

By Richard A. Phelps, Anderson, Clayton & Co., Houston, Texas

ABSTRACT

N76-17486

During the past few years Anderson Clayton has utilized in their remote sensing program imagery from several types of platforms from light aircraft to the LANDSAT (ERTS) satellites. We prefer inexpensive imagery over expensive magnetic tapes. Emphasis has been on practical application of remote sensing data to increase crop yield by decreasing plant stress, disease, weeds and undesirable insects and by improving irrigation. Imagery obtained from low altitudes via aircraft provides the necessary resolution and complements but does not replace data from high altitude aircraft, Gemini and Apollo spacecraft, Skylab space station and LANDSAT satellites. Federal government centers are now able to supply imagery within about thirty days from date of order and deserve to be commended. Nevertheless, if the full potential of space imagery in practical agricultural operations is to be realized, the time span from date of imaging to user application needs to be shortened from the current several months to not more than two weeks.

INTRODUCTION

My company and I sincerely appreciate the invitation to report our remote sensing activities at this Earth Resources Survey Symposium.

Mr. Ronald Reagan, before he became Governor of California, and when he was sponsored by a company heavily involved in the space program, used to present a stirring speech to groups all over the United States (1). My wife and I were fortunate enough to be in the Dallas Freedom Forum audience one night in February, 1962 when he was interrupted by applause 31 times during delivery of what came to be called "The Speech".

My original reason for mentioning "The Speech" was that after reviewing material for this talk I realized that more or less the same speech had been given when our company was invited to participate in remote sensing sessions in Tucson (2), Memphis (3), Phoenix (4), NASA-JSC (5), Galveston (6), and in Washington (7). Obviously it was time to prepare entirely new material. Of course, if there had been an opportunity to present the talk a few thousand times, with new slides, then Mr. Reagan's style might be emulated a little more than will be obvious today.

Before leaving the subject of Mr. Reagan's speech, an address I highly recommend to anyone concerned about the future of the country and the space program, let us use a portion of it to relate current world conditions to agriculture. On page 7 of the February 1962 speech Mr. Reagan quoted a former Director of the Budget as follows, "The greatest threat to our nation today is not Berlin nor is it Viet Nam, or the Congo, or Laos. It is the precarious situation of our balance of international payments and with it the potential erosion of the world's confidence in the dollar."

In 1974 the United States exported agricultural commodities valued at approximately 22 billion dollars while importing only about 10 billion dollars worth (8). Yet during the same period we exported nonagricultural goods valued at 75 billion dollars while importing 90 billion dollars worth. Thus despite almost a 12 billion dollar trade surplus of agricultural goods from efficient American agriculture we ended the year with a total trade deficit of over 1.5 billion dollars (9).

A thought provoking analysis of our agricultural exports by a former member of the Hudson Institute contains the following sentence in the preface, "American dominance of the agricultural export market is greater than Arab dominance of the petroleum market" (10).

The main body of the report provides impressive supporting evidence. Thus, the value of the dollar and our political influence in the world seems to depend on maintaining an efficient agricultural system. Furthermore, we must accomplish this in the face of increased problems created by people who appear to many agriculturists to do a remarkable job of concealing any knowledge they may have of agriculture. Yet these same people distinguish themselves by generating regulations which lead directly to increased food costs for all of us. America certainly needs whatever production efficiencies can result from the wealth of remote sensing data being generated. Let us turn to the practical application of this data.

1971-73 REMOTE SENSING ACTIVITIES

Our remote sensing efforts from the spring of 1971 through the fall of 1973 have been outlined in several reports (2-7), so I hope a brief summary will suffice.

Our main objectives have been to utilize color infrared photography and scanner data for (a) detecting potential areas of severe disease and insect infestation in cotton and (b) for improving irrigation, weed control, etc., in a wide variety of crops.

The initial experience with color infrared photography of commercial fields encouraged us to "back-track" to experimental plots where we could more easily correlate false color tones with irrigation treatments, cotton varieties, weeds, etc. When we returned to the study of commercial fields we were able to differentiate, via color infrared film, several types of weeds, short vs. long staple cottons, land leveling scars, water stress, inadequate irrigation, salinity effects, herbicide damage, wilt disease, etc. We are still unable to identify nematode damage in commercial fields via color infrared photography and have detected several unusual tone patterns which remain unexplained.

