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REMOTE SENSING  
APPLICATIONS - USDA VIEWPOINT  
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INTRODUCTION

First, I should qualify to some extent the title of this paper. It would be presumptuous for me to assume that I could accurately present the Department of Agriculture's viewpoint on applications of remote sensing, assuming that there is one. Rather, I will be giving my impression of what I perceive to be the current thrust and focus of remote sensing research within the Department.

The Department of Agriculture has been a major user of remote sensing for many years. Until the past decade the major sensor was the aerial camera used to provide photography for use in support of major departmental missions. Both current and historic aerial photography are still used extensively for day to day program activities within the Department. With the development of other sensors, such as the Multispectral Scanner, along with satellite platforms there has been an increased interest in exploiting these new remote sensing technologies to provide improved information for administering Department programs. The advent of computer technology combined with digital data from satellite remote sensing has the potential of significantly improving the Department's existing information system. Unfortunately, research and development activities for exploiting this technology have not been well coordinated either

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within the Department or with other public or private agencies. In 1973 the Department did establish a Remote Sensing User Requirements Task Force which cataloged some 3,000 plus data or information needs which could be partially or completely satisfied by use of remote sensing technology. The work of this group was completed in 1978, but did not establish a comprehensive set of priorities among the large number of identified needs. Also in 1976, the Secretary of Agriculture established a Remote Sensing Coordinating Committee and a Remote Sensing Coordinator which has largely served as a means of information exchange but has more recently been heavily involved in developing and implementing Department policy pertaining to all aspects of remote sensing.

Within the past 18 months at the direction of Secretary Bergland, the Department has conducted a comprehensive review of ongoing remote sensing research within the Department. Following this, a list of key information requirements was developed and ranked in priority order. These requirements have been used to provide a focus for planning future research activities designed to develop and test remote sensing applications. In fact, a major planning effort has been conducted during the past year. This effort has been a joint undertaking with the National Aeronautics and Space Administration, Departments of Commerce, and Interior, and with some involvement of the Agency for International Development. It has resulted in plans for a six-year joint remote sensing research program to be cooperatively conducted by the involved agencies. USDA roles and responsibilities under this program, sometimes referred to as "The Secretary's Initiative," "The Agriculture Research Program," and now called "AgRISTARS," is what I would

like to discuss briefly with you today.

### SPACE REMOTE SENSING -- A DATA SOURCE

The overall approach of the Department of Agriculture to space remote sensing is that this new data source must be shaped to fit missions and program needs of the Department rather than missions and programs being shaped to fit the new data source.

Remote sensing data are regarded as an additional input into existing USDA information systems, which when merged with other types of data, can lead to improved information, in terms of reliability, timeliness and objectivity. The information provides a background for decision making, both within the Department, and throughout the U.S. agriculture and forestry sectors. Like aircraft remote sensing, the Department is incorporating space remote sensing into its programs as space methods of acquiring data demonstrate that they can provide new or better information or the same information at less cost or in a more timely fashion.

### CURRENT SPACE RELATED ACTIVITIES IN THE DEPARTMENT

The principal space related activities of the Department in 1979 are being accomplished by those agencies which have historically used remote sensing in their program activities. Virtually all of the research activity in USDA related to space remote sensing and relationships with NASA, will be included under the framework of AgRISTARS beginning in FY 1980. Major efforts of individual USDA agencies are briefly described below.

1. Economics, Statistics, and Cooperatives Service (ESCS) -- Three on-going projects use space remote sensing data or are aimed at developing procedures and techniques for expanded use of aerospace technology. These

projects are designed to improve crop acreage estimation techniques, establish an efficient system for use of space remote sensing data in land use inventory and monitoring, and to aid in the development and use of area sampling frames. This includes improvement of existing frames in the U.S. and the construction of new frames in developing countries, under AID sponsorship.

Full frame interpretation of landsat data when combined with extensive ground gathered data, improved the official year end estimates of Iowa's planted corn and soybean acreages for 1978. This was the first time that ESCS researchers had analyzed data from Landsat for an entire state in time for regularly scheduled reports of crop acreage. The satellite data helped reduce sampling errors and demonstrated that Landsat data can be used to improve crop acreage estimates (based only on very small sample surveys) at the state and sub-state level. However, resource efficiencies in utilizing Landsat data and timely acquisition of Landsat data must be improved before this approach can be used on a broad scale for operating program input.

Development of sampling frames is a vital part of the statistical estimation procedure. The use of remotely sensed data is particularly useful for the development of improved area frames. A new sampling frame for California was completed earlier this year. The new California frame placed heavy emphasis on use of satellite imagery to get better land use stratification. Satellite imagery was used as a basic source for establishing homogeneous strata and the entire frame was digitized to improve

area measurement accuracy. Initial planning is now underway with AID to extend these sampling frames procedures and techniques to cooperating host countries. Such frames would become a foundation for improving agriculture statistics systems in developing countries.

