G USDA/FEDERAL USER OF LANDSAT REMOTE SENSING

Richard Allen (Chief/Remote Sensing Branch - US Department of Agriculture - Washington, DC)

The title assigned to this presentation is quite appropriate - the United States Department of Agriculture does feel that it is a major "user" of global remotely-sensed data in both research and operational programs. Crop condition assessments, renewable resources inventories, crop acreage estimation, conservation practices inventories, and water management are a few examples of the varied applications for remote sensing in USDA.

The Department considers Landsat as one of a multitude of information gathering tools which can be used to accomplish its statutory responsibilities for agriculture and natural resources. Other information tools to be used include ground collected data, weather data, aerial photography, in-situ sensors and aerospace sensors other than Landsat.

Since the launch of the first Landsat satellite (ERTS 1) in 1972, USDA has invested large amounts of resources in research and development of space remote sensing as a major source of more timely and accurate information. This better information is required for a multitude of decisions affecting global economic conditions.

The USDA has broad statutory responsibility for agriculture and renewable resources. A critical element is acquisition, analysis and timely dissemination of information on crop supply and demand. Timely and reliable information on major crops, including forecasts of production and supply is a significant element of National economic and political decision-making. The value of this information can be traced across a broad spectrum of public and private sectors. Some readily identifiable groups are US producers, consumers, agricultural marketers. exporters and shippers and government policymakers.

The value of crop information has increased in recent years as the countries of the world have become interdependent for food supplies. Exports of agriculture products is one of the bright spots in the US Balance of Payments. Constant improvement of information on the potential grain production levels of the United States' customers and competitors in the world market will allow for greater stability of economic conditions within the US.

It has been hoped, within the USDA, that improved sensor systems might allow for forecasts of production levels in countries which are

currently recipients of US food assistance programs. Better monitoring of individual country needs for food could avoid needless payments from the US Treasury for some of these assistance programs.

The extensive droughts of the past decade in the United States have increased the interest in monitoring the effects of weather upon crop production. Water shortages also highlight the need for information about water availability from underground sources as well as from current rain and snowfall. Evaluation of water supply and soil moisture conditions are important factors in intelligent use of US cropland resources. Satellite imagery such as that provided by Landsat, with its synoptic coverage, can be an important water supply information source in the future.

Since there is a later presentation in this conference which deals extensively with the AgRISTARS Program, I will not provide details on that program in this session but will try to focus on the broad aspects of uses within USDA.

USDA Agencies Using Remote Sensing

Several agencies have developed techniques which currently use remote sensed data for information needs or are developing such programs. The US Forest Service has long used aerial photography in conjunction with on-the-ground information to inventory its vast holdings, to make arrangement decisions, to detect and monitor disease and insect problems, and as an aid in fighting forest fires. The Forest Service Nationwide Forestry Application Program is exploring uses of Landsat data for monitoring and management. The techniques being studied not only provide point-in-time estimates, but also estimate annual increments of change. The Landsat analysis techniques were proven quite successful compared to conventional methods in the first phase pilot test involving one county in South Carolina. The next phase involves several counties in South Carolina with a full state demonstration planned for Idaho next year. Other remote sensing interests of the Forest Service include use of airborne thermal scanners for forest fire detection and mapping and the development of a forest fire deployment model in Southern California which monitors the total amount of fuel present as an aid to positioning fire fighters.

The Soil Conservation Service (SCS), is utilizing enhanced Landsat images as an improvement in its basic soil mapping and conservation monitoring programs. SCS is interested in improved land use mapping, using Landsat data. Monitoring of snow pack and prediction of subsequent runoff and water supplies, is another key need for SCS for which

procedures and models are being tested. SCS is especially interested in the development of insitu sensors which will be able to monitor soil moisture availability and transmit that information.

The Econimics & Statistics Service (ESS) has developed procedures for matching probability collected ground data with Landsat data for improving estimates of major crop acreages. These procedures are now being evaluated for transfer to State Statistical Offices of ESS. Also of current interest for ESS is to adapt these procedures to land cover and land use change estimates to gain multiple advantages from Landsat data sets. Landsat imagery is also used by ESS as a first stage mapping tool for construction of area sampling frames stratified by land use both for the United States and for foreign countries.

