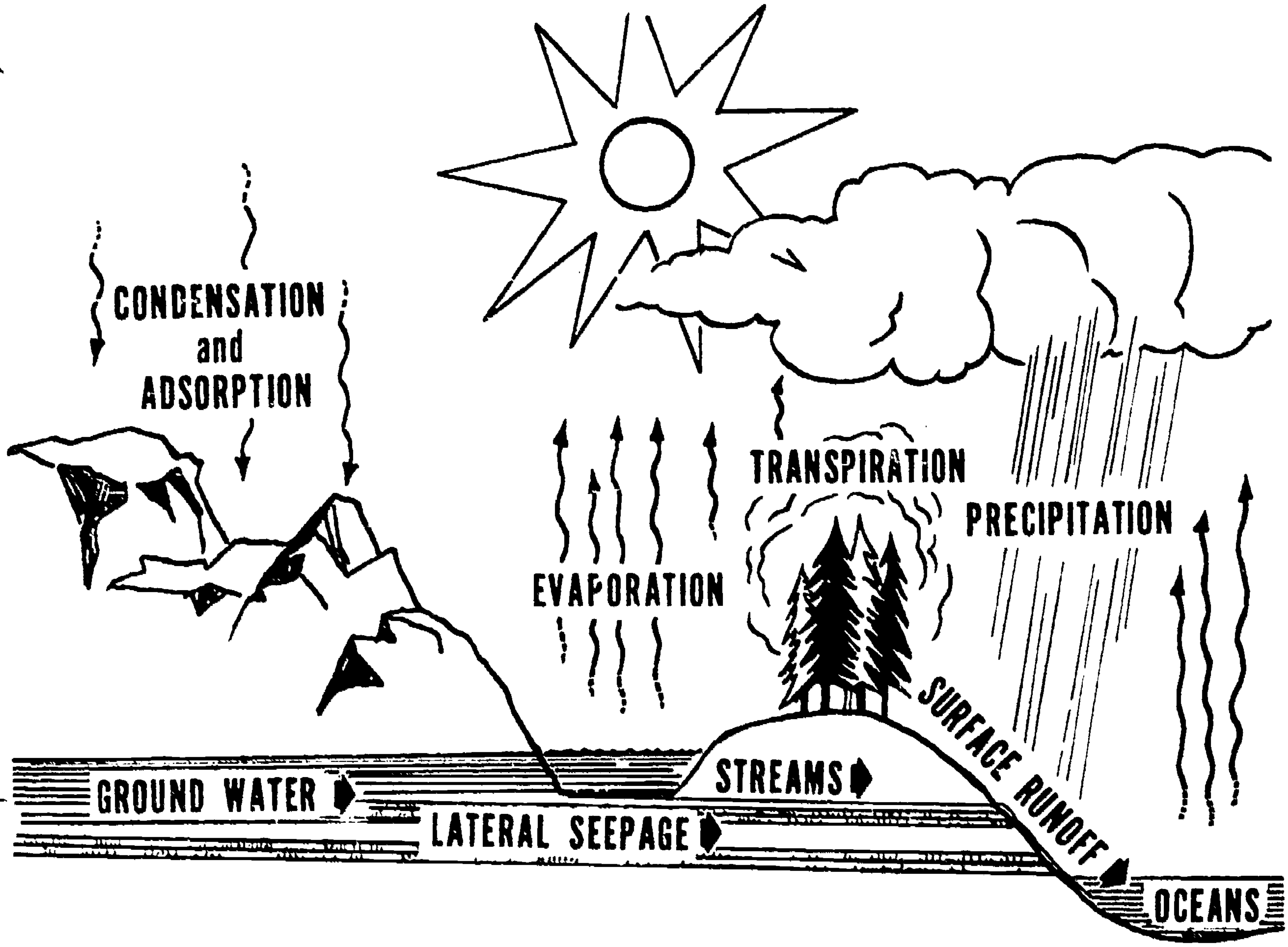
1. EXTERNAL
   A. EVAPO-TRANSPIRATION
      INFLUENCED BY:
      1. MORE SUNLIGHT = MORE LOSS
      2. LESS HUMIDITY = MORE LOSS
      3. HOT DAY = MORE LOSS
      4. DRY WINDS = MORE LOSS
      5. HIGH SOIL MOISTURE LEVELS = MORE LOSS
   B. SURFACE RUNOFF
2. INTERNAL LOSSES
   PERCOLATION - DOWNWARD MOVEMENT OF WATER THROUGH SOIL, RESULTS IN LEACHING (LEACHING: REMOVAL OF NUTRIENTS BY SOIL WATER)

