

[COST/BENEFIT ANALYSIS--
A LEGISLATIVE BRANCH VIEWPOINT]

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Frederick Chasnov

U.S. General Accounting Office
Washington, D.C.

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ABSTRACT

This paper presents the author's involvement with remote sensing programs conducted by the U.S. Department of Agriculture, National Aeronautics and Space Administration, and National Oceanic and Atmospheric Administration. The author participated in General Accounting Office reviews of the Landsat program in 1975 and LACIE program in 1977 and conducted an investigation of the AgRISTARS program for the Senate Committee on Appropriations in 1979. The paper examines cost/benefit analysis issues for each program and presents suggested improvements for future remote sensing projects and programs.

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1. THE LEGISLATIVE BRANCH

The legislative branch of the Federal Government constitutionally consists of only the two chambers of Congress, the House of Representatives and the Senate. In fact, the Congress is much more than its members. It also includes committees and subcommittees composed of members and staff. In addition, each member has personal staff to assist him in the performance of his duties. The result is an arrangement that oversees the activities of the executive branch with considerable overlap, both between and within the House and the Senate. Although the Congress has many staff members, each is generally prohibited from conducting an extensive examination of any particular program because of his/her large individual range of responsibilities.

To satisfy this oversight requirement, the Congress has established several agencies. The Office of Technology Assessment, Library of Congress and General Accounting Office can all be called upon to provide assistance to the Congress. In addition, the Congress, itself, has established investigations staffs as part of each chambers' appropriations committee. All of these groups and agencies help the Congress by providing detailed reports and briefings to members and staff.

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The General Accounting Office provides the vast bulk of this assistance. Its large cadre of over 4,000 professionals in a variety of technical and managerial areas makes it possible to be responsive to congressional requests. In addition, through its self-initiated work, the GAO can bring

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significant issues to Congress without the need for a formal request.

2. LANDSAT PROGRAM REVIEW

In 1975, the General Accounting Office initiated a review of the Landsat program in response to congressional interest. For this review the Landsat program included the production of additional satellites, production of Landsat photo-products and computer compatible tapes, and a large variety of NASA-sponsored technical investigations. Our overall reporting objective was to provide an information report on this new remote sensing technology which would assist the Congress in determining the direction of this program. A primary specific objective was to address whether an operational Landsat program was warranted.

At the time of this review, there were two contractor studies concerning the costs and benefits of an operational Landsat system. Landsat applications are very diverse including areas such as forestry, hydrology, snow mapping, pollution monitoring, mapping, and classification of cropland and rangeland resources. Both of these studies were very comprehensive in their scope and treatment of applications. They did reach somewhat different conclusions, despite their similarity in approach. The differences were primarily due to differences in the degree of possible achievements by a satellite-based remote sensing system. The study sponsored by NASA established benefits at a level which supported an operational system while the second study contracted by the Department of the Interior did not define a range of benefits which clearly supported an operational Landsat system. The major difference in the benefits was different assumptions about the ability of Landsat data to improve crop production forecasting. In fact, well over one-half of the projected benefits in the NASA-funded study came from improved agricultural forecasting based on assumed improvements in technology.

At the time of this early review, the technical possibility of achieving improved forecasting through remote sensing was uncertain. While many investigations had been conducted in this area, the results were not uniform and systematic methods were not always employed. Further, we recognized that possible improvements in acreage estimates might be of little value if yield estimates could not be improved.

Both studies have been criticized for particular portions of their economic analyses. It is unfair to be critical of the contractors because the tasks assigned were tremendous given the time and funds allotted. Despite a considerable amount of additional study, many of the benefit areas have

yet to be quantified with the degree of precision required for clear decision-making.

The studies were incomplete in one aspect, cost analysis. NASA provided the contractors with estimated costs of the satellite-program but did not estimate related data processing and analysis costs. The proposed AgRISTARS funding at over \$300 million over a six year period and the LACIE cost of over \$50 million over four years indicates that this technology is not only expensive to provide but expensive to use as well. As a result, we advised that a decision to make Landsat an operational program was premature.

3. LACIE REVIEW

In 1977, the GAO conducted a self-initiated review of the Large Area Crop Inventory Experiment (LACIE). The term "self-initiated review," means GAO undertook this assignment without a specific congressional request. It was a logical extension of our continuing work to inform the Congress on the Landsat program.