In earlier reports we also indicated that our choice of color infrared photography and infrared scanner data was governed by practical considerations. We still believe it was the proper choice but realize that other portions of the electromagnetic spectrum yield valuable data.

In previous talks we commented on the apparent dearth of qualified interpreters of color infrared (false color) film, at least as far as cotton is concerned. We still have not located the person who can look at film of commercial cotton fields and differentiate, for example, cotton stressed for water vs. cotton infected with nematodes.

The serious problem of excessive delays in obtaining satellite and other types of remote sensing data through the EROS Data Center was also mentioned in earlier reports. During the past few months the EROS Data Center has greatly improved their service and deserves to be commended. Until the time period from satellite sensing to user receipt is shortened to about two weeks, however, agricultural application of such data cannot achieve full potential.

1974 REMOTE SENSING PROJECT

During the summer of 1974 we filmed more than 10,000 acres of cotton in Central Arizona as part of our continuing program to detect and control a damaging boll rot problem and to improve cotton cultural practices.

In earlier reports we emphasized the serious nature of the boll rot problem. A particular type of hot weather-loving mold infests cotton bolls that have been previously attacked by insects and produces undesirable by-products in the unharvested bolls. These mold products remain in the cottonseed during harvest and survive the high temperature and pressure used to convert the cottonseed into cottonseed meal used for animal feed. If the cottonseed meal contains more than 0.000002% of these mold products the meal cannot be shipped interstate.

The small amount of mold products, 0.000002%, may be more easily perceived if viewed in the context of space, time and joy. Twenty parts per billion (0.000002%), or 20 micro-

grams per kilogram, is about 20 feet along a line to the moon or 20 seconds in 32 years. For the dry martini connoisseur it is 20 jiggers of vermouth in 1000 railroad tankcars of gin.

Extensive field sampling of cotton during the past few years has indicated that most of the boll rot problem in Arizona, for example, was confined to the lower elevations and appeared to be more of a problem near irrigation canals and citrus orchards. Since we expect high humidity near canals and know that citrus trees are planted in what are hoped will be frost-free areas we have some important clues to our problem. Nevertheless we were still unable to locate anyone who could with certainty identify which cotton fields contained seed with the mold by-products. The only way to be certain that cotton bolls in a particular field contained the mold products was to harvest several samples of 100 bolls each, remove the lint (gin), dehull the seed, grind the kernels and analyze the extracted ground kernels by a laborious chemical test called thin layer chromatography. With 425,000 acres of cotton in Arizona yielding over 260,000 bolls per acre (at 2 bale/acre yield) or 167 million bolls per section (1 square mile or 640 acres) of land, it is easy to see the impracticality of widespread field sampling by conventional methods.

Several years ago we tried to develop a more sophisticated system. A 70 acre field of Arizona cotton that Herb Schumann of the USGS had photographed with color infrared film on several occasions during the peak of the growing season was sampled extensively. We learned from that study that the mold products were more prevalent in the over-irritated portions that could be detected by heavy leaf canopy and crimson tone, and were essentially absent from water stressed (under-irrigated) portions.

In the summer of 1974 we extended the above study to more than 10,000 acres. Unfortunately, Mother Nature did not cooperate because we could not find an area within the 10,000 acres that displayed a high level of the mold products. The highest level found, however, was in an area of relatively rank, solid planted cotton. We are reasonably certain that improper irrigation, failure to dissipate humidity beneath the leaf canopy and poor insect control are major factors in producing the boll rot-mold product complex. We are also attempting to solve the problem by genetically altering the cotton plant.

Unfortunately we have not adequately measured the role of insects in the mold problem. Most of the boll rot and much of the insect damage is usually on the lower third of the cotton plant and shielded from view by the extensive leaf canopy. In addition, the boll rot and associated ultraviolet fluorescing lint are usually inside an unfluffed cotton boll and not detected until the boll is torn apart. Consequently we have been forced to employ indirect, rather than direct, means of detecting the condition by remote sensing. If the sophisticated and capable engineers are able to develop a direct and practical method for detecting internal boll rot and/or associated mold problems, they will receive considerable attention.

