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Purdue University

LABORATORY FOR AGRICULTURAL REMOTE SENSING

Summary of Seminar-Workshop on Remote Sensing and Agricultural Development

On July 10 and 11, 1967, a seminar-workshop was held at Purdue University to consider the general theme "Remote Sensing and Agricultural Development". The objective of the seminar was to bring together twenty-five agricultural leaders from government agencies, industry, farm, and private organizations to meet with Purdue personnel and to consider the following topics:

1. Agricultural remote sensing -- where are we?
2. What are the potential needs and applications of remote sensing techniques to agricultural development and management problems?
3. Remote sensing -- a tool in river basin planning.
4. The use of remote sensing and systems analysis in the development of resources in the Wabash River Basin.

A great deal of interest in potential uses of remote sensing and automatic data processing techniques was generated at the Seminar-Workshop.

As a basis for discussion purposes, a list of potential applications was prepared and listed under three categories according to the degree of seeming difficulty of obtaining information by remote sensing techniques. This list of agricultural applications of remote sensing and automatic data processing techniques is presented below.

Category A - These tasks appear to be feasible with present equipment and techniques.

1. Map of bodies of water (lakes, rivers, streams)
2. Winter wheat acreage map
3. Green vegetation map
4. Map of roadways
5. Measurement of relative surface temperatures
6. Bare soil map (light colored, dark colored soils)
7. Detection of plant stress

Category B - These tasks are more difficult but it seems reasonable that they can be accomplished.

1. Map of wet soil areas
2. Map and measurement of crop species
3. Topographic maps
4. Map and measurement of forest types
5. Gross characterization of soil permeability
6. Map and measurement of crops severely damaged by wind and hail

Category C - These tasks are difficult but perhaps possible.

1. Measurement of crop cover density
2. Measurement of available soil moisture
3. Detection and measurement of crop disease areas
4. Detection and measurement of areas of insect infestation
5. Prediction of crop yields
6. Detection of plant nutrient deficiencies
7. Weed surveys
8. Detection and location of certain water pollutants

Summary of Workshop Sessions.

During the workshop sessions many ideas were presented and discussed concerning the potential applications of remote sensing to the problems of agricultural development. In the discussions, it was clearly indicated that these techniques might serve agriculture and contribute to the efficiency of production within the two broad categories of nations, namely: (1) those with highly mechanized and productive agriculture and (2) those with less efficient agriculture of low productivity.

Nations with Highly Productive Agriculture. The United States, Canada, Japan, and several countries of Western Europe have rather effective systems of collecting and analyzing agricultural data and of making the results available to the public. However, even in these countries the lagtime between the date of data collection and information dissemination may be months, or even years in some instances. In the United States each year many millions of dollars are expended in the collection, analysis and dissemination of agricultural statistics.

The key to the contributions which remote sensing and automatic data processing techniques can make to agriculture in these countries is the timeliness with which vital information can be made available to the decision-makers, the planners, the producers. Rather than replace the present data collection systems, remote sensing techniques should be used to supplement them and to increase their efficiency and accuracy if possible.

Nations of Low Agricultural Productivity. In this group of nations a primary gap in the development process is a lack of knowledge of the available resources. One of the first tasks of the Food and Agriculture Organization, the Ford and Rockefeller Foundations, the U. S. Agency for International Development, or any other agency which undertakes an agricultural development project in one of these countries, is to prepare an inventory of the disposable resources. Very often many man years may be expended in assembling essential information and preparing such an inventory. In many countries agricultural statistics are nonexistent.

Remote Sensing and automatic data processing techniques could be applied very usefully in obtaining important resource information which could be used initially in development planning and later in resource management. For example, one of the critical agricultural problems in the humid Pampa Region of Argentina is poor soil drainage. Large areas throughout the Pampa are relegated to very low productivity because the soils are waterlogged during a major part of the growing season. The total area covered by these depressional soils and the drainage properties of the Pampa soils have never been characterized and mapped. A significant contribution could be made with remote sensing and automatic mapping of all standing water in the Pampa immediately following a general rain. These techniques could be used in preparing maps of the same area three days and ten days after the general rain. Analysis and comparison of the three maps should indicate rather vividly where the most serious drainage problems are. Further, the information would serve as a first good approximation in defining the drainage properties of the Pampa soils. Such information is basic to any rational scheme of providing artificial drainage facilities.

Potential Users of Automatic Surveys. In the agricultural sector of many nations automatic crop and soil surveys can serve as useful tools at many different levels. The following users could benefit greatly from their application:

1. The Agricultural Producer. Today's experienced and highly skilled agricultural producer uses a great quantity of information in arriving at resource management decisions. If information from automatic crop surveys were available to him in near real time, there are many benefits he could derive from this service. Early detection and warning of crops under stress caused by drought, insects, weeds, and diseases could become an invaluable aid in management. Early information about world crop conditions could have an important bearing on planned cropping patterns. Characterization of forage cover on rangelands by remote sensing could bring a new dimension into range management methods.

