4. Term Paper (Independent Research)
5. Hand Out Material
6. Films
7. Opportunities for facts rather than second-hand or slanted opinions.

3. If you were teaching the course what changes would you make?
   1. Eliminate term papers being presented orally
   2. Make term papers count for extra credit
   3. Have more visual aids
   4. Have a guest speaker for each area covered
   5. Have more class discussions
   6. More outside reading
   7. Have longer class period to allow for class discussion
   8. More challenging exams
   9. Do away with daily tests
4. What advice will you give other students who might be thinking of scheduling this course?
   12 would advise others to take the course
   3 would give students no advice
5. Other comments and suggestions.
   1. More difficult tests
   2. Daily tests should be more thorough and graded harder
   3. Bonus points awarded for extra outside reading
   4. Do away with term papers being presented orally

*NOTE: Twenty students enrolled in the course; four dropped early; three were absent on the day of the evaluation.


Hosts and Prexies


Jack C. Everly (left) University of Illinois, recipient of E. B. Knight Journal Award for 1970; Frank Carpenter, Chairman and recipient of 1969 Award.

Relating Agricultural Instruction to Environment Improvement: The Role of Land and Soil

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INTRODUCTION

Man's waste can serve man . . . or pollute his environment.

Technically, that's the gist of the problem. The technology and know-how needed to harness refuse in the service of man is with us here and now.

The will to act is with us, too; but, so far, it appears to be too feeble to meet the political, social, and economic challenge. We may, however, take some comfort in the fact that the will to act may be gaining strength, slowed only by dollars. Instruction in environment improvement is needed and it must begin with the young people who are forming their political, social and economic habits.

I can at least see some change in people's thinking since a decade ago when I said, in a published article, "Man cannot afford to wait any longer to solve his waste disposal problems."

I felt alone, then. Today, I hear many voices echoing the same message.

Historically, waste has been discarded carelessly at little or no cost, as a way of life. This is changing and we now must pay to maintain or better our environment. Fortunately, there are solutions. Agricultural instruction is one of these.

This discussion is drawn from four main experiences I have had over the last 25 years.

1. USDA Soil Conservation Service, one of the first pollution abators. It was commended, in a recent report to the President of the United States, as being an excellent example of man's awareness of environmental improvement (having been initiated in 1932 by an act of Congress, long before the hippie movement).

2. US Department of Health, Education, and Welfare; US Public Health Service. Also pointed to as an early and effective pollution control program, long known for keeping man's sewage and city effluent under health control and the envy of foreign countries.

3. A student-organized ENVIRONMENT AWARENESS lecture-discussion seminar, undertaken, planned, and managed by upper-classmen and graduate students with faculty adviser for bringing together the best talent on environment improvement, pollution control, solid-waste management, and planning for future environment management for the betterment of man.

4. Water Quality Control Research and recent involvement as a member of the Arizona State Water Quality Control Council.

5. Five-year membership on the study and consulting board of the HEW, US Public Health; Office of Grants, Contracts, Fellowships and Trainee-ships in Solid Waste Disposal program.

I bring these sources of pollution awareness and abatements to your attention because they have been so sadly overlooked by the din and tinkle of the new movement on pollution, that occasionally has reached hysteria proportions.

Pollution ends up either in the soil (land) or ocean, since air and streams primarily are vehicles of transport into these end-systems. Sensitivity over what enters the ocean has become so keen, only the soil is left for mass disposal. The soil is an experienced "old-timer" at effective and efficient digestion and disposal of plant and animal waste. Pollution can be *controlled through* the soil. Indeed, I will illustrate how effective the soil is in controlling biological cycles of nutrient supply and digestion of wastes, but first a few words about agriculture and the environment.

A CASE FOR AGRICULTURE

Too often the finger has been pointed at agriculture as a polluter of the environment. Too often agriculture has not responded in an intelligent way to such criticism partly because our people are poorly informed concerning the leadership agriculture has provided in pollution abatement, and partly because not enough time has been taken to study the environment-pollution problems.