MEASURING LEACHING

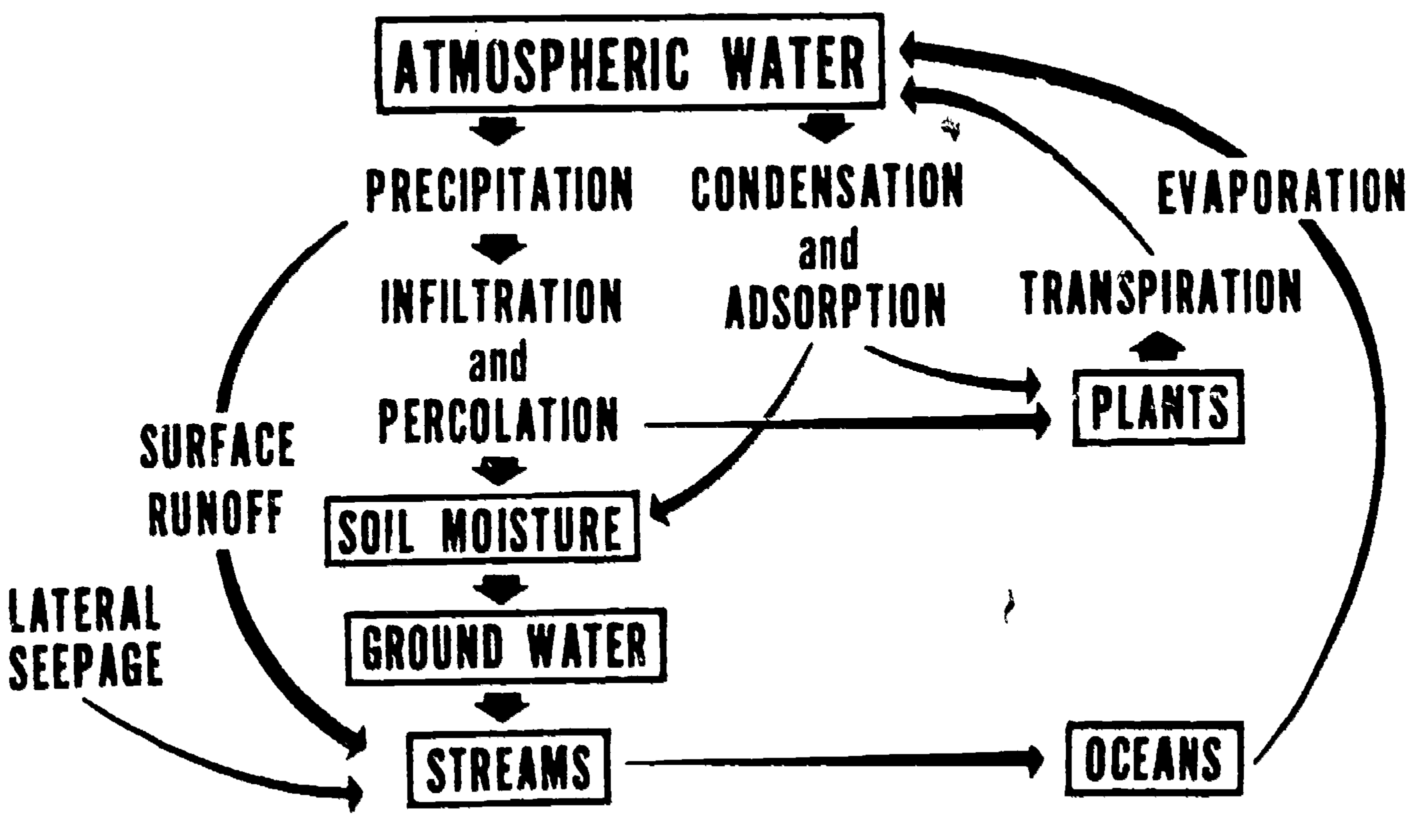
1. BY LYSIMETERS
   A) BLOCK - MONOLITH
   B) TANK
   C) RUSSIAN
2. AT TILE DRAINS

RANKING OF ELEMENTS LOST

1. NITROGEN
2. CALCIUM
3. MAGNESIUM
4. SULFER
5. POTASSIUM (VERY LITTLE)
6. PHOSPORUS (WILL NOT)



THE WATER CYCLE


ATMOSPHERIC WATER
PRECIPITATION
CONDENSATION
and
ADSORPTION
EVAPORATION
INFILTRATION
and
PERCOLATION
TRANSPIRATION
PLANTS
SURFACE
RUNOFF
SOIL MOISTURE
LATERAL
SEEPAGE
GROUND WATER
STREAMS
OCEANS

NUTRIENT LOSS MEASUREMENT

METHODS OF STUDY

1. LYSIMETERS

ADVANTAGES:
- A) AVOIDS VARIATION OF LARGE FIELD
- B) EASILY CONTROLLED
- C) WORK OF CONDUCTING STUDY NOT AS GREAT

TYPES:
- A) BLOCK-MONOLITH - IRON PLATE PLACED UNDER SOIL FOR WATER TO RUN THROUGH AND BE COLLECTED
- B) TANK - SOIL REMOVED FROM FIELD AND PLACED IN TANK
- C) RUSSIAN - TUNNEL UNDER SOIL AND COLLECT WITH A FUNNEL.

