ERTS—For File or Field?

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A technological tool developed in the past decade and capable of minutely monitoring earth's resources via satellites orbiting the earth is to be launched by NASA before the summer of 1972. Vital information to the farmer, forester, or water conservationist will be contained in the photos transmitted from the satellites to receiving stations. But, the authors contend no plans have been made for Extension, USDA, or land-grant university staffs to receive, interpret, or apply the data. How would you go about acquiring access to such information so that Extension's clientele might benefit from its use?

Next year, the American farmer and city dweller will start benefiting directly from our Earth Resources Technology Satellites (ERTS).[1] Tiros weather satellite photographs are already a familiar sight on the evening news, but the earth resources satellite photos will be much more detailed. This tool could help the farmer-businessman save dollars and increase yields. Extensive crop damage due to storms, floods, blights, insect infestation, and pollution show up in space photography as well as crop maturity, soil-water conditions, and land-use patterns. The data will be collected to support ERTS's main objective . . . to develop and demonstrate the capability for more effective management of the earth's resources.[2]

Can space TV cameras from 492 nautical miles up detect the difference between a plowed field and a field of wheat? That's easy. Can the space cameras detect the difference between a field of alfalfa and a field of wheat? That's a little harder, but if the plants are a few inches tall, it's easy. Can the TV cameras pick out diseased wheat from healthy wheat? They can do it three out of four times before you can with the naked eye.[3]

Space TV cameras coupled with an instrument called a spectrometer form an accurate combination to aid the farmer. The spectrometer receives the reflected energy from the ground sector being viewed. The different plant species have unique spectral signatures just as you have a unique hand signature. Together, the space TV cameras and the spectrometers can survey the fields, timber, and streams of America.

This combination of remote sensing equipment is a dependable source of information. For example, a particular field of corn may have an undetected infestation of spider mites. The satellite passes overhead. Photos are taken by the TV cameras and the spectrometer scans the area. Both the photos and the spectrometer data are transmitted to a ground receiving station, recorded, and analyzed (probably by a computer). A problem is noted in a particular portion of the area. The exact nature of the problem may not be detected from the photo and spectral data, but a field visit with the farmer will reveal the infestation.

The earth resources space TV cameras help the farmer monitor his crops and can help save him time and money. The smallest detail in the photos is about the size of an acre so that things like cows, tractors, garden plots, stills, and details of defense plants won't show up. Better cameras could be used, but they're much more expensive and no more detail is needed because TV cameras and spectrometers can furnish the required data.[4]

The earth resources satellites will bring scientific precision to many difficult projects. They can monitor glaciers and snow conditions in remote areas for runoff prediction, improve earthquake prediction, monitor ocean pollution, detect large schools of commercial fish, detect the continental extent of pollutants, inventory crops, and detect crop diseases. This may sound a little like science fiction, but the technology is well under way for these tasks and, in many instances, has been tested.

Perhaps we shouldn't say that the earth resources satellites do all these things. Rather it's really people and the machines programmed by people that perform all these tasks. It's people working as a team analyzing the data gathered by the satellites and converting it to information useful to American citizens. The satellite is just a platform for the TV cameras and spectrometers. The ground receiving stations, the network of data lines, the computers—these are all tools of the specialists who analyze the data. The raw data are in the form of photos and images.

To go back to the example of the corn field problem: the specialist analyzing the data noted the poor spectral signature of the corn that he knew was planted there from the crop inventory taken the last time the satellite passed over that sector. He passed this information on to a field staff. The poor spectral signature was due to the spider mites mining the leaves of the corn which removed some of the chlorophyll. Not all signatures are known, not all specialists are infallible. There are errors (called noise) in the raw data, so there are going to be a few false alarms. When normal spectral signatures are noted, the information will be catalogued and used for study and will be available on request.

Another facet of the data collected by ERTS is that from ground sectors relayed through the satellite. Ground platforms will be installed by universities and other resource agencies and the platform data will be relayed through the satellite and returned to the organization that installed the platform. NASA has some funds to assist organizations that install these platforms.

We've painted a general picture of earth resources satellite capabilities, but with launch coming up early in 1972 before the summer season begins (assuming there's no delay), we can be much more specific. NASA has published some very detailed plans,[5] which indicate that ERTS-A will be placed in a 492 nautical mile circular polar orbit. It will view the same area of the earth every 18 days, so the survey data from this first satellite will be at the most 18 days old. The satellite will carry three TV cameras and a six-channel spectrometer. The smallest detail that the spectrometer and the TV cameras will see is about an acre. The total field of view of the cameras is 100 nautical miles square.

As part of the classification of spectral signatures, there are many ground truth sites scattered across the United States and in some foreign countries. The photos from the satellites will be transmitted to the receiving stations and sent by data lines to the National Data Processing Facility, Goddard Space Flight Center, Greenbelt, Maryland.