One of the classical examples of environment improvement is that of the USDA and the State Agricultural Experiment Station's long-standing program of soil conservation. We have been aware of the need for an action program in soil and water control and management for many years. A conservation program has been actively underway for about 40 years. Agriculture has been and is involved in many environmental improvement endeavors.

Another historical program is that of organic matter utilization. Animal manures have been returned to the soil and used for fertilizers and soil conditioning since the beginning of man's organized growing of crops. Only since the concentration of animals in feeding pens, change in agricultural chemicals economy, and high cost of transportation has disposal of manures been a problem. Like other wastes, dollar input is necessary. Manures will not pay for putting them on the land where transportation is involved.

Complaints of fertilizer contributing to contamination of water systems, streams and lakes are proving to be poorly founded in the light of recent research data accumulation. Phosphate, for example, is so tightly held to soil particles it does not move except as the soil moves. Nitrates are rapidly denitrified and lost to the atmosphere in so many ways, rarely can it be shown (only in shallow water tables) that fertilizer nitrogen moves into water recharge systems or accumulates in groundwaters. In fact, nitrates in raw vegetables, salads, spinach, etc., far exceed limits placed on water sources by the US Public Health Service.

All material is subjected to microbial attack, though some inorganic substances such as glass, chromium and organics as plastic, DDT and oil only slowly degrade. If microorganisms did not transform substances, we would not be here. Plant residues would long since have enveloped the earth in debris many meters thick. The soil is an ideal medium for decay, degradation, and transformation of waste and debris. Recovery of certain materials from solid waste is not considered here since the whole problem is one of place and refinement or processing economy. The primary object of this presentation is to discuss how the host of microorganisms in the soil transform certain waste products and convert them into soil or soil-like material. Decay and transformation of crop residues, leaves, straw, twigs, and forest debris is a continuing downgrade process since the beginning of life on the earth, ending up primarily as harmless carbon dioxide and water and beneficial soil humus. The role of the land (or soil) to improve the environment is almost overwhelming. Soil scientists must train and plan now to be ready for the great demands for environment control.

Before getting into specific microbial transformations that take place with the various substrates, let us examine the medium for these activities, the soil. Vast numbers and kinds of macro- and micro-organisms inhabit the soil and it is never without them, regardless of the climatic conditions. Bacteria number into billions per gram of soil, fungi in hundred thousands, worms and insects also form a great permanent living part. The environment of the soil is one of the most dynamic sites of biochemical reactions in nature, being involved in (a) the destruction of organic substances, (b) transformations of mineral elements, (c) weathering of rocks, and (d) a reservoir of nutrients for plant growth.

The size and character of the soil population is controlled almost exclusively by the nature of their energy or food source. Environmental changes may upset the equilibrium existing between species, kind and population densities, but this does not last long since the large, complex flora adjusts and readjusts readily to even the most severe habitat. As has been said many times, "The population reflects the habitat."

The seeding or inoculation of the natural soil with organisms has not been shown to result in any significant shift in the nature or quality of the soil microflora. In fact, the seeded organism or organisms meet with such competition from the existing flora that they are often eliminated in a few days or weeks. There is yet to be shown a beneficial effect to plant growth of seeding large populations of alien bacteria to soil. "The invaders do not become established and soon die out. The habitat is foreign, and the invaders fail to find a niche . . . the ability of an organism to compete is probably governed by its capacity to utilize the carbonaceous substrates found in soils, its growth rates, and nutritional complexity."[1] The organisms most capable of undertaking the job are already present in large numbers, waiting to grow and expand to the fullest extent of the energy source present. Neither vitamins, harmones, nor amino acids in trace amounts seem to alter their activity. Trace elements or micronutrients have little effect on the character or overall activitiy of the indigenous soil population. In short, all the microorganisms need to undertake the necessary soil transformations are already present and waiting on the soil, except for an energy source. They will flare up (in numbers) just as the coals of a fire burning slowly, rapidly burst into flame, consuming fuel as it is applied.