The Large Area Crop Inventory Experiment was initiated in 1974 after early results following the launch of the first Landsat in July 1972. The program's objective was to determine the feasibility of improving foreign crop production estimates through the use of Landsat data and weather information. At the time of our review, LACIE had completed estimates for the U.S. Great Plains wheat crop in 1975 and 1976, and the Canadian wheat crop in 1976. LACIE had also estimated the 1976 Soviet wheat crop but the results were difficult to evaluate because the estimates were for only an "indicator region." Official Soviet figures for the "indicator region" were not yet available.

From discussions with LACIE project officials and others knowledgeable about remote sensing, we found several problems with the methods employed. First, the project used a technique called "ratioing" to estimate spring wheat which, upon analysis, would not allow the achievement of the 90/90 criterion (at harvest production estimates should be within 10% of the final USDA figures, 9 years out of 10). Ratioing to be described simply, is to attribute to wheat, its historical percentage of cropland. Secondly, the yield forecasting methods utilized by NOAA relied on regression models of aggregated weather data to forecast yield. These were insensitive to extremes and changes according to earlier USDA studies. The available results tended to support the contention that these methods were of limited value.

Based on the results obtained to date, we believed that an operational program based on this technology was not war-

ranted. Rather, it appeared that the LACIE project was premature in its initiation and a research-oriented approach would have been more useful. We were encouraged, however, that as part of the LACIE project, a comprehensive cost/benefit analysis of improved foreign wheat production forecasting would be attempted.

Under the Memorandum of Understanding between the three agencies, USDA would conduct a cost/benefit analysis of the proposed technology. Certain key elements were required:

- the costs of the proposed system,
- an understanding of the internal use of crop production forecasts within USDA,
- the historical accuracy of USDA's forecasting methodology,
- the accuracy of the new system, and
- the means to quantify the additional benefits from a new improved technology.

The LACIE project had completed the first four steps by the end of our review.

We had some minor reservations with the method used to calculate the accuracy of the current system. Primarily, these centered on the assumption that the current forecasting methodology resulted in normally distributed errors. We felt that the errors tended to be more uniformly distributed which resulted in underestimating the accuracy of the current system. Overall, the analysis was useful because it treated area, yield, and production forecasting errors separately.

The analysis of current forecasting errors did show that for certain countries like the Soviet Union, production forecasting errors were almost solely due to errors in yield estimation. We reached the conclusion that improvements in forecasting in several economically important countries could be accomplished through improved yield estimation alone. This was upsetting to NASA officials. They contended that the final Soviet estimates of production were reliable but the accuracy of the area and derived yield estimates were not. They questioned the validity of the analysis because the USDA final estimates reflect the final Soviet figures which are suspect. Since that time, the position of NASA officials has changed on the issue of the accuracy of Soviet acreage and derived yield estimates.

The assessment of the internal USDA use of foreign crop production estimates showed that, under the existing policies, improved information would have little impact on decision-making. USDA actions, such as set-asides, have to be made before domestic farmers begin fall planting, usually in August or September. This is also before the other northern hemisphere producers begin planting as well. Due to low levels of reserve grains, each crop year has an independent impact on price. Most USDA officials surveyed tended to believe that the major benefits to improved forecasting would be in stabilizing the commodity markets.

While we were not in complete agreement with the accuracy assessment of the current forecasting methodology or the ascribed improvements of a LACIE-type system, we were told that any model developed could be adjusted to quantify the benefits of a range of performance improvements. USDA had tasked its Economic Research Service (now part of the Economics Statistics and Cooperatives Service) to develop the means to quantify the benefits of improved wheat production forecasting. At the end of our review, this effort was in the early stages. We were aware that the task was extremely difficult because the benefits had never been adequately modeled. The LACIE Economics Evaluation Team planned to utilize some new models which we reported needed to be evaluated carefully before the results could be used meaningfully.

4. AGRISTARS INVESTIGATION

In March 1979, the GAO received a request from the Chairman of the Senate Committee on Appropriations for direct assistance in one of its investigations. In response, I was detailed to the Investigations Staff of the Committee. The Appropriations Committee needed assistance to evaluate a new remote sensing initiative utilizing Landsat and other remote sensing techniques called the Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing (AgRISTARS). The AgRISTARS proposal was a costly initiative--\$317 million over 6 years without escalation to be funded by USDA, NASA, and NOAA. To the Committee, this was a new start which required an investigation prior to funding approval.

