ENVIROTRON

New Word for a New Scientific Tool

Wallace H. Fuller

Editor's Note: Dr. Fuller, head of the Department of Agricultural Chemistry and Soils, here coins a new word, "Envirotron," defined as a habitat where all factors of a biological environment are controlled as precisely as possible. He uses the word here to describe a plant habitat only, since this is the present area of research.

Research itself could be very simply defined as "finding things out," and in the laboratory, experimental field, barn or corral, this is done by trying to isolate or evaluate alike and unalike factors or characteristics.

To find the result of fertilizer you you must compare fertilized plants with exactly similar plants which have not had that fertilizer. But error creeps in as one realizes that each plot has slightly different soil conditions, slight errors and variations in handling, even differences in air currents which affect plant growth.

Thus the seeking for a habitat where all conditions can be controlled, the ultimate goal of complete absence of accidental differences. Dr. Fuller's new word and the device he describes can be of great use and value to scientists in many fields.

The concept of the envirotron originated from a need for more precise knowledge of: (a) the extent that each component in the natural environment of plants can influence plant growth and economic productivity, (b) the interactions of one environmental factor on the others in relation to plant growth and productivity, (c) interrelations between root and top environments, (d) interaction between microorganisms and plant nutrient availability and transformations, (e) the movement of water, salts and air in soils as influenced by varying the components of natural habitats.

These objectives can be accomplished only by a system capable of controlling precisely the components found under natural environments such as: (a) temperature, (b) light, (c) oxygen, (d) carbon dioxide, (e) humidity, (f) root environment, (g) water, (h) physical damage, and (i) disease.

Integrated With the Normal

Our concept of the envirotron must be integrated with the development of a desert community which is self-supporting in power, water and food. Around this overall objective, individual projects will be oriented.

A few research problems which urgently need our attention are discussed, more to prompt creative thought than to offer quick or ready solution.

General Basic Problems

I. *More precise evaluation of the threshold parameters of the individual environmental components on plant growth and economic production.*

For example, it is not easy to measure the effect of temperature; i.e., intensity and duration, on the persistence of various plant species under field or even greenhouse conditions. Too many variables cannot be controlled. This applies to forage or grass on the range as well as cotton on irrigated fields. Moreover, interactions between two variables are not possible to evaluate precisely unless some means is provided for control of all other components indigenous to natural field environments. The "Envirotron" will permit such control and opportunity for precise evaluations.

II. *Plant potential productivity* — This refers to the absolute, fullest capacity of a given genetic plant species to grow and produce, whether it be for food, fiber, lumber or any other economic commodity.

Some of the questions that need answering are: What is the maximum potentiality of a specific genetic species to produce? Can an answer be obtained? If so, what limits the attainment of this maximum under present management or farming practices? How can present farming practices be improved to better realize this potential productivity?

III. *Soil potentiality* for maximum plant growth and plant productivity. It is well known that all soils do not produce crops equally well, even under identical climatic environments. Even when supplied with all the available plant nutrients believed to be deficient in the soil in question, soils do not produce equally well. Why? If the plant nutrients are adequate and moisture and temperature identical, then one could logically suspect the limiting components to be the physical make-up of the soils.

Yet there remain certain microbiological factors also unknown to us. Perhaps organic growth regulators differ in quantity and quality in different soils which make plants respond differently. Whatever the differences are, it is high time soil scientists begin to uncover basic knowledge that will help bring soils up as close to their maximum potential plant productivity as is genetically possible.

The Envirotron again is conceived to aid in discovering why soils have not been brought up to the same high level of productivity by present technical manipulations under field conditions.

Specific Problems

The first three items discussed concern general basic problems that have confronted scientists for as long as history itself. To get to the solution of these basic problems, specific components involved in the environment of plants must be studied in extreme detail under as controlled conditions as possible.

The Envirotron will be designed to study specific variables while holding all others constant. Some examples of specific problems that will receive attention are enumerated. No doubt others will receive attention as the Envirotron program gains momentum and as individual ingenuity and creativeness develops.

I. *Evaluation of soil organic matter.* There is certain evidence that organic matter has value for plant growth and productivity that exceeds its value based on plant nutrient content. Manures, composts, etc., fall into this category also. It is hoped that the Envirotron will assist in the evaluation of such materials. This evaluation is particularly important in arid and semiarid soils, where the