MICROBIAL TRANSFORMATIONS OF CARBON COMPOUNDS

Large quantities of carbonaceous materials in the form of above-ground as well as below-ground parts decompose each year: literally billions and billions of tons over the earth's surface. Animal residues, tissues, fowl, fish, and insects add to this burden of decay along with cells of microorganisms. These organic residues ultimately yield carbon dioxide and water on complete decomposition. If this were not so, life would long since have been smothered in its own debris. We would not be here. See Fig. 1.

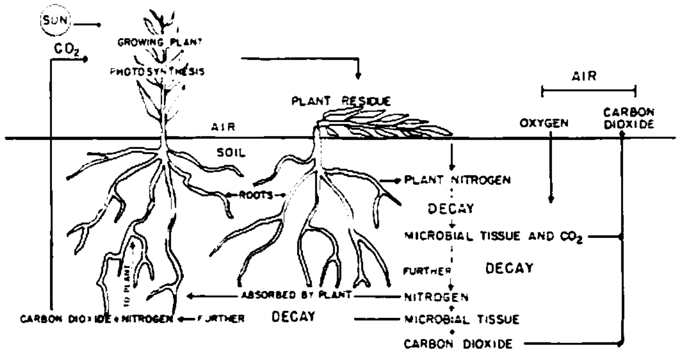

Fig. 1 – Carbon Cycle as Related to the Dissimilation of Plant Materials in Soil.

The most abundant organic constituent in nature is cellulose. Mature plants are approximately half cellulose, 5-30% lignin, 10-30% hemicellulose, water-soluble substances, nitrogen, minerals, and simple sugars 5-25%. Protein is usually much lower than carbonaceous compounds. The rate of transformation of these constituents varies greatly. Highly lignaceous materials decompose most slowly.

The rate of transformation primarily depends on:

1. Moisture
2. Temperature
3. Ratio of C to N compounds
4. Nature of constituents (cellulose, lignin)
5. Aeration
6. pH
7. Salinity, alkalinity, etc.

Transformation of residues takes place most rapidly when mixed in the soil, than when they lie on top.

Municipal refuse decomposes most rapidly when incorporated into soil. When it is put in a hole, pit, or a cell structure, it breaks down more slowly because oxygen is limited. By shooting streams of oxygen in old, buried dumps they catch fire rapidly and burn in the area of oxygen penetration. Municipal refuse is primarily cellulose.

Refuse (picked of ferrous metals, glass, rags and rubber, etc.) ground into fine material, decomposes rapidly in the soil, and makes suitable compost. Some tests using municipal refuse passed through a hammer mill, grinder, and screened, have demonstrated a real possibility of improving the soil when incorporating into the soil. Certain nutrient and organic matter benefits can be arrived at by this method of disposal without damaging the soil for crop production.

OXYGEN TRANSFORMATIONS

Oxygen content of the soil air, though quite variable, in general is quite similar to that of the atmosphere. The oxygen pressure is related to the presence or absence of oxidizable substances, their rate of susceptibility to biological oxidation, and quantity available. Thus, adding easily transformable alfalfa hay, grass or immature plant residue to the soil immediately places a great burden on the oxygen supply. Oxygen is used and carbon dioxide escapes. Under these circumstances, the soil oxygen is reduced temporarily and carbon dioxide content increased until the rate of transformation slows down.

The underlying principles of oxygen content are the chemical and biological reactions in soils. Both increase CO_2 production and reduce O_2 content.

MICROBIAL TRANSFORMATIONS OF NITROGEN

Nitrogen transformations are continually going on in the soil. They are so dynamic and diverse, attempts (under cultivated as well as disturbed soil conditions) to get a balance sheet of identifiable losses has not been possible. Nitrogen is the most susceptible major plant constituent to be influenced by biological transformations. These are listed as (also see Fig. 2):

