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A SURVEY OF RESEARCH IN  
AGRICULTURAL METEOROLOGY

by

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## FOREWORD

This Survey of Research in Agricultural Meteorology was presented by Mr. Downey at the Southern Region's Conference of Agricultural Meteorologists, October 11 - 13, 1965 at Fort Worth, Texas. The problem addressed in the article - staying abreast of developments in meteorology and applications of the science - is common to all of us in weather work. The paper will be of specific interest to meteorologists with line responsibility for identifying and defining meteorological support needs for agriculture. It will be of more general interest to forecasters and climatologists who must formulate the meteorological products adaptable to the needs of agricultural users.

Interactions between land, plants, water, and air are preceptive to agricultural meteorology. Understanding and integrating what goes on in the planetary boundary layer is critically important to extend weather forecasts farther into the future, but there also is a direct interface of micrometeorology with local and mesoscale weather analysis and prediction. For these reasons, general service forecasters will be alert to peruse references such as those included with the article.

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## SURVEY OF RESEARCH IN AGRICULTURAL METEOROLOGY

A casual glance at publications in agricultural journals during the past eight months indicates the continuing interest in environmental factors as they influence plant growth, plant diseases and cultural practices. No less than twelve articles have appeared in the AGRONOMY JOURNAL during this period dealing with the effects of weather on various aspects of plant growth. Similarly, in CROP SCIENCE, a total of seven articles deal with weather effects on various crops. This is by no means a new development, since interest along these lines by agencies other than the Weather Bureau has become increasingly evident during the past few years.

Although the volume of such publications is too large for the Agricultural Meteorologist to digest thoroughly, he nevertheless must spend some time in scanning recent scientific publications and become familiar with the trend in technical studies. By this means he can also familiarize himself with techniques that may prove helpful in solving his own special problems in regard to a particular study. An example may be cited: The May-June 1965 issue of the AGRONOMY JOURNAL contained short articles entitled: "Light Quality under Saran Shade Cloth" by T. A. Gaskin and "Artificial Light for Plant Growth" by C. A. Federer and C. B. Tanner. In the first article, Gaskin used a Gossen Sixticolor Meter to measure light quality and a Weston light meter to measure relative light intensity. Increasing emphasis is being placed on light intensity and light quality as they affect crop response and these tools may prove helpful in studying light relationships in sensitive crops in the Southern Region. The second article deals with spectral distributions of various light sources used in plant growth chamber studies. Since some Experiment Stations have growth chamber facilities available, this information may be of help in determining what light source would best fit the needs of a particular study.

As is the case in many scientific fields, the volume of research papers dealing with meteorological subjects has increased at a phenomenal rate during the past ten years. The Agricultural Meteorologist, while trying to stay abreast of the latest studies in synoptic and dynamic meteorology, must make the most pronounced effort in keeping up with meteorology as it applies to agriculture. A great diversity of studies dealing with meteorology has been apparent in many government agencies for the past few years. Environmental studies are being conducted by such diverse government agencies as the National Aeronautics and Space Administration, the U. S. Army Quartermaster Corps, the U. S. Army Signal Corps, the Agricultural Research Service of the USDA, the U. S. Forest Service, the various Departments of Defense Arsenal and missile sites, Argonne National Laboratory and the U. S. Air Force. Each of these agencies is pursuing studies which correlate weather parameters with their particular field of interest. With many of these studies, the Agricultural Meteorologist has no immediate interest, but a surprisingly large number of these studies are aimed at correlating weather information with plant and animal response.

Most of the meteorological research of the Agricultural Research Service, Forest Service and U. S. Army Signal Corps fall into the realm of interest of the Agricultural Meteorologist.

Perhaps the most comprehensive studies of widespread interest to Agricultural Meteorologists of the Southern Region are those sponsored by the U. S. Army Electronics Research and Development Activity, Fort Huachuca, Arizona. Contracts have been let to many universities and to other government agencies for a concerted effort in studying the basic meteorological parameters involved in:

- 1) turbulence
- 2) Energy-balance relationships at the earth's surface
- 3) Surface-subsurface relationships

The turbulence studies sponsored by the Meteorology Department, Fort Huachuca, Arizona, are being conducted at the Round Hill Field Station at South Dartmouth, Massachusetts and at the University of Wisconsin, Madison, Wisconsin. The studies started in the late 1950's. Much of the early work involved fabrication or refinement of instrumentation to make the extremely precise measurements necessary in such studies, but much basic information has been forthcoming since then. The studies at the University of Wisconsin involved some infra-red mapping techniques, carried on over limited areas of Wisconsin and assessed the energy characteristics involved with different topographic and soil features.