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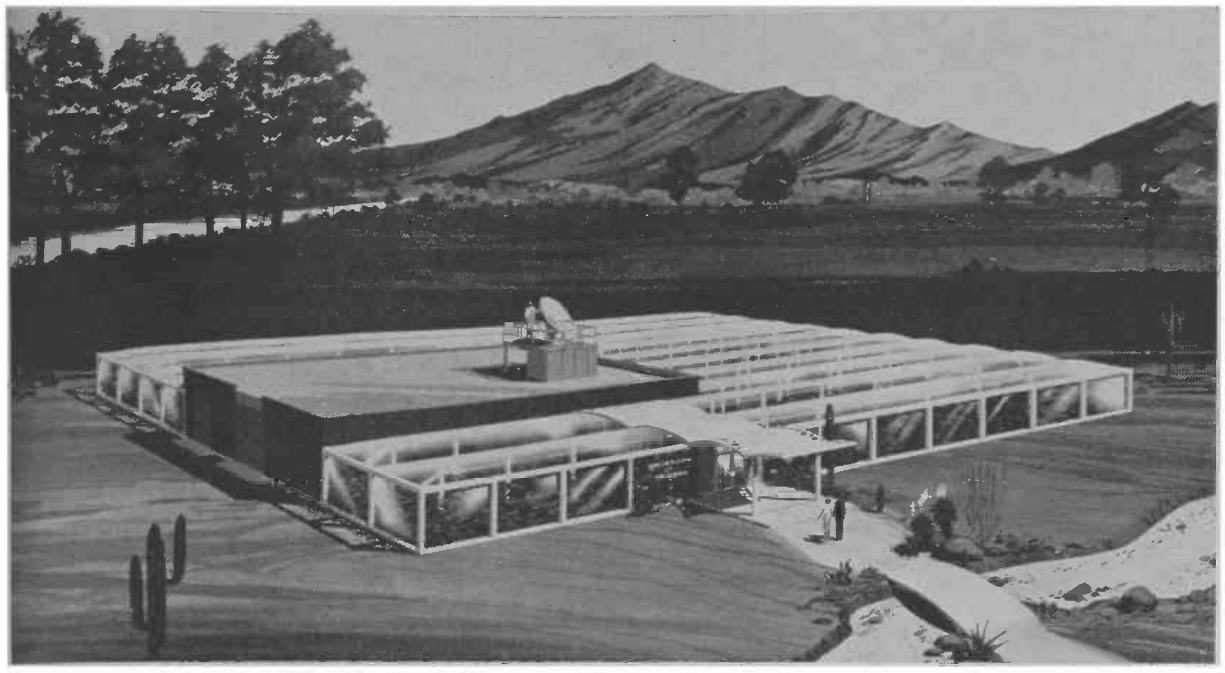
the best guides to eating quality in meat are:

—Shop at a reputable supermarket
—Apply the right methods of storage and cooking
—Relate the best cooking method to the cut
—And, in general, make intelligent use of the available consumer service information published by magazines, meat companies, U.S.D.A. publication #118, and Arizona Extension Circular #259.



ARTIST'S CONCEPTION of the environmental research laboratory "Envirotron" under construction.

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natural content of organic matter is characteristically low.

II. *Influence of organic residues and soil organic matter on tilth.* There is good evidence that soils well supplied with organic matter are in better tilth than those poorly supplied with organic matter. Again, because of the low level of organic matter in arid and semiarid soils, there is need to develop some parameters, of what these low levels provide, in terms of effect on tilth.

What is the minimum level that can be shown to contribute to tilth? What tilth-improvement values can be assigned to increasing amounts of organic matter? Can a characteristic curve be developed relating organic matter and improvement of tilth, or is this a straight-line function within the limits of practicability?

III. *Vapor movement in soils at field levels of thermal gradients.* Laboratory models have been developed showing the movement of soil moisture in the vapor phase. In arid lands, soil moisture movement to root zones of desert vegetation has not been studied under precise, controlled conditions sufficient to understand the contribution of this form of soil moisture movement on persistence of desert plants.

The Envirotron can aid in evaluating the effect of temperature gradients throughout the root zone of soils on the income and out-go of water. Seasonal thermal changes need evaluating with respect to water movement in the unsaturated phase.

IV. *Effect of soil temperature in relation to air temperature on plant growth.* This is a problem long needing attention. The soil plots in the Envirotron could be wired such that root penetration, root density and nutrient uptake could be studied as influenced by various root temperatures. This research could then be extended to show air-root-zone-temperature interactions on crop growth and productivity.

V. *Salt movement and precipitation.* What happens to salts in soil solutions when the soil moisture changes from one phase to another? Does water drop its salts and proceed in a purer state? Is this a mechanism of purification for groundwater recharge on a practical basis?

There are many questions, an infinite variety of questions, and perhaps the Envirotron, as a new tool of research, will help us find the answers.

Ag. Chem. & Soils NFS Scholarships

The four recipients of a $600 10 week summer National Science Foundation undergraduate scholarship are pictured here with the director of the program, Dr. D. D. Evans, professor of Agricultural Chemistry and Soils at The University of Arizona.

The students are (l. to r.): A. David Andrews from Tucson, senior majoring in Ag. Chem. and Soils; Samuel Balsley also from Tucson, currently a senior in Chemistry with a minor in Ag. Chem. and Soils; Dr. Evans; Wilson Nolan from Salome, senior majoring in Agronomy, and Dennis Fenn, a native of Benson, a junior also majoring in Ag. Chem. and Soils.

This is the third year for this program, which permits qualified students to carry out an independent research project on a subject related to soil science. The research projects this year dealt with determining sodium in soils using a glass electrode; determining aluminum, silicon, titanium and iron in soils by atomic absorption spectroscopy, electrode potential of Nitrogen oxidation states, and the inhibition of calcium carbonate precipitation, using minute quantities of sodium hexametaphosphate.