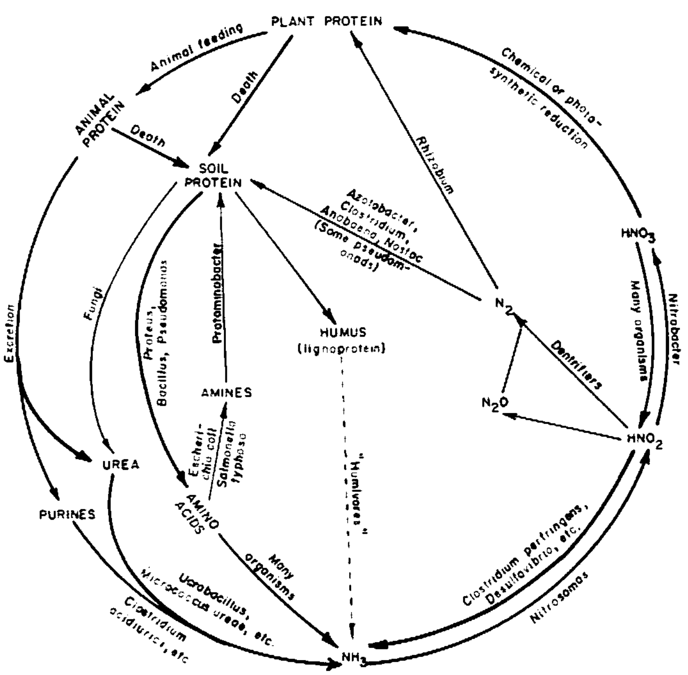

Fig. 2 – The Nitrogen Cycle in Nature as Depicted by Thimann.

1. Ammonification
2. Mineralization
3. Nitrification
4. Nitrate reduction
5. Immobilizations
6. Denitrification
7. N_2 fixation, non-symbiotic
8. N_2 fixation, symbiotic

They include organic, inorganic and volatile nitrogen compounds. Loss of nitrogen to the atmosphere by several denitrification pathways is a common and continual process and plays a role in pollution control. Recent research in our laboratories shows very little if any fertilizer nitrogen reaches the ground water. Where groundwater is shallow there may be a real possibility of nitrate movement into water.

MICROBIAL TRANSFORMATIONS OF PHOSPHORUS

Phosphorus exists in many different forms and readily changes roles. It is a constituent of meteorites, igneous rock, in lakes, rivers, sea and the soil. It is present in the sun's atmosphere. Phosphorus cycles readily between inorganic and organic systems. All life depends on phosphorus since it is an essential constituent of living organisms, Fig. 3.

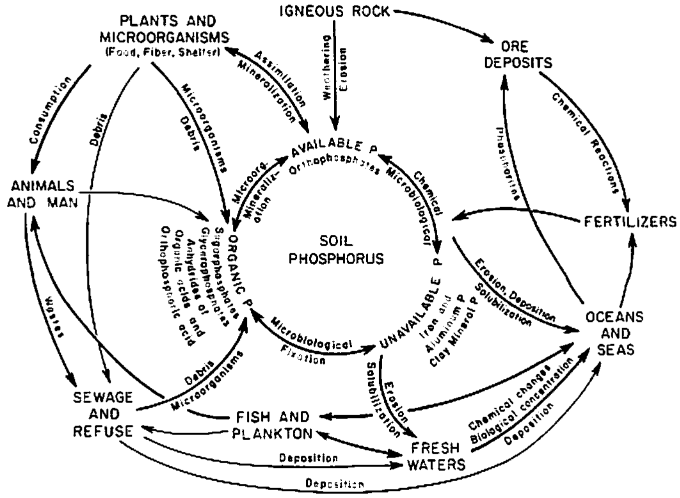

Fig. 3 – Phosphorus Cycle in the Universe.

The early deposits of phosphate formed in waters now represent the majority of phosphate-rich ores which are mined. Rich phosphate deposits are being scattered to the four corners of the earth, with man's relatively recent rapid development of uses for phosphorus in industrial and domestic chemicals. The agricultural chemicals industry is a specific example in which life processes of the biosphere for both animals and plants have been altered. As the population of Homo sapiens continues to explode over the earth surface, man's cyclic effect on concentration, utilization and deposition will increase in geometric proportion to population increases. The "homosphere" as a segment of the total biosphere even now is playing a critical part in the redistribution of phosphorus on the earth's surface. Some examples are:

(a) Accelerating soil erosion with consequent loss of the organic soil layer, the layer of richest accumulation of phosphorus, to river bottoms and sea floors.