While this talk has concentrated on the boll rot aspect of our 1974 project, we did study and detect other serious cotton problems. Cotton stunted from presently unknown causes, root rot, water stressed cotton, unfavorable soil conditions, etc. were all clearly visible on the film.

One unexpected result from the 1974 filming was the detection of a 230 ft. x 100 ft. NW-SE oriented rectangle in one of the Arizona cotton fields. The rectangle had not been detected prior to developing the film despite considerable activity within and around the field. Within the rectangle the cotton was approximately a foot taller than surrounding cotton in the same field and displayed more wilt. High altitude January film of the same area indicated the rectangle may be at least partially visible when the field is fallow, but a ground check in April 1975 showed nothing but a slight ground depression in one portion of the rectangle. The purpose and origin of the rectangle remain a mystery, but possibly the archaeologists have a ready explanation.

"OVERSELLING" OF THE SPACE PROGRAM BENEFITS

During the past few months we have received several communications which contained criticism of the space program. The common complaint seems to be "overselling" of the program and particularly the capability of the LANDSAT satellite. It might be preferable to term it "improper selling". We have found LANDSAT and Skylab transparencies to be very helpful for (a) providing relative crop and soil conditions over wide areas, (b) permitting comparison of one or more crops between adjacent farms, (c) measuring relative acreage of a particular crop within a large area, (d) "learning the territory", etc. Magnetic tapes cannot substitute for imagery for some of the above objectives. If we need detailed data on weeds, irrigation, etc., we use large-scale aircraft imagery. There is no more reason to expect the LANDSAT satellite to detect small area weed problems than there is to expect the Queen Mary to tow a water skier. Realization of the proper role of each type of "platform" sensor, tape and image should reduce the complaints and increase the appreciation of this most valuable "tool" for agriculture.

REFERENCES

- 1) What Price Freedom?, Ronald Reagan, 27 Feb., 1962, Published by Dallas Freedom Forum, Fidelity Union Tower Lobby, Dallas, Texas.
- 2) Aerial Photography and Fungal Infestation of Cotton in Maricopa County, 7 Nov., 1971, Richard A. Phelps, Proc. 2nd ARETS Symposium, Tucson, Arizona.
- 3) Remote Sensing Project in Arizona, Richard A. Phelps, 11 April, 1972, Report to Spring Meeting of Research and Education Committee, National Cottonseed Products Ass'n, Memphis, Tenn.
- 4) Remote Sensing in Agriculture, 25 Jan., 1973, R. A. Phelps, West Coast Oilseeds Development Council Annual Meeting, Phoenix, Arizona.
- 5) Practical Application of Remote Sensing in Agriculture, 30 May, 1973, Richard A. Phelps, Skylab Press Conference, Johnson Space Center, NASA, Houston, Texas.
- 6) Practical Application of Remote Sensing in Cotton Production, 19 June, 1973, Richard A. Phelps, International Oil Mill Superintendents Ass'n, Galveston, Texas.
- 7) Remote Sensing and Agricultural Productivity, Richard A. Phelps, 29 Jan., 1974, American Institute of Aeronautics and Astronautics, 10th Annual Meeting.
- 8) 1974 Handbook of Agricultural Charts, Agricultural Handbook #477, Oct. 1974, USDA, Washington, D. C.
- 9) Personal Communication, 22 May, 1975, United States Department of Commerce, Houston, Texas.
- 10) Can We Avert Economic Warfare in Raw Materials? U.S. Agriculture as a Blue Chip, 1974, William Schneider, National Strategy Information Center, Inc., 111 E. 58th St., N.Y. 10022.

NEED FOR REMOTE SENSING IN AGRICULTURE

A-19

by Hosea S. Harkness, Cook Industries, Memphis, Tennessee

The preceding papers have told us the job can be done. Now, let's look at why it needs to be done. We hear and read daily in the news media that world population problems are leading to world food shortage.