2. TILE DRAINS - NUTRIENT LOSSES CAN BE DETERMINED FROM A RELATIVELY LARGE AREA.

METHODS OF MEASURING AMOUNT OF WATER IN THE SOIL

1. GRAVIMETRIC METHOD: WEIGH SAMPLE, HEAT 100 °C, WEIGH

$$\% \text{ MOISTURE} = \frac{\text{LOSS OF WT.}}{\text{OVEN DRY WT.}} \times 100$$

2. TENSIOMETER OR IRROMETER

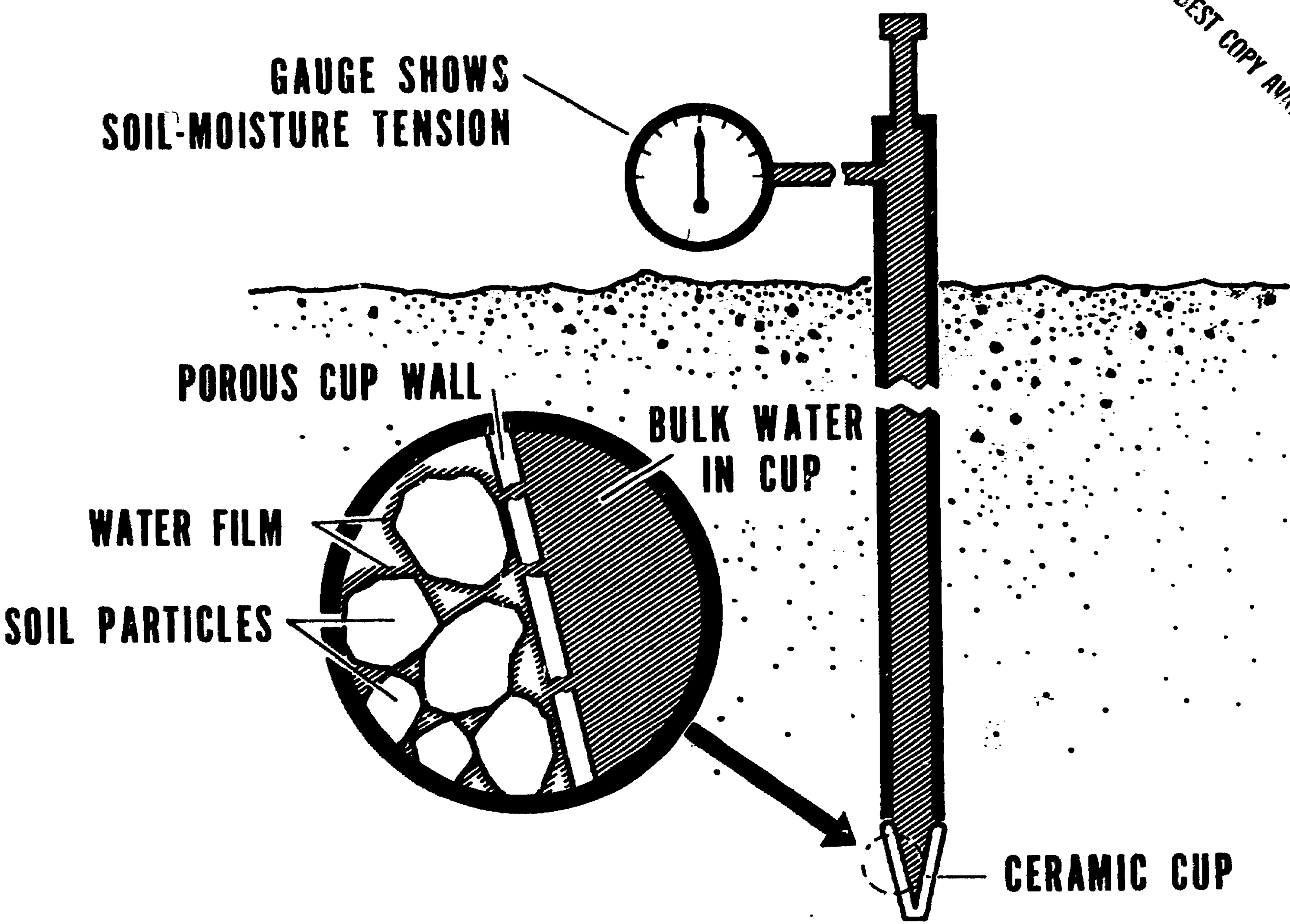
   MEASURES VACUUM WITH WHICH WATER PULLED FROM INSTRUMENT

3. RESISTANCE BLOCKS (GYPSUM BLOCKS)

   FLOW OF ELECTRICITY AS WATER ENTERS BLOCK

4. NEUTRON SCATTERER - MEASURES NEUTRONS THAT BOUNCE BACK FROM HYDROGEN IN WATER

TENSIOMETER



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CONTROLLING EVAPORATION

MULCHES

ADVANTAGES:

1. PROTECT SOIL FROM SUN
2. PROTECT SOIL FROM WIND
3. LIMIT CAPILLARY WATER MOVEMENT
4. GREATER ABSORPTION OF RAINFALL
5. PREVENT PUDDLING

TYPES:

1. ARTIFICIAL - PLASTIC
2. STUBBLE - REFUSE OF PREVIOUS CROP
3. SOIL (DUST) - NOT NECESSARILY APPROVED

WATER REQUIREMENT OF PLANTS - POUNDS OF WATER REQUIRED TO PRODUCE ONE POUND OF DRY MATTER.

CROP	POUNDS
SMOOTH BROMEGRASS	1,016
ALFALFA	831
SOYBEANS	774
OATS	597
RED CLOVER	576
WHEAT	500
BARLEY	464
POTATOES	385
CORN	368
SUDAN GRASS	359
MILLET	271

CONSERVING WATER ON A FIELD

1. KEEP SOIL LOOSE
2. USE COVER CROPS
3. USE MULCHES AND PLASTIC COVERS
4. STOP LOSSES - CONTROL WEEDS

MAKE BEST USE OF WATER YOU HAVE!

1. FERTILIZE
2. DON'T PLANT TOO THICK
3. GROW CROP ON LAND DURING WETTER SEASONS - WHEAT, BARLEY, ETC.
4. SUMMER OR ALTERNATE FALLOW
5. ALTERNATE ROWS

GETTING BY WATER PROBLEM

1. CHOICE OF REGION
2. SELECT SUITABLE CROPS
3. IRRIGATION
4. CHOOSE DEEP SILTY SOIL
5. CONTROL WEEDS
6. FERTILIZE
7. MULCH
8. SUMMER FALLOW
9. FALL PLOW
10. LIST ON CONTOUR
11. REGULATE RATE OF PLANTING
12. USE OF ROTATIONS AND GREEN MANURES

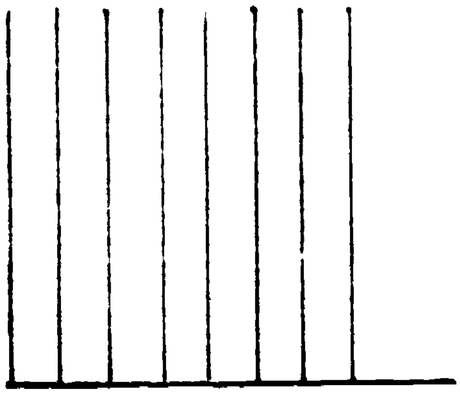
GETTING RID OF EXCESS WATER

1. TILE DRAINS
2. SURFACE DRAINAGE
   A) DRAINAGE DITCHES
   B) LAND BEDDING
   C) LAND LEVELLING
3. TERRACING
4. FERTILIZE

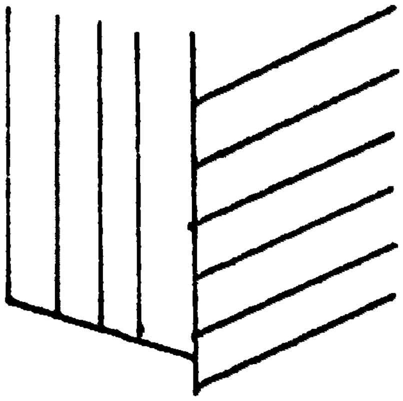
IMPROVEMENTS THROUGH DRAINAGE

1. SAVES TIME - NO WAITING FOR DRYING
2. SOIL WARMS MORE RAPIDLY
3. IMPROVE AIRIATION
4. ROOT RESPIRATION DEPENDENT UPON OXYGEN, NUTRIENT UPTAKE DEPENDENT UPON RESPIRATION
5. DEEPER, FASTER ROOT DEVELOPMENT
6. BETTER SOIL STRUCTURE
7. LESS WINTER KILL (HEAVING)
8. INCREASES FARMABLE LAND
9. HARBOR FEWER DISEASES
10. WEED CONTROL IS EASIER
11. POSSIBLE TO LEACH SALINE SOIL