2. Government Agencies. Any new system which can add efficiency and economy to an important function of a government agency should be seriously considered. The Soil Conservation Service, the Economic Research Service, and the Statistical Reporting Service, to mention only three, are agencies which collect, analyze, and classify large quantities of agricultural information. Automatic agricultural surveys offer these agencies the possibility of more timely and potentially more accurate survey information.

3. Industry. The stockpiling and movement of agricultural chemicals to key distribution points at the appropriate time means success or failure to industry. Automatic surveys of crop conditions could alert industry to the specific needs for agricultural chemicals in a region. Early reporting of regional crop conditions and yield estimates could help to assure adequate harvesting, storage, and transportation facilities at the time and place of greatest need.

4. International Agricultural Development Agencies. There are many private organizations and foundations, as well as government agencies, involved in international agricultural development programs. Some of these operate only in a very limited area. Others have rather sizeable operations and are involved in resource development planning at regional and national levels. The latter group could benefit greatly from automatic surveys of the soils and vegetation of a region. Basic to any scheme of agricultural development is an inventory of disposable resources. Remote sensing and automatic data processing may save much time and energy in characterizing the natural resources of an area hitherto unexplored or undeveloped.

5. The Research Scientist. The agricultural economist, the economic geographer, the soil scientist, and the land use planner may all come to depend upon remote sensing and automatic data processing methods to collect certain types of agricultural information for research purposes. These techniques should be adapted readily to follow the changing land use patterns with time. Information about changing cropping patterns, marketing trends, dates of various farming operations is of interest to the farm management specialist.

<u>Potential Applications of Remote Sensing Techniques</u>. The potential applications which were suggested and discussed in the workshop sessions may be listed under one or more of five broad classes of natural resources, namely; land (soils), vegetation, animals, water resources, and climate.

1. Land (soils)

a. Mapping of bare soil areas. Depending on the time of year this measurement could provide information on fallow acreage, amount of fall plowing, acreage to be planted to a certain crop.

b. Characterization of soil moisture conditions. This information is always useful for management purposes. Detection of drought conditions can alert the operator to the need for irrigation. A map of soils under continual conditions of saturation may provide a guide for the drainage engineer.

c. Mapping of land use patterns. For resource planning purposes, it is very useful to have an inventory of present land uses and to follow the change of land use with time.

d. Mapping of land use capabilities. Another useful application somewhat related to land use patterns is the preparation of land use capability maps based on physical and chemical properties of the soils.

e. Detection and mapping of saline soils. The capability to perform this task could prove valuable to the irrigation and drainage engineer involved in the development of undeveloped land areas to be brought under irrigation. This information would also be important to the producer on whose land saline conditions are developing.

f. Mapping of soils. It is of primary concern to the soil surveyor to be able to delineate differences in soil color, soil texture, topography, moisture holding and drainage properties of soils. If remote sensing techniques can be used to obtain such information, it can make a great contribution in the field of soil classification and survey.

g. Detection and mapping of areas of active erosion. Both the Soil Conservation Service and the land owner are vitally interested in the early detection of erosion problems.

2. Vegetation

a. Vegetative cover maps and acreages of planted crops. In a world critically short of food, it could be of great benefit to have an inventory of the total world cropland, the total grain supply. This kind of information has important international implications. The same kind of information on a much smaller scale is basic to regional and national planning for agricultural development.

b. Crop yield predictions. This information is of great utility to those involved in harvesting, marketing, processing, storing, and transporting agricultural products.

c. Identification and mapping of weed infestations. Not only is this information valuable to the producer and to the herbicide industry, but the capability of identifying and mapping weed species automatically would be a valuable tool to the scientist; (1) in weed density studies, (2) in studies on the effectiveness of herbicides, (3) in following the invasion rate of a particular species new to an area, (4) in weed growth and development studies, and (5) in studies of the effects of weeds on crops.