Other major ESCS efforts include research on improving forecasts of crop yields which when combined with acreage determine crop production. Much of the work is based on developing equations or models using environmental information and plant measurements to simulate plant growth and grain production. The research is focused on three domestic crops -- wheat, corn and soybeans.

2. Forest Service (FS) -- In 1979 the Forest Service continued its efforts under the Nationwide Forestry Application Program, a cooperative effort with NASA, to identify and investigate new remote sensing methods with special emphasis in the application to renewable resources inventory procedures and to applications of remote sensing technology to the management of forests and rangelands.

Specific project areas include detection, classification, and measurement of disturbances including forest insect and disease damage; classification and mensuration of forest and rangeland resources; regional and large area renewable resource inventories, including timber management surveys; environmental monitoring and the land management planning process; and vegetation classification with topographic data.

3. Science and Education Administration/Agricultural Research (SEA/AR) -- Current research in SEA/AR related to space remote sensing is

covered by four broad objectives: To provide early warning of environmental changes affecting production and quality of agricultural products; to forecast the effects of changes on crop yields; to assess soil water resources related to crop yield prediction models and systems; and to detect pollution and evaluate its impact.

Much of the SEA/AR activity can be characterized as basic research, which will become an input to projects of other agencies. For example, SEA/AR considers such subject matters as determining the reflectance and emission characteristics of various types of land cover, which will aid subsequent identification, assessment of crop conditions, or other measurements by remote sensors, including those carried by satellites.

4. Soil Conservation Service (SCS) -- The Soil Conservation Service is currently engaged in research for delineating and mapping land use. Initial efforts are being made to follow-up on projects related to soil moisture.

5. World Food and Agriculture Outlook and Situation Board (WFAOSB) -- The Board functions as coordinator of remote sensing activities and as a coordinator of weather and climate activities and data within the Department. Responsibility for coordinating remote sensing activities within USDA has been delegated to the Director of Economics, Policy Analysis and Budget who in turn calls upon the Chairman of the Board for assistance. In consequence, the Board has participated in the planning activities of the Secretary's Initiative, has arranged for support to the Crop Condition Assessment Division of FAS and, with the participation of other units of the Department

has been active in interdepartmental space remote sensing studies in response to Presidential directives and requirements, specifically, the Integrated Remote Sensing Systems Study, the Private Sector Involvement Study, the Space Transport Enhancement Study, and other interagency studies.

There is a close link between weather and remote sensing that needs to be established through the use of NOAA environmental satellites for supplementary global weather data, and the use of Landsat to confirm "crop alerts" based on weather data. Information on possible weather impacts on crops is passed from the USDA-NOAA Joint Agricultural Weather Facility (JAWF), in Washington, D.C., by Board meteorologists to the Crop Condition Assessment Division (CCAD) of USDA's Foreign Agricultural Service. CCAD checks the weather alert against Landsat data to provide commodity analysts with additional information for crop assessment. ("Alerts can originate in CCAD based on Landsat data and go to JAWF for analysis.)

#### FUTURE PROGRAM

As mentioned earlier, in early 1978, the Department of Agriculture joined with the Departments of Commerce and Interior, NASA, and AID in planning a Joint Program for Applications of Aerospace Technology in Agriculture. This Initiative, now named AgRISTARS, of the Secretary of Agriculture is based on the close cooperation of the indicated five Federal agencies and includes all the affected program areas of USDA.

The overall goal of AgRISTARS is to determine the usefulness, costs, and extent to which aerospace remote sensing technology can be integrated

into existing and future USDA information systems to improve the objectivity, reliability, timeliness, and adequacy of information required to carry out Departmental missions.

The specific objectives of the program include development, testing and evaluation of procedures for adapting space remote sensing technology to improve the Department's capabilities to provide early warning and timely assessment of changes in crop conditions, to provide more objective and reliable crop production forecasts, to assist in inventory and assessment of land, water and other renewable resources, and to develop a cost base to permit the Department to assess feasibility of integrating space remote sensing technology with existing data systems.

Briefly stated, the approach of this effort is to achieve a balanced program of remote sensing research, with consideration given to Landsat, environmental, and communications satellites and other airborne remote sensors. Research and development will be combined with user-conducted application tests to determine operational feasibility and procedures for using remote sensing data. The program is scheduled to begin in FY 1980 and continue through FY 1985.

The program will focus on priority information requirements of USDA which can be satisfied by remote sensing. The seven information requirements are:

1. Early warning of changes affecting production and quality of renewable resources
2. Commodity Production Forecast
3. Renewable Resources Inventory

4. Land Use Classification and Measurement
5. Land Productivity Estimates
6. Conservation Practices Assessment
7. Pollution Detection and Impact Evaluation

Because of the high priority assigned to early warning and commodity production forecasting, approximately 75% of the planned work is in direct support of these two requirements. However, it should be noted that a significant part of the effort in support of these two categories will be of direct benefit in satisfying some of the information requirements in the other categories.

