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APPROACH TO REGIONAL RESEARCH ON EVAPOTRANSPIRATION IN THE GREAT PLAINS 1/

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The problem of supplying an adequate amount of water for present and future needs is widely recognized.

"Man's future depends on his wise and effective use of water. Water in ever-increasing quantities is needed for the production and processing of food for the dramatically expanding populations of the world. The maintenance of even primitive health standards requires good water, and our modern industrial economies would flounder without it" (1).

Our use of water is increasing faster than our population. Modern inventions and conveniences of the home require more water. Industry has a tremendous demand for water that continues to increase. For example, 600,000 gallons of water are used to manufacture a ton of synthetic rubber and 320,000 gallons of water are used to produce a ton of aluminum.

Yet agriculture places the largest demand on our water supply. Evapotranspiration from the vegetated lands in conterminous United States consumes 3.38 billion acre-feet of water or 71 percent of the average annual precipitation. Irrigation agriculture uses over 95 percent of the massed water supply that is consumptively used (7).

We have essentially four approaches toward meeting the demands for water in producing food, fiber, and sanitation for an expanding population. These were summarized in a review (6) of the Symposium on North American water balance as: (1) modification of weather to control precipitation, storage in glaciers, or other natural processes; (2) redistribution of water that has fallen from areas of surplus to areas of shortage; (3) better use of available water by such means as suppressing evaporation, recycling, desalinating, or improving irrigation practices; and (4) limitation of the need for water by means such as controlling land use or redistributing population.

At this ET seminar we have considered various aspects of water use in agriculture, including better use through understanding and influencing factors of ET amenable to modification. In our area of endeavor, an overall objective may be to increase the plant's water-use efficiency in assimilating CO_2 and converting solar energy into food for man and animal.

I envision three general objectives to this phase of the water balance problem. First, to understand the crop response function to water and fertilizer for the soils, climate, and weather of the Great Plains; in other words, to understand the soil-plant-atmosphere continuum (SPAC). Second, to manipulate the whole SPAC as a system--furnish inputs for optimum utilization of resources. Third, to favorably change the crop response function to water and fertilizer for the soils, climate, and weather of the Great Plains.

An increase in our understanding of ET and SPAC will come about as groups of scientists initiate and carry out meaningful investigations that supplement and complement the investigations of other scientists. The scientists working on related problems should get together occasionally (perhaps annually) to informally compare failures and successes and to stimulate one another.

Physicists and biologists working today on the most advanced problems communicate mostly by face-to-face contact and by telephone (5). One Nobel laureate (2) admitted that he learned about most new things by talking with other people. It seems that any results of importance are known among the knowing long before publication, and that they use the journals as a matter of record.

So an informal, but scheduled, meeting would greatly facilitate research by exposing scientists to each others' experiences. It could accelerate our experience in theory, measurement technique, and application. It might prevent some of us from repeating someone else's mistakes. "A fool learns by personal experience and a wise man learns from the experiences of others."

There is also a certain amount of hazard of too much communication or familiarity. The noncreative may become conformists and perhaps all make the same mistakes. "Invention is an act of nonconformity. Conformists cannot invent, except outside their fields of conformity" (3).

A regional research attack on some phase of the water balance problem could emerge as a natural consequence as regional scientists or groups of scientists recognize and identify a problem that needs cooperative effort. Such projects might include: (1) characterizing crop coefficients for evapotranspiration, (2) characterizing responses for different climatic or cropping conditions in the Great Plains, (3) establishing a network of weather stations to supplement data presently being published by ESSA, (4) investing in truth of measurement, (5) developing a simple measurement that would predict plant water-use efficiency under a wide range of environmental conditions, and (6) furnishing data for constructing and testing models.

Once we understand the response of a crop to its environmental factors amenable to modification, we can manipulate the systems to some extent, and furnish inputs for optimum utilization of resources. Lemon (4) listed various research approaches to altering the environment and plant characteristics, and estimated the chances of success for increased production efficiency and water-use efficiency. He rated chances excellent for success in several areas, including controlling soil moisture, i.e., mulches, irrigation, fallow, plastics, chemicals, tillage, and rotations.

A change in the response function of a crop to its environment to increase water-use efficiency might be brought about by manipulating germ plasm. Lemon (4) rated as excellent chances for success in several areas that involve selection and/or breeding: high solar light conversion; direct conversion of photosynthate to desired products, sugar, starch, protein, vitamin, fiber; altering rooting patterns. Others might include: change architecture of plants; discover new crops that produce the desired end product but use water more efficiently; develop drought- and temperature-hardy plants such as plants that have open stomata at night and store carbon dioxide, then close stomata in response to light.

Many such approaches lend themselves better to team approach through communication by involved individual scientists with other involved scientists.

As we approach the problem, we should seek ways of improving the things we know and also seek entirely new solutions. Such action might be categorized as immediate and ultimate thinking. "The immediate quality thinker improves the buggy whip; the ultimate quality thinker invents the automobile ... both kinds of quality are important ..." (3).

In summary, to increase production efficiency and water-use efficiency we need to: (1) understand the response function of the crop to the Great Plains environment, (2) furnish inputs for optimum utilization of resources, and (3) favorably change the response function of the crop to the Great Plains environment. Regional activities or projects that might help in accomplishing these goals should emerge from the discussions of this seminar and subsequent periodic informal conferences.

Literature Cited

(1) Brady, Nyle C. Foreword in Research on Water, ASA Special Publication Series No. 4, Soil Sci. Soc. Amer., Madison, Wisc., 1964.

(2) Debye, Peter. Density of Discovery. Science and Technology. Conover-Mast Publication, New York, September 1965.

(3) Kerr, Willard A. Creativity in Engineering and Industry. Agr. Engin. 44(12):663, 679-680, 1963.

(4) Lemon, E. R. Methods to make beneficial changes in energy use in the soil-plant-atmosphere continuum (SPAC). In Proceedings of Seminar "Modifying the Soil and Water Environment for Approaching the Agricultural Potential of the Great Plains," Agr. Council Pub. No. 34, Vol. 1, pp. 95-105, 1969.

(5) Platt, John Rader. The step to man. Amer. Sci. 54:245-358, 1966.

(6) Silberman, Edward. Water balance in North America. Science 166: 1191, 1969.

(7) Wadleigh, Cecil H. Fitting modern agriculture to water supply. In Research on Water, ASA Special Publication Series No. 4, pp. 8-14, Soil Sci. Soc. Amer., Madison, Wisconsin, 1964.