The Science & Education Administration (SEA), is involved in basic research for a number of remote sensing applications. These include models for early detection of disease, insect and moisture stresses; soil moisture determination; crop condition assessments; and identification and monitoring of pollution. SEA has research centers across the country involved with specific research projects which are mostly now coordinated under AgRISTARS.

Development of Operational Approaches

A goal of USDA remote sensing efforts is to transfer techniques from research units to operational units as rapidly as possible. The goal of the Forest Service Nationwide Forestry Application Program is to develop procedures that can be used by managers within each National Forest. One major emphasis under the AgRISTARS Domestic Crops and Land Cover Project is to involve ESS State Statistical Offices each year in increasingly more of the necessary steps to edit, capture, and match ground data with Landsat data for major crops. Tied to the major crops acreage estimates, is the cooperation of ESS state offices with local and state agencies to identify new uses of Landsat imagery. The operational Area Frame Construction Unit of ESS is now developing sampling frames for the AgRISTARS Foreign Commodity Production Forecasting Project.

The primary objective of the Crop Conditon Assessment Division (CCAD) of USDA's Foreign Agricultural Service (FAS) is to operationally provide USDA with prompt and reliable information about the conditions and expected production of foreign crops of economic importance to the United States. This information is used by the Department's Commodity analysts in developing its worldwide agricultural supply and demand estimates fordistribution to the public.

The CCAD routinely receives, processes and analyzes digital Satellite and meterological data to monitor high priority foreign crop producing areas. In carrying out these functions, the CCAD utilizes mini-computers located in Houston, Texas and Washington, DC. During 1980, the CCAD produced condition assessment reports for 10 major countries/regions and about 15 crops. In preparing these reports, the CCAD analyzed about 15,000 Landsat images covering more than 500 million acres.

USDA Adapts Procedures to Needs

Although the main emphasis of this topic is uses of space remote sensing it may be of interest to describe quite a different remote sensing approach that the USDA has developed. The other end of the continuum, so to speak. The Agricultural Stabilization & Conservation Service (ASCS), has the responsibility for administering various crop production programs of the USDA. Some of these programs require determinations of specific crops. In order to qualify for the benefits of the program, a farmer must register with the local ASCS office and certify which crops are planted in each field on the farm. ASCS then has a responsibility to the general public to monitor and check compliance with the planting restrictions.

Traditional compliance monitoring methods have involved selection of a sample of farms and determination of actual acreages by on-the-ground measurements or measuring on rectified photo enlargements. In the past few years, ASCS has gone largely to an approach of flying production areas with 35 mm cameras using color film. This flying is at low altitudes in light aircraft for which state offices have made arrangements. ASCS has purchased the cameras and ASCS employees do the photography.

These current color slides are used as the main vehicle for checking compliance. They can be projected onto rectified photography for marking field boundaries and planimetering. ASCS is also acquiring equipment which allows determination of acreages directly from the slides by establishing a numerical relationship between the slides and a rectified enlargement. The cost effectiveness of this 35 mm photography approach over the conventional methods is approximately 3-1.

Other agencies of the USDA have found the 35 mm photography now available in most county ASCS offices (about 1800-2000 counties are covered in part or totally) helpful for other purposes. The Federal Crop Insurance Corporation uses the 35 mm slides for monitoring crop conditions. The Economics & Statistics Service uses duplicate slides or prints for precision editing of field boundaries for ground data segments in its Landsat studies and is exploring use of prints as an aid in interviewing

farmers in operational surveys. Other state and local agencies and individuals have realized the value of these slides for planning and other purposes. ASCS county offices will select coverages for individual requests and send slides out for commercial processing for the cost of reproducing plus a nominal service charge for handling (usually $ 1. for selected slides, $ .50 per slide for full county coverage). The only restriction is that the office is not currently working with the slides for compliance at the time of the request. This availability of high resolution, current coverage may prove to be of value to many of you in the audience.