Department and agency roles have been outlined for the Initiative. The Department of Agriculture will define the information requirements for the Initiative and will undertake research and development in accordance with existing mission requirements. That is, USDA will be the major participant in research on crop yield models, develop an agronomic data base, and participate in research on aerospace applications to determine land use, productivity and renewable resources applications. NASA will concentrate on providing Landsat data to support the research, development and test program and will develop techniques for using space remote sensing data, such as Landsat, in agricultural and forestry applications. The activities of the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce will center on development of a meteorological data base and research on the use of conventional and satellite acquired weather data in assessments of crops, renewable resources, conservation and pollution.

The Department of Interior will provide Landsat data storage, retrieval and dissemination in a reimbursable service role while AID will monitor the program to determine possible applications in developing countries. USDA roles are listed below:

1. Define USDA Information Requirements
2. Yield Model RD&T and Applications
3. RD&T - Applications Analysis for Area, Yield, and Production Estimation
4. Agronomic/Ancillary Data Base
5. User Evaluation
6. Ground Data Collection
7. RD&T and Applications Crop/Weather Assessments
8. RD&T and Application for Early Warning
9. RD&T and Applications for Renewable Resources Analysis
10. RD&T and Applications for Land Use, Productivity, Conservation, and Pollution Analysis
11. RD&T for Soil Moisture Measuring Techniques
12. Large Scale Applications Tests

For coordination and joint management, the AgRISTARS program has been structured into eight major projects. These projects are:

1. Early Warning
2. Commodity Production Forecasting
3. Supporting Research
4. Yield Modeling
5. Domestic Cover and Land Classification
6. Conservation and Pollution

7. Soil Moisture

8. Renewable Resources

Lead agencies have been designated for each of the eight projects.

Individuals are being assigned and implementation plans for FY 1980 will be completed by the end of July. Personnel from all participating agencies are being assigned as needed and as available to the projects. Within the Department of Agriculture the Foreign Agricultural Service will provide support to the Early Warning and Commodity Production Forecasts projects. The Economics, Statistics, and Cooperatives Service will be involved in five projects, including Early Warning, Commodity Forecasting, Supporting Research, Yield, and Domestic Cover/Land Classification. The Soil Conservation Service will lead the Soil Moisture project, and will be involved in Conservation and Pollution, Domestic Cover and Land Classification, and Renewable Resources. The Agricultural Research component of the Science and Education Administration (SEA/AR) will provide leadership and support as required to Soil Moisture, Conservation and Pollution, and Supporting Research. In addition SEA/AR will provide the major leadership and resources for early warning research and yield modeling. The Forest Service will lead the Renewable Resources project.

USDA RESOURCES

A summary of the Department's expenditures (estimated) for FY 1979 and proposed for 1980 are given in two charts. These are broken down by agency and by activity.

AgRISTARS

Budget Summary: FY 1979, FY 1980 (Proposed)

(\$ in millions)

<u>Agency Summary</u>	<u>FY 1979</u>	<u>FY 1980 (Proposed)</u>
FAS	\$ 3.5	\$ 3.5
ESCS	1.5	3.9
SEA/AR	2.1	4.3
SCS	.5	.8
FS	.6	.6
Total	\$ 8.2	\$13.1

Activity Summary

Early Warning	\$ 3.6	\$ 5.0
Commodity Production		
Forecasts (includes yield models)	2.7	6.2
Land Use	.5	.5
Renewable Resources	.6	.6
Conservation Practices	.4	.4
Pollution Detection	.4	.4
	\$ 8.2	\$13.1

## SUMMARY

The Department is engaged in a broad-based program of research and development to determine applications of aerospace technology to agriculture and forestry. The program focuses on the LANDSAT series of satellites for crop monitoring. However, other sensors and platforms are considered, such as the large-format camera to be mounted in the space shuttle and the environmental satellites which are operated by NOAA. In addition to research and development, the program includes testing of aerospace technology under operational conditions. For example, Economics, Statistics, and Cooperatives Service (ESCS) will be processing digital LANDSAT data for two states in 1980. Every acre on the ground will be covered unless no LANDSAT data are available because of clouds or satellite malfunction.

The Department has recognized the need for coordination between agencies involved in space-related technology, and has taken a lead role in initiating a multiagency program to assess the technology provided by current and projected earth resources satellite systems. This Joint Program for Application of Aerospace Technology in Agriculture (AgRISTARS) includes the Departments of Agriculture, Commerce, and Interior, the National Aeronautics and Space Administration, and Agency for International Development (AID). All of the participating agencies are closely linked in a joint program management structure with guidance provided by technical and implementation plans. These plans are now being developed for review and approval by USDA and other joint program participants.

The Secretary's Initiative is considered to be the "umbrella program" for the Department of Agriculture's space-related remote sensing activities, and includes research, developmental, and test projects of individual USDA

agencies. For FY 1980, the Department has submitted a budget request for \$13.1 million to cover the program. The sum reflects a proposed increase in funding of \$4.9 million over FY 1979. The remaining funding represents re-designation or re-programming of existing resources.