First, let's set the stage as to why remote sensing is needed in agriculture and more specifically in relation to the marketing of agricultural commodities by looking at the 1960's. In 1960, we had enormous stocks of grains in the U.S. and throughout the world. Crop disasters developed early in the 60's in a few parts of the world. By mid-1960, our Secretary of Agriculture was telling us the United States had the responsibility of feeding the world. This was a little premature since there still existed means by which the producers of the world could recover from this disaster. Expanded crop land area, coupled with good weather, led to the recovery, and once again grain surpluses occurred. However, this recovery was only for the short run.

Moving into the 1970's, the U.S. was immediately confronted with a combination of corn blight and drought. This was probably one of the worst crop disasters that had confronted a single crop since the potato famine in Ireland in the 1800's. In 1971, grain crops were good throughout the world. Then 1972 came with adverse weather early in the year in Australia and Argentina. A poor winter in the U.S.S.R. was followed by a poor growing season for small grains. Suddenly the fish were gone from the coasts of Peru. In late 1972, excessive rain hit the U.S. harvest. Early 1973 drought occurred in South Africa followed by excessive rains at harvest time in Argentina. Thus, suddenly the demands for grain were greater than the 1972 supplies and large quantities of the then existing surpluses were utilized.

In 1974, once again there were many problems as excessive rain delayed planting of the U.S. crop followed by a mid-summer drought and early crop-killing frosts. Excessive rains have once again hurt the Argentina harvest in early 1975 and Australia, which had poor weather last year, is continuing to be confronted with dryness. Late planting seasons occurred in Europe while severe drought sharply reduced production in North Africa.

Along with this, we had the affluent societies of the world in 1972 demanding less carbohydrates and more proteins. The free economies had more money to spend and the state controlled economies wanted to upgrade their standards of living.

The result has been the depletion of world surpluses. We have not been able to recover quickly as we once could. Land is now a limiting factor and where there are expansion areas in the world, they are slow in developing due to political or economic reasons.

In looking to what lies ahead, we have Bangladesh where there are seven births each minute; India where the population density is over 425 per square mile. Medical care in many parts of the world extends the survival of infants considerably from that of a few years ago. World population by 1980 will be up 13 percent and we will have over 4.25 billion inhabitants.

This is the stage that is set. To solve this situation, we need an informed public. Why an informed public? Because an informed public operating in the market place provides an orderly market place. There will be less risk involved and all involved, even the farmer, have the opportunity to maximize their profits.

In looking at today's world information systems, we have a few countries that are sophisticated data collectors; we have a group of countries that may be sophisticated but they won't release their information because of political reasons; and there are countries with essentially no information. We must keep in mind that unbiased statistics are not manufactured but are collected.

With an informed public, the farmer and agri-business community can react. Today, we are at a disadvantage in the world because of lack of information. If we knew the exact situation, transportation systems could distribute agricultural commodities more efficiently. The merchant could have a competitive advantage and operate on a lower margin. The affluent consumer throughout the world would not have to over-react and hoard foods. The best examples are the scare we had on meat two years ago and more recently the sugar shortage.

If we are to solve these problems, we need a better worldwide information system. Little can be done to improve the sophisticated countries, only their warning system can be improved. However, much can be done to improve the systems of the unsophisticated data collectors of the world.

Remote sensing offers the basis for a uniform information system. It has the ability to give worldwide coverage on a continued and timely basis.

The kind of information that remote sensing could provide to the sophisticated countries would be an early warning of crop stress; be it moisture, disease, insects, or crop progress development. In all other countries, remote sensing could provide a basic cropland inventory so that everyone has a common base to work from. Once the base was obtained, these countries would also need early warning of crop stress factors.

After we have learned how to handle the crop stress factors, we will learn how to develop crop yields, which countries that are not currently surveyed by other means could utilize. Other disciplines working on soil moisture and temperatures, etc. would be utilized in understanding crop yields.

In conclusion, we need an information system that collects crop data on a comparable and timely basis. This system must then inform the individual countries and the world so that the market place can be alerted to taking corrective action. Again, remote sensing offers that basis.