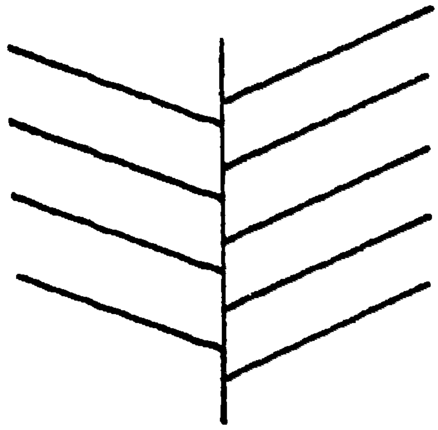
TYPES OF TILE DRAINAGE SYSTEMS



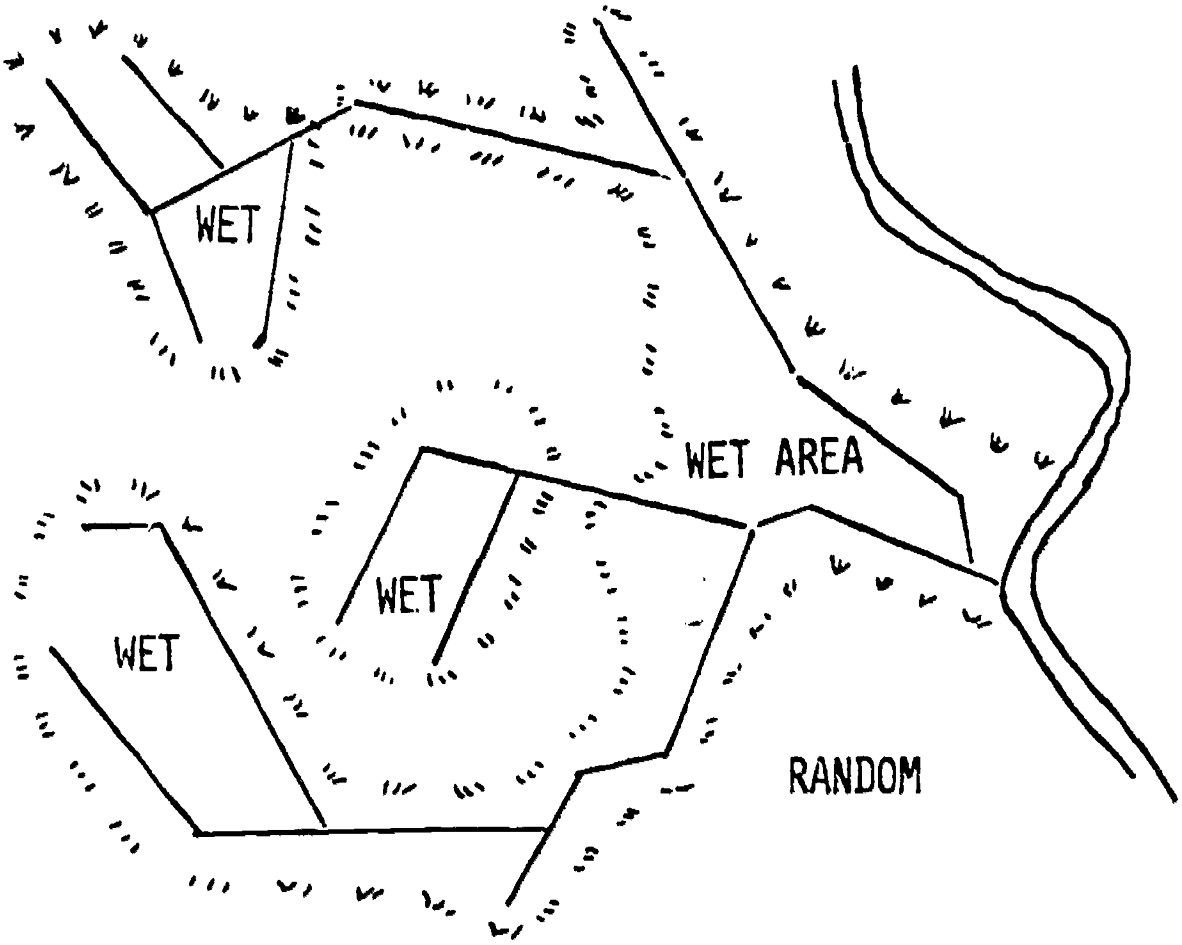
PARALLEL



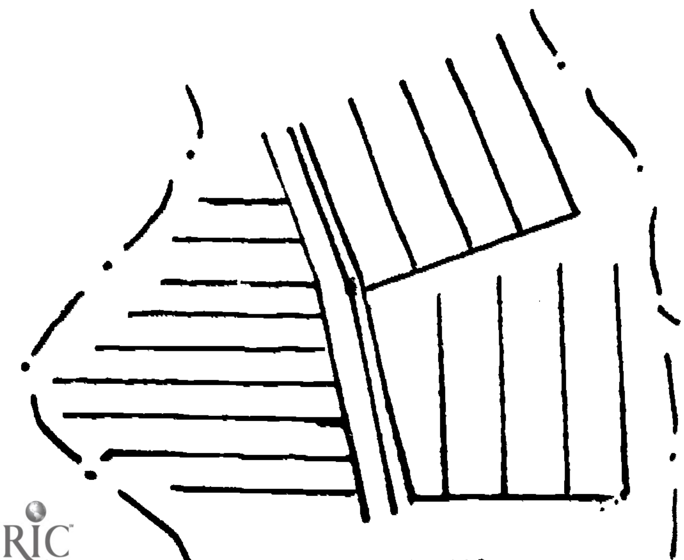
GRIDIRON



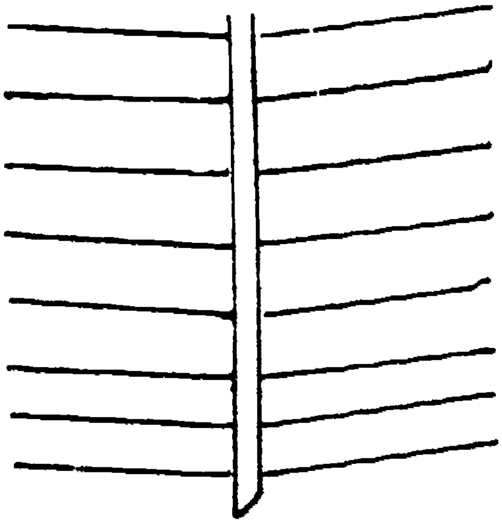
HERRING-BONE



RANDOM



GROUPING



DOUBLE MAIN

REASONS FOR TILE DRAINAGE

1. PLANT ROOT EXTENSION -

   REMOVAL OF SUPERFLUOUS WATER;
   BETTER ROOT SYSTEMS

2. SOIL WARMS FASTER -

   SEEDS WILL GERMINATE MORE QUICKLY

3. MAKES IRRIGATION MORE PRACTICAL

4. EARLIER SPRING CULTIVATION IS POSSIBLE

5. INCREASES AMOUNT OF AIR IN THE SOIL

6. INCREASES BACTERIAL ACTION -

   GIVES DEEPER O. M. AREA AND
   RELEASES MORE NUTRIENTS

7. INCREASES DEPTH OF TOP SOIL

8. DECREASES SOIL EROSION

9. CAN RELIEVE SOIL OF TOXIC SUBSTANCES

WATER IN THE SOIL

Purpose: To demonstrate that soils contain water.

Materials: A handful of soil
An old pan

Procedure: Place some moist soil in a pan with a lid and heat. Notice the droplets of water that form under the lid.

Explanation: The droplets of water that formed under the lid came from the soil. What important role is played by water in the soil?

(a) The hydrogen and oxygen of water serve as nutrients for plants.
(b) Water is a solvent for plant nutrients in the soil.
(c) Water carries nutrients to the plants.
(d) Water prevents plant roots from drying out.
(e) Water aids physical and chemical processes in the soil.
(f) Water is required by living organisms in the soil.
(g) Water slows up temperature changes in the soil. (Moist soils warm up slower and cool off slower than dry soils.)

AVAILABILITY OF WATER TO PLANTS

Purpose: To demonstrate that all of the water in soil is not available to plants.

Materials:
1. A pot of soil
2. A few seeds
3. A scale
4. An oven

Procedure:
1. Plant a few corn or bean seeds in a pot of soil.
2. Water the plants adequately for 3 or 4 weeks.
3. Stop watering the plants and allow them to wilt.
4. Weigh the pot with soil in it.
5. Place the pot and soil in a heated oven for about an hour.
6. Weigh the pot again. The loss in weight is due to water which was in the soil when the plant wilted. This water was unavailable to the plants.

Explanation: Much of the water, especially in clay soils, is held very tightly by the clay particles and cannot be used by plants. Some clay soils can be almost as droughty as sandy soils.

All of the rain that falls cannot be used by crops; some may run off, some evaporates, and some is held in the soil unavailable to plants. The water in the soil that plants can readily use is known as the available water supply.

SOIL PERMEABILITY AND WATER HOLDING CAPACITY

Purpose: To demonstrate that soils differ in their ability to allow water to pass through them and in their ability to hold water.