Information about areas of the concentration of Canada thistle, loco weed, and other noxious weeds would be most beneficial to the producer and the herbicide industry. Such information could serve as a guide to industry in the regional distribution of herbicides.

d. Detection and mapping of areas of nutrient deficiencies. If early detection of deficiences can be made, steps may be taken to supply the crop with the deficient nutrient. A synoptic or regional map of broad nutrient deficiency areas could alert agricultural scientists, producers, and the fertilizer industry to the potential nutrient needs of the area.

e. Detection and location of disease infestation. This information would be valuable not only in alerting the producer to the conditions of his crop and the need for action. It might also serve as a guide for establishing areas of quarantine to prevent the spread of the disease. The capability to detect and map such areas automatically would be an invaluable tool to the researcher in his study of the disease -- its spread, its cycle, its control, and the prediction of its increase.

f. Detection and location of insect infestation. This would be of service to industry, the farmer, and the researcher for the same benefits as outlined under disease detection. A continuous monitoring of the movement of an invasion of insects would be beneficial to those involved in quarantine and control work.

g. Characterization of range conditions. The livestock industry could benefit immeasurably if it could obtain periodically rather accurate information concerning range conditions. The identification and location of overgrazed, undergrazed, and droughty areas would be very useful to the rancher. This and other data could provide an estimate of available forage on range lands.

h. Identification and mapping of weeds in lakes. Such information might serve as a guide to a more effective control program.

i. Identification and mapping of forest species. This kind of information is valuable to those who are responsible for forest management, including the harvest of trees and reforestation projects.

j. Characterization of forest conditions. Mapping of burned over areas, of areas of regrowth, and monitoring cut over areas are important bits of information to forest management personnel.

3. Animals

a. Identification and count of animal species. It is important to SRS, USDA, industry, and producers to know the number of livestock on the range in order to estimate market potentials.

b. Census of wildlife. In order to conserve and preserve many species of wildlife, it is necessary to understand their habits and life cycles. Remote sensing techniques might be used effectively in such studies.

c. Survey of forage areas. A survey which could provide information concerning range conditions would be valuable in predicting quality of animals and movement to market. Survey and mapping of forage areas in developing countries would be valuable information for development planning.

d. Monitoring movement of animals. A better understanding of animal behavior under various conditions is important to any program of improved production and management.

e. Detection and location of animals having abnormal body temperatures. If this task can be performed by remote techniques, it might be possible to locate a sick animal before the illness reaches an advanced stage and to apply medication much earlier than would be done normally.

4. Water Resources

a. Mapping areas covered by water. From such information general soil drainage properties might be characterized; flooding conditions could be measured; downstream flooding could be predicted.

b. Rainfall maps. Immediately following rainstorms, maps could be provided which would provide a synoptic view of the geographical area receiving precipitation.

c. Maps of snow cover. It would be of real interest to the watershed engineer to have an estimate of the snow cover, the depth of snow, and the water yield estimates from snow fields.

d. Water pollution studies. With remote sensing devices, it might be possible to provide a synoptic picture required to isolate pollution sources from minor currents in a watershed. Estuaries with tidal action which cause downstream pollutants to be forced back upstream could be located and studied.

e. Measurement of water losses. In water management, it is essential to have a more thorough understanding of water loss by runoff and by evapotranspiration.

f. Flow patterns in large bodies of water. It might be possible to use remote sensing to study the flow patterns and currents in the Great Lakes and other large bodies of water.

5. Climate

a. Rainfall data collection. It is of importance to everyone involved in agricultural production to have information about amount of rainfall, intensity of rain, and geographical area covered.

b. Measure of cloud cover. Cloud cover has a direct affect on the amount of heat units received by a growing crop. This kind of information is important in making crop yield predictions and in production management decisions.

c. Temperature measurements. Both ambient and soil temperatures are important to agriculture. Soil temperature information determines the optimum time of planting many crops. Temperature measurements are also useful in estimating moisture losses.

d. Estimates of storm damage. Remote sensing techniques could provide a useful service by measuring and mapping crop areas damaged by hail and wind. Such information would be invaluable to the insurance industry.

APPENDIX A

List of Participants

The following persons were participants in the Seminar-Workshop:

Non-Purdue Personnal

Dr. L. T. Alexander, SCS, USDA
Dr. Peter Badgley, NASA
Dr. Simon Baker, ERS, USDA
Dr. B. K. Barton, Wabash Valley Interstate Commission
Mr. Charles Centers, NASA
Mr. Joe W. Clifton, ASCS, USDA
Mr. Charles Coons, Indiana Farm Bureau Coop Assn.
Dr. William G. Duncan, Univ. of Kentucky
Dr. George Enfield, FES, USDA
Mr. Wendell Hannah, Indiana ASCS, USDA
Mr. Donald L. Henry, McDonnell-Douglas Aircraft Corp.
Dr. Earl E. Houseman, SRS, USDA
Dr. Max A. Jeter, Indiana Farm Bureau Coop Assn.
Dr. Charles Kingsolver, Biological Labs. Ft. Detrick
Dr. A. J. Loustalot, CSRS, USDA
Mr. Percy Luney, ERS, USDA
Dr. Don McCune, TVA
Dr. Malcolm H. McVickar, Chevron Chemical Corp.
Dr. Ervin L. Peterson, Development and Resources Corp.
Mr. J. Herbert Roadruck, Farmer
Mr. Herbert E. Skibitzke, GS, USDI
Dr. Marlow Thorne, Univ. of Illinois
Mr. Ardin Weiss, McDonnell-Douglas Aircraft Corp.
Mr. James F. Wilson, GS, USDI