Normal distribution of the data is presently planned to be sent to 10 users, a browse file on the second floor of Building 23 at Goddard Space Flight Center, and archival storage at the same place. The preliminary description of the data handling system didn't include plans for application of the data toward the solution of day-to-day problems in the management of the earth's resources. However, NASA has made provision to supply data to institutions, such as universities, on a request basis through its users' services.

The reported capability of ERTS indicates an unusual bag of tricks. The promises and possibilities are exciting and mind-stretching. But, where do we stand in that elusive arena that turns promises into reality?

A brief inventory of what has been done to extend the information from collection to field application reveals that we're not ready or even preparing for the use of this technological windfall.

Among those who might benefit from ERTS, little is known about the venture. In agriculture, for instance, to our knowledge, no effort has been made to establish communications to help dissemination of the data. There are no provisions in the staffing patterns of Extension, USDA, or land-grant university staffs to accommodate reception, interpretation, and application of the data. One briefing conference was conducted in Washington, D.C., but no training workshops or other educational efforts have been held to start coordination or preparation to fully use the data.

In other words, a technological tool will soon be a reality—a tool that has been in the developmental process for more than a decade. But with present capacity its potential to provide useful information to the local farmer, forester, or water conservationist will be thwarted. In aerospace jargon, all the interfaces haven't been worked.

Several questions can be raised at this point. What is needed? What should be the division of responsibility? If further research is indicated, who should conduct it? Possibly, the most important questions to ask are: Does the farmer or forester want this kind of information? Can he . . . will he . . . use it? Answers to all these questions won't be attempted here. However, we're offering some opinions and observations in hopes of developing interest and concern.

Any effort to make practical use of information from ERTS needs to consider what can best serve the user such as a farmer or water conservationist. For instance, from among all the different kinds of information possible, what does each type of consumer need most? In what form is it most usable in the field? Since crop and forest production are dynamic processes, what time considerations are important? The answers to these and other questions should help identify what's needed. When this is determined, the effort will have a goal and can be organized toward that end.

To indicate the scope of the problem, let's examine the importance of time. Three time factors should be considered. One is a decay factor. The value of information decays or declines with time, so that value is greatest when the delivery time is shortest. A second factor is the time lapse from one collection to the next. ERTS is programmed so that a given ground sector will be photographed every 18 days. This allows time for field visits between orbits over a given area. The third consideration relates to the first. It's the phenomenon about which information is being collected. Different crops have varying growth habits. Disease and insect damage progress at varying rates. These factors contribute to the decay of information.

To produce and deliver the needed information, a system must be developed. The proposal offered here is based on dependable access to crop and livestock producers, forest managers, and water conservationists. The Cooperative Extension Service has access to these audiences and is capable of a national distribution mission. Extension's orientation to the land-grant system, together with its extensive state organization, qualify it for a major role in a distribution and educational effort.

Vital to the whole process is the procedure whereby infrared photos are transformed into field information. Reading the photos requires training and experience. Interpretation requires observation of the ground sites that have been photographed.

If the system is to work, there must be teamwork. Two of the main team members might be a NASA photo technician and an Extension specialist. The technician provides liaison between NASA and Extension, receives infrared photos, and works jointly with the specialist to interpret the photos. The Extension specialist, in addition to assisting with interpretation, supplies local Extension staffs and others with field information. He also cooperates with experiment stations to correlate field conditions to photo characteristics.

As stated earlier, the production and transmission of information must be timely. It may be necessary to make extensive use of WATS lines, radio, and TV. We may well see a TV reporting service similar to the Tiros weather photos.

The potential service to agriculture is evident, but not yet fully realized. The technology has been developed and partially tested. The infrared photos will become available with the launching of ERTS in 1972. It remains for someone to initiate and assemble the necessary interpretation and communication processes. NASA has opened the door a crack by inviting interested agencies and individuals to apply for receiving equipment. It's a gesture that encourages additional investigation and proposal. A fully supported reporting system still awaits development. Will Extension and NASA respond to this challenge?

Footnotes

1. *Earth Resources Technology Satellite Ground Data Handling System Preliminary Description* (Philadelphia, Pennsylvania: General Electric Company, 1970), p. 1.
2. *Ibid.*
3. I. R. Philpotts and Z. R. Wallen, "IR Color for Crop Disease Identification," *Photogrammetric Engineering,* XXXV (November, 1969), 1116-25.
4. C. L. Wiegland *et al.,* "Multibase and Multiemulsion Space Photos for Crops and Soils," *Photogrammetric Engineering,* XXXVII (February, 1971), 147-86; H. R. Condit, "The Spectral Reflectance of American Soils," *Photogrammetric Engineering,* XXXVI (September, 1970), 955-66; and Alden P. Colvocoresses, "ERTS-A Satellite Imagery," *Photogrammetric Engineering,* XXXVI (June, 1970), 555-60.
5. *Earth Resources,* p. 1.