USDA Concerned About Data Continuity & Cost

The USDA has supported decisions to establish an operational space based land remote sensing system. Landsat data have shown great potential but this potential will only be achieved by insuring a steady flow of time, quality Landsat type products at reasonable costs. Cost comparison of Landsat data utilization with other alternatives will be the key management concern in determining the amount of operational use within USDA.

Many within the Department have been concerned with the long term effects if an extended data gap of Landsat data is encountered. If a gap occurs, there will be a loss of initiative related to operational developments and the gap may create an inertia which will be harder to overcome than were the initial hesitations about beginning Landsat utilization studies. Already the "doom and gloom" merchants within the Department are raising flags about the appropriateness of continuing present development efforts, in view of the present uncertainties in the Landsat program.

Some of the utilizations now being considered by the USDA can be pursued with retrospective data but many can not. For example, ESS would be able to utilize recent Landsat data for land cover estimates by matching against current ground data but it would not be possible to improve specific crop acreage estimates by the use of retrospective data. The Forest Service could continue much of its evaluations of new techniques with retrospective data but would not be able to achieve the true goal of the Nationwide Forestry Application Program without current data.

The Crop Condition Assessment Division of FAS has taken specific steps to bridge the data gap until Landsat D and insure continuity of procedures by utilization of data from NOAA 6. The infrared Bands of NOAA 6 (Bands 1 & 2) are similar to Bands 6 & 7 of the MSS on Landsat. Software adjustments have been made and CCAD is utilizing NOAA 6 data on a regular basis as of March 1981.

CCAD now has a contract to get tapes daily from NOAA (Camp Springs/MD). Tapes are shipped by air express, overnight, to CCAD in Houston, TX; time from acquisition of data by the satellite to receipt by the CCAD analyst in Houston is 48-72 hours. Although the resolution of the NOAA 6 data is gross (1 km vs 80 meters, Landsat MSS), CCAD is able to make useful qualitative assessments of crop vigor based on relative "greenness" of the observed vegetation. At present, coverage is obtained over most major crop regions of the world with a 5 day repeat cycle. (Data is not being collected for some Southern Hemisphere areas by NOAA 6. For example, Australia and South America.) Launch of NOAA 7, which should permit coverage of the areas currently missed, is expected in May 1981.

USDA Supports Future Improvements

Many of the data information needs of the USDA would require very fine resolution data in order to adapt from conventional procedures to Landsat utilization. Detailed soil mapping and development of specific conservation plans for small areas are examples of USDA programs which require very specific, high quality data for a point-in-time rather than repetitive coverages.

ESS has limited its crop acreage estimation work to date, mainly to states which have relatively large fields and which have only a few major crops. It is felt that the current ESS procedures would not be applicable to crop acreage estimates for many eastern states, given the resolution of the Landsat MSS sensors. Implementation of the Thematic Mapper (TM) Sensor, with its finer resolution, should allow extension of crop acreage studies into states with smaller fields and to estimates of acreages of more minor crops in states presently being studied.

There has sometimes been some confusion about USDA plans for utilization of TM data when available. If TM results in an improved procedure over the use of MSS data and one which is cost effective, then the TM data will likely replace the MSS data. It is not assumed that many applications will process both MSS and all TM data for the same purpose. It will be essential to continue the flow of MSS data until determinations of applicability of TM and adjustments of processing procedures have been completed.

The USDA hopes that the TM sensor does prove successful and that the new spatial and spectral characteristics improve the usability of present Landsat techniques and make new utilizations feasible. However, the USDA supports continued development of new or improved sensors and

platforms. Improved camera systems for vehicles such as the Space Shuttle would be very helpful to the soil mapping and conservation monitoring requirements of USDA. Similarly, aerospace radars which might improve soil moisture monitoring ability might be extremely helpful since soil moisture is such an important factor in crop yield and early warning models and in other crop condition assessments.