Purdue Personnel

Mr. Paul Anuta, LARS
Dr. M. F. Baumgardner, LARS/Agronomy
Mr. Ron Becker, LARS/Civil Engineering
Dr. Ludwig Eisgruber, Agricultural Economics
Dr. N. K. Ellis, Agricultural Experiment Station
Dr. Roger Hoffer, LARS
Dr. Roger Holmes, LARS/Electrical Engineering
Dr. Larry Huggins, Agricultural Engineering
Mr. Chris J. Johannsen, LARS/ Agronomy
Dr. Cynthia Kozin, LARS
Dr. H. H. Kramer, Agricultural Experiment Station
Dr. David Landgrebe, LARS/ Electrical Engineering
Mr. R. B. MacDonald, LARS
Dr. Jerry V. Mannering, Agronomy
Dr. Clair Merritt, Forestry and Conservation
Dr. William Miller, Agricultural Economics
Dr. Carl Noller, Animal Science
Dr. Robert Peart, Agricultural Engineering
Dr. John B. Peterson, Agronomy
Mr. Terry Phillips, LARS
Mrs. Carol Roe, LARS
Dr. Jack F. Schafer, Botany and Plant Pathology
Dr. Marvin Schreiber, Botany and Plant Pathology
Mr. Tom Sinclair, LARS/Botany and Plant Pathology
Mr. Robert Straszheim, Agricultural Statistics
Dr. D. Woods Thomas, International Programs in Agriculture
Dr. Norman J. Volk, Agricultural Experiment Station
Dr. Joe L. White, Agronomy
Dr. Dan Wiersma, Agronomy
Dr. Gerry Wilcox, Horticulture/ Agronomy
Dr. Ramon Wilson, Cooperative Extension Service
Dr. Joe Yahner, Agronomy
Dr. Gerry L. Zachariah, Agricultural Engineering

APPENDIX B

Agenda

The agenda for the Seminar-Workshop was as follows:

Monday Morning, July 10, 1967, Memorial Center, Room 214

8:00 -- Registration

8:30 -- Introduction

Welcome -- Dr. H. H. Kramer, Director, Purdue Agricultural Experiment Station

9:00 -- Agricultural Remote Sensing - Where Are We?
Dr. Roger Holmes, Principal Researcher, Measurements Programs, LARS

Discussion

10:15 -- Coffee Break

10:30 -- What Do We Do With All the Data?
Dr. David Landgrebe, Principal Researcher, Data Processing Programs, LARS

11:30 -- Panel - Application of Remote Sensing and Automatic Data Processing Techniques to a Specific Agricultural Problem - Principal Researchers, LARS

12:15 -- Lunch

Monday Afternoon, July 10, 1967

1:45 -- Tour of LARS Facilities, McClure Research Park

3:00 -- Memorial Center, Room 214

Agricultural Research in Remote Sensing
Dr. Roger Hoffer - Principal Researcher, Agricultural Research Programs, LARS
Mr. C. J. Johannsen - Graduate Research Assistant

Discussion

Monday Evening, July 10, 1967

6:15 -- Chicken Barbecue at Morris Bryant's Restaurant - Courtesy of Wabash Valley Interstate Commission

8:30 -- Potential Requirements and Applications in Agriculture for Remote Sensing Technology
Dr. M. F. Baumgardner, Principal Researcher, Agricultural Requirements and Applications Programs
Dr. Roger Hoffer, Principal Researcher, Agricultural Research Programs
Mr. C. J. Johannsen, Graduate Research Assistant
Mr. R. B. MacDonald, Technical Director

Discussion

Tuesday Morning, July 11, 1967

8:00 -- Instructions for Workshop Groups - Dr. M. F. Baumgardner

8:30 -- Workshop Groups to Consider, List, and Discuss Potential Applications of Remote Sensing to Agriculture.

Group A - Chairman, Dr. Norman J. Volk, Director Emeritus, Agricultural Experiment Station.

Recorder, Dr. A. J. Loustalot, CSRS, USDA

Group B - Chairman, Dr. J. B. Peterson, Head, Purdue Agronomy Department.

Recorder, Dr. George Enfield, FES, USDA

10:15 -- Coffee Break

10:45 -- Summary Session

11:30 -- Adjourn