Materials:
3 ringstands
3 clamps
3 clampholders
3 plexiglass tubes
3 pieces of cloth each 3" x 3" and 3 rubber bands
3 calibrated containers to catch water
1 pint of finely ground fine-textured soil
1 pint of coarse-textured soil
1 pint of fine-textured soil with a good structure. If necessary use a sieve to remove the fine material from a sample of soil.
1 measuring cup

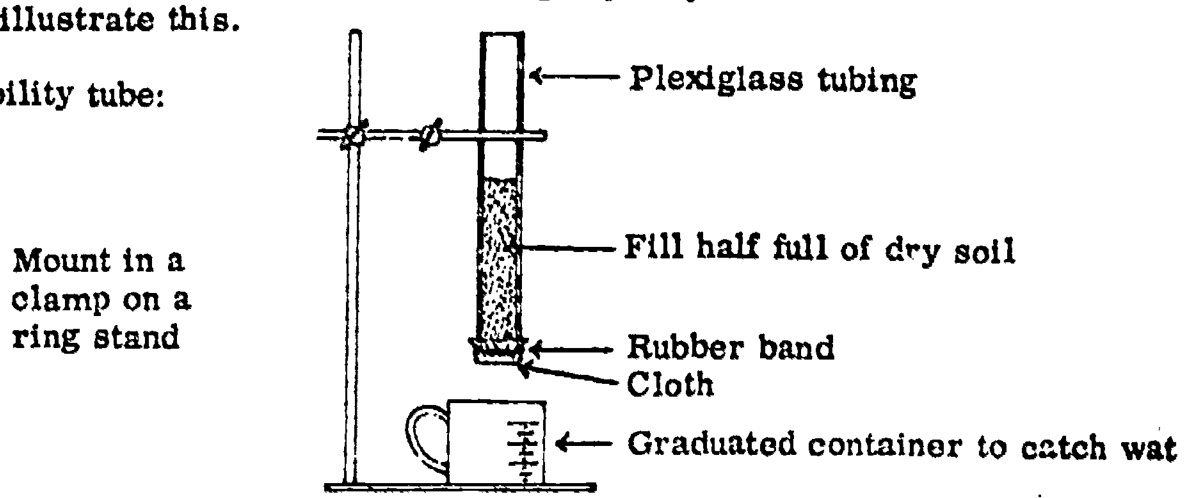
Procedure:
1. Fasten a piece of cloth over one end of each tube with a rubber band.
2. Fill one tube 1/2 full of dry, coarse-textured, soil such as a sandy loam.
3. Fill another tube 1/2 full of dry, finely ground fine-textured soil such as a silty clay.
4. Fill the third tube with the well aggregated soil.
5. Mount the tubes in clamps on ring stands.
6. Place a separate container under each tube
7. Pour the same amount of water - about 1/2 cup - into each tube.

Explanation: 1. Permeability is the rate at which water moves through soil, usually given in inches per hour. Note the length of time it takes for equal amounts of water to run through the three soils. Water should run through the coarse-textured soil very rapidly because coarse-textured soils are rapidly permeable while fine-textured soils are slowly permeable. (Be sure the fine textured soil is finely ground). Notice what happens to the well aggregated soil. Water runs through it almost as quickly as through the sand. Fine textured soils with a well developed structure (soils in good tilth) are usually quite permeable.

2. Moisture-holding capacity - the amount of water that a soil can hold. Measure the amount of water that runs through the soils into the containers. The fine textured soil will retain the most water. Notice that the well aggregated fine-textured soil also retains more water than the sand. This means that coarse-textured soils dry out and become drouthy sooner than fine-textured soils and that fine-textured soils hold plenty of water even though they are well aggregated. (Be sure to begin with dry soils for an effective demonstration of moisture-holding capacity.)

Organic matter content also influences water-holding capacity. The next demonstration may be used to illustrate this.

How to set up a permeability tube:



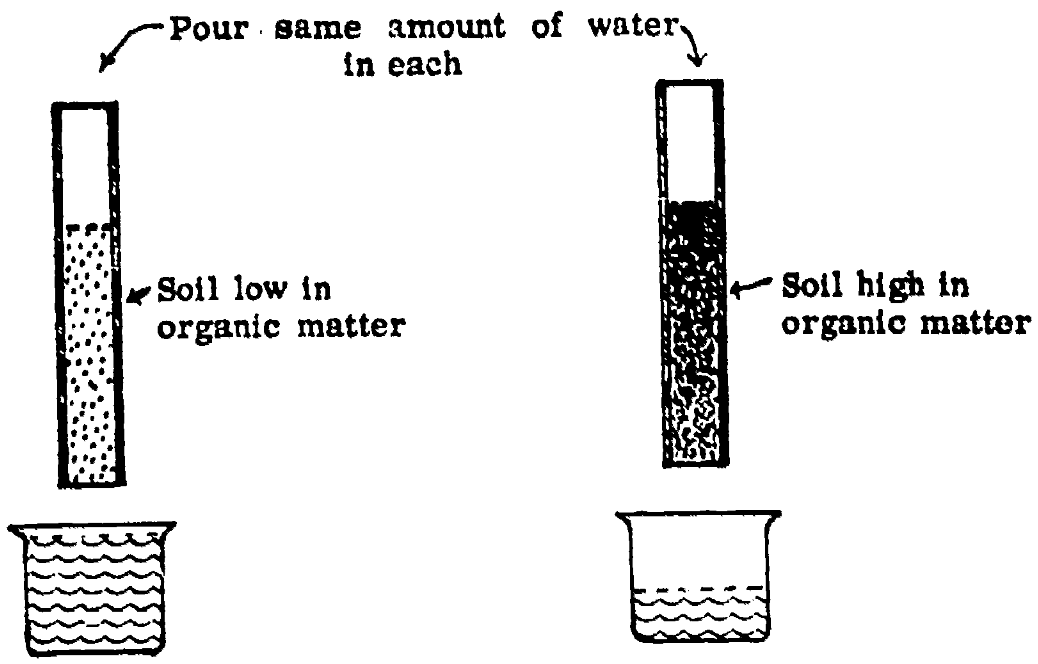
ORGANIC MATTER AND MOISTURE

Purpose: To demonstrate that organic matter helps hold moisture in soil.

Materials: 1 pint of peat moss
Materials used in demonstration No. 25

Procedure: Put a sample of soil high in organic matter or mixed with peat moss in one permeability tube and a sample of soil low in organic matter in another. Add equal amounts of water and note the amount that passes through each soil. Determine the amount of water that was retained by each soil.

Note: Although organic matter increases the water-holding capacity of a soil, it does not necessarily increase the amount of water available to plants.



WATER MOVES UP IN SOILS

Purpose: This demonstration is designed to show how water moves upward in soils of different texture.

Materials: 3 1/2-inch plexiglass tubes
1 pan for water
1 ringstand
3 clamps
3 clampholders
1/2 pint of each - (1)coarse sand, (2) medium sand, (3) fine sand, silt, or loam

Procedure: Fill 1/2-inch glass or plastic tubes with:

1. Coarse sand
2. Medium sand
3. Fine sand, silt, or loam

Tamp each well.

Tie a cloth over the lower end of each of the tubes and place in a pan of water so that water may move up in the tubes. Note the rate at which water moves upwards and the height to which the water in each tube rises. Time should be allowed because of movement rates.

Explanation: Texture influences the rate of water movement and the height to which it rises. The size of the pores, which varies with texture, influences the rate at which the water rises. The amount of surface area (a given amount of clay has more surface area than an equal amount of sand) influences the height to which water rises.

Water stored in the subsoil can move upward as long as the soil is not too dry. The water that moves up can be used by plants or it may move out through cracks in the soil and evaporate.

Water will rise highest in the soil with the finer texture but not necessarily at the most rapid rate. For example, water may rise 30 feet in a clay but only about 3 feet in a fine sand. It will probably rise faster in the sand however than in the clay.

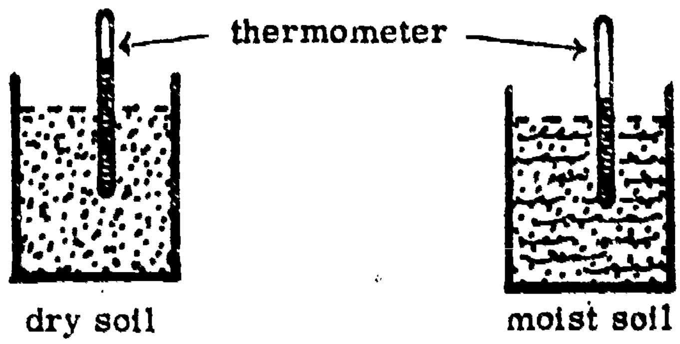
WELL-DRAINED SOILS WARM UP FASTER IN THE SPRING

Purposes: 1. To illustrate the effect of soil moisture and soil color on soil temperature.
2. To illustrate that well-drained soils warm up quicker in the spring.

Materials: 2 cans of soil
2 thermometers

Procedure: Fill two jars or tin cans with a dry soil. Saturate one of the soils with water. Place a thermometer at equal depths in each. Place both containers in the oven at about 90°F., on a sunny window sill, or on a register. Measure the temperature of each sample at intervals and note any relative changes.

Explanation: The dry soil should warm up more quickly than the wet soil because heat is needed only to warm the soil in one case while the other needs heat to warm both soil and water. Would you expect plants to have more heat for good germination and growth in a well drained or in a poorly drained soil?



Soils should be approximately the same color since light-colored soils reflect heat energy. Dark-colored soils absorb most of the heat energy that falls on them and warm up more quickly than light-colored soils. If you want to show the effect of color on soil temperature, use samples of dark- and light-colored soils, each with the same moisture content. Dark-colored soils warm up more quickly than light colored soils.