(b) Redistribution of agricultural chemicals – fertilizers, pesticides, minerals – from phosphate ores to vast areas of the earth's surface, poor in concentration, where much of the phosphorus becomes fixed in the pedosphere in a form unavailable to life processes.

(c) Losses of crop phosphorus through sewage disposal that eventually "dead ends" in river and ocean bottoms.

(d) Industrial and domestic losses through development of phosphorus chemicals, detergents, and solvents and consequent disposal.

(e) Pollution losses as gases or colloidal particles to the atmosphere, and final dilution by thin layer distribution over the earth's surface.

Directly, soil phosphorus contributes in a reversible manner, as:

soil <--------------> plant <---------> animal <---------> sewage
rock ———————— fresh water ---------
(irrigation of soils)

MICROBIAL TRANSFORMATIONS OF SULFUR

Desert soils contain sufficient sulfur compounds to provide all the necessary sulfur needs of plants. Sulfate (SO_4^{--}), the most highly oxidized form, occurs abundantly and is widespread. Gypsum ($CaSO_4 \cdot 2H_2O$), the calcium deposits are mined. Certain acid soils require sulfur as an essential element of growth. See Fig. 4.

Sulfur is also found in the organic fraction of soil, locked in combination with other elements. Soil microorganisms make this source available to plants through decomposition of organic substances. The transformations of sulfur resemble those of nitrogen, the difference being primarily in the solubility of the different compounds and gases in the soil solution. Here again, the soil microorganisms play the key and vital role in sulfur availability to plants.

The sulfur cycle in soils is dominated by certain major processes of:

1. Oxidation of elemental sulfur (S) to sulfates and of inorganic compounds as sulfides, polysulfides, thiosulfates and polythionates.
2. Reduction of sulfates and other sulfur compounds.

THE SULFUR CYCLE

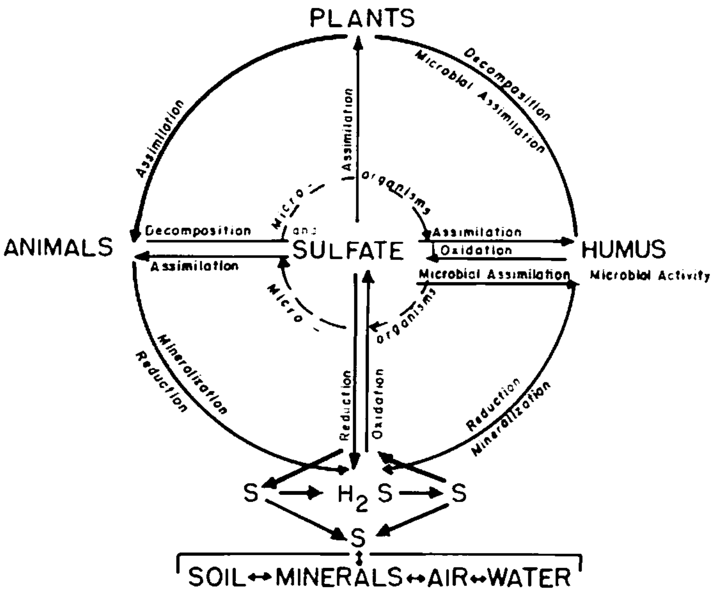

Fig. 4 – The Sulfur Cycle in Nature.

3. Assimilation and immobilization of sulfur compounds by incorporation into microbial cells.
4. Dissimilation or decomposition of organic sulfur compounds and complexes with the ultimate cleavage into smaller molecules and release to inorganic forms.

Desert soils differ from soils of more humid climates by having a greater proportion of the sulfur in the inorganic rather than the organic form. Gypsum is the primary sulfur carrier.