The energy balance studies were performed mainly by groups of scientists at the University of California, Davis, California; the Northeast Branch, Soil and Water Conservation Research Division, ARS, USDA, in cooperation with N.Y.S. College of Agriculture, Cornell University, Ithaca, N. Y.; and the U. S. Water Conservation Laboratory, ARS, USDA, Tempe, Arizona. The broad objectives of this research are to measure and evaluate the energy balance components at the earth's surface and to devise and test theories on the energy disposition at the earth's surface under typically prevailing outdoor conditions. The work done at Davis is entitled: "Investigation of Energy and Mass Transfers near the Ground including the Influence of the Soil-Plant-Atmosphere System". The work done at Cornell University was entitled: "The Energy Budget at the Earth's Surface" and ranged from studies on soil drying and photosynthetic efficiency to radiant energy exchanges within a corn crop canopy. Interim and yearly reports on the results of this research are not readily available, and the channels for acquiring these data are not clear cut. Perhaps the best avenue of approach to securing copies of this data are through the Armed Services Technical Information Agency, Arlington Hall Station, Arlington 12, Virginia. The publications are a valuable aid in not only defining the main problems in the area under study, but also excellent reviews of what has already been accomplished. An excellent bibliography is cited in the special studies. Descriptions of instrumentation, instrument exposure and methods of analysis used by these extremely capable scientists may lend themselves to some of the weather-crop studies currently being performed in the Southern region. The Soil and Water Conservation Research

Division, ARS, USDA, Watkinsville, Georgia is also involved in the studies with a broad objective of evaluating the role of plants as a factor in the transfer of water from the soil to the atmosphere.

The surface-subsurface studies sponsored by the Meteorology Department, Fort Huachuca, Arizona are being performed by personnel at the U. S. Salinity Laboratory, ARS, USDA, Riverside, California; by the Agronomy Department, Utah State University, Logan, Utah and by the Department of Agricultural Chemistry and Soils, University of Arizona, Tucson, Arizona. The U. S. Salinity Laboratory project is entitled: "Water Transfer from Soil to the Atmosphere as Related to Soil Properties, Plant Characteristics and Weather". The work at Utah State University and the University of Arizona has to do with moisture movement through soils.

Other government research agencies who often publish research material of immediate and direct interest to AAM's include the Geophysics Research Directorate (GRD) Air Force Cambridge Research Center, USAF, Bedford, Massachusetts. These research notes cover a broad range of subjects. GRD Research Notes # 12, however, is entitled: "Numerical Experiments in Forecasting Air and Soil Temperature Profiles". The numerical forecasting model described in this study may have promise in an objective forecast technique for forecasting soil temperatures in the Southern Region during the critical spring planting season.

Other sources of research reports of immediate interest to AAM's are those sponsored by private or semi-private organizations. Commercial airlines, Travelers Research Center, aircraft manufacturers and private meteorologists often publish reports that may have agricultural significance in addition to the specific use for which it was intended. The Weather Bureau Accession lists should be studied as a potential source for updating material in the field of agricultural meteorology.

This, briefly, is a synopsis of some of the research that is being performed. The basic research being accomplished by the Weather Bureau and numerous universities is, of course, a ready source of information on the more basic weather processes and the possibility of integrating these basic studies into agricultural-weather problems should not be overlooked.

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## RESEARCH PUBLICATIONS

- 1) The Energy Budget at the Earth's Surface...Interim Report 62-1 through 62-9 and 63-1.

E. R. Lemon, USDA, Research Investigations Leader  
Northeast 1 Branch, Soil and Water Conservation Research Division, ARS,  
USDA in cooperation with N.Y.S. College of Agriculture, Cornell  
University, Ithaca, N. Y.

- 2) Surface Energy Balance in Arid Lands Agriculture (1960-61)  
Production Research Report No. 76  
ARS, USDA, Issued December 1963
- 3) Research in Plant Transpiration: 1961  
Production Research Report No. 70 May 1963  
ARS, USDA, for Meteorology Department, U. S. Army Electronic Proving  
Ground  
Fort Huachuca, Arizona
- 4) The Energy Budget at the Earth's Surface  
Production Research Report No. 71  
ARS, USDA, in cooperation with N. Y. State College of Agriculture for  
U. S. Army Electronic Proving Ground, Fort Huachuca, Arizona
- 5) Annual Report - Water Transfer from Soil to the Atmosphere as Related  
to Soil Properties, Plant Characteristics and Weather  
1961, 1962, 1963  
Cross Service Order No. 2-61, 2-62, 2-63  
U. S. Salinity Laboratory  
ARS, USDA, Riverside, California
- 6) Investigation of Energy and Mass Transfers near the Ground Including  
the Influences of the Soil-Plant-Atmosphere System  
University of California at Davis (Department of Ag Engineering and  
Department of Irrigation)
- 7) Interim Report: Energy Balance Studies over Sudangrass, 1962 U. S.  
Water Conservation Laboratory, ARS, USDA, Tempe, Arizona 85281
- 8) GRD Research Notes....No. 12  
Numerical Experiments in Forecasting Air and Soil Temperature Profiles  
Donald W. Stevens, July 1959  
Geophysical Research Directorate  
Air Force Cambridge Research Center  
Air Research and Development Command  
USAF  
Bedford, Massachusetts

NOTE: Apply for GRD Research Notes at: U. S. Department of Commerce  
Office of Technical Services  
Washington, 25, D. C.