One must not confuse the effects of elemental sulfur (S) and sulfate ($SO_4^=$) in soils. Elemental sulfur is the reduced and sulfate is the oxidized form. Before sulfur (S) can be available to plants it must be made soluble. Oxidation of S is brought about by soil microorganisms as follows:

$$S + 1\tfrac{1}{2}O_2 + H_2O \xrightarrow[\text{Bacteria}]{\text{Thiobacillus thiooxidans}} H_2SO_4$$

Sulfur + oxygen + water ——————— Sulfuric acid

The oxidation of sulfur in soils is not restricted to the genus Thiobacillus. A host of other organisms may do the same thing and desert soils appear to be rich in sulfur-oxidizing organisms.

Sulfate, as such ($SO_4^=$) is not needed in desert soils because of its natural abundance and because irrigation waters contain sulfate.

Sulfur, on the other hand, is a recommended soil amendment because it solubilizes certain soil constituents through its acid action, making necessary plant nutrients available such as phosphorus and iron. Additions of sulfur to soils have been shown to control and prevent iron deficiencies as exhibited by chlorosis or yellowing of plants. Best results may be obtained by thoroughly mixing fine sulfur powder into the soil of the root zone or seedbed.

TRACE ELEMENTS

Iron, copper, zinc, lead, manganese, cobalt, molybdenum, are subjected to microbial transformations in soil. They may be oxidized or reduced readily depending on the oxygen tension in the soil. Time does not permit a discussion here. Disposal of solid wastes of all kinds are greatly affected by the microbiology of the soil.

CONCLUSIONS

Interdisciplinary programs should be developed, geared to: (a) evaluating the effects of agricultural production on environment pollution, (b) developing means of abating or controlling environment degradation through research, (c) providing economic surveys and assessments of environment pollution control and, (d) developing education courses at the college level (lower division, particularly) to inform students of the means required to improve man's environment. An all-campus seminar series may be developed to create an awareness of environment improvement. More and better expertise are needed to prevent hysteria in control programs. State Control personnel may be useful in providing some information on Environment Improvement. Agricultural specialists should be trained to provide lectures and visual aids for the public education.

[1] Alexander, Martin. Introduction to Soil Microbiology. John Wiley and Sons, New York, N. Y. (1961)

The 1970's - Decade of Crisis for Higher Education

J. Wayland Bennett
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Presented at the Annual Meeting of NACTA, Sterling, Colorado, June 17, 1971

It is a privilege for me to have the opportunity to speak to you today as your incoming President. I consider it a great honor to have been selected to serve as President of this Association and accept the responsibilities that are inherently a part of this position with the promise that I will, *to the best* of my ability, serve the Association and its membership during the coming year. I ask your help and support in this effort, being fully aware that whatever accomplishments the Association is able to make in improving the level of college instruction is primarily dependent upon the efforts of each of its members. Your support is earnestly solicited.

Within recent months an increasing number of Commission reports related to higher education, news articles, interviews with prominent educators, and the actions of state legislatures in their annual appropriations to higher education gave birth to and nurtured the topic of my address today – "Decade of Crisis for Higher Education." A recent report by the Carnegie Commission on Higher Education highlighted the critical financial crisis confronting both private and public universities at the present, as well as, in the foreseeable future.

If you asked people today if there is a crisis in American higher education, I am sure you would find that most people would say "yes". And if you asked them what they considered the crisis to be, I believe most people would tell you that the crisis revolves around student demonstrations, student demands and general unrest associated with the university campus.

These are big problems, to be sure, and on some campuses they have reached crisis proportions. But there is, in my opinion, an even bigger crisis looming on the horizon for every college – large or small – private or public. The new crisis is one that has been creeping up for a long time without a lot of fanfare, without much coverage from the news media, and without the knowledge of the general public.

The major crisis coming that will affect virtually every school in America is the crisis in financing higher education.

The 1950's and 1960's were decades of unprecedented development and remarkable accomplishment in American higher education. There was vast growth in the number of students, faculty members and facilities. Total higher education outlays, public and private, have been increasing at two- and one-half times the rate of increase in the Gross National Product which has, itself, grown nearly fourfold since 1950.

We have now reached a kind of pause in the postwar boom in higher education. En-