In contrast to a GAO audit, the investigation by the Committee had a restrictive time constraint in order to be available during deliberation on the budget requests. The GAO LACIE review took seven months of direct work by two auditors while the AgRISTARS investigation was completed in less than 10 weeks. AgRISTARS is a much bigger effort than LACIE in terms of both dollars and scope. Besides a foreign commodity production forecasting project, it includes projects on domestic crops and land cover, renewable resources inventory, soil moisture and several others. Each has a unique research history and employs different technical strategies.

There were some common threads to the AgRISTARS projects. After some investigative work, it was possible to categorize them into three categories:

- Projects and project segments related to extending LACIE techniques to other crop/country combinations for foreign crop production forecasting.
- Projects and segments characterized by proven technological potential but in need of development for large scale application.
- Projects and segments characterized by the need for basic research to make assessments concerning potential.

From an auditing viewpoint, there was very little to be analyzed for the basic research projects. Auditors need some results to form opinions and those available were inadequate to form a meaningful assessment. Other projects had varying degrees of preliminary research work completed. The results indicated considerable potential to meet their AgRISTARS objectives. In all of the projects, there was one significant question that could not be answered. Assuming it can be done, is it worth it?

For those projects and segments characterized as having proven technological potential or requiring basic research, no cost/benefit analyses were available to support the budget. Several AgRISTARS officials stated their belief that cost/benefit analyses of research projects cannot be done until the level of performance is known.

For the foreign crop forecasting projects, I had hoped to rely on the LACIE cost/benefit analysis. Unfortunately, this effort was terminated. USDA officials provided the following reasons as justification for their decision:

- Program direction changed entirely from concentration on development of forecasts to research.
- Inadequate data for conducting an objective and reliable cost/benefit analysis:
 - Additional data needed for proper evaluation of current systems.
 - Absence of data on expected reliability (accuracy) of a LACIE-type system.

- Earlier studies were criticized for these shortcomings.
- Research results from AgRISTARS will provide a part of these data.
- Final 1979 estimates will become available in 1980 to give a 7-year record for measuring the reliability of the current system.
- During the intervening period, the following examples of potential benefits can be identified:
 - 1977 Soviet wheat crop,
 - 1978 Brazilian soybean crop.

The examples of potential benefits were similar in that prices rose throughout the marketing period in at least partial response to information about production shortfalls in other countries. The "benefits" of improved information arise from earlier increases in commodity prices during the marketing season. The Federal Government benefits through lower wheat deficiency payments and the farmers benefit from higher prices for their soybean crop. But these are basically income transfers from the final consumers to the farmers and Federal Government. In addition, if an increase in foreign crop production was detected earlier (or an underestimate improved) it follows that farm prices would drop sooner. Farmers would get lower prices for their crops and wheat deficiency payments by the Federal Government would increase. The examples do not, in themselves, justify the program.

The termination of the LACIE cost/benefit analysis was disturbing. It had been our expectation that the analysis would lay the groundwork for realistic quantification of benefits from improved public information. USDA, through its variety of publications, disseminates its production estimates to interested members of the general public. In the commodity markets, there is a loser for every winner. Any advantage a party may have from improved information is diminished if others have the same information. Very little economic research has been done on the benefits of improved public information.

There were a number of reasons which led us to suggest that the Senate Committee on Appropriations withhold funding for the foreign commodity production forecasting portion of AgRISTARS. Certainly, the technical problems encountered in LACIE and the retreat to a research posture in AgRISTARS played a large part in our decision. However, the lack of

a meaningful cost/benefit analysis was a significant factor. Whether the technical goals of AgRISTARS could be met or not, their worth was unknown.

5. CONCLUSIONS AND SUGGESTIONS

In each case weaknesses in available economic analysis played a significant role in the opinions and recommendations made. The lack of adequate assurance of the net benefits, if any, to be derived has played a major role in the GAO decision not to endorse an operational Landsat system. We did not endorse an operational wheat forecasting system based on LACIE techniques partly because of the lack of a meaningful economic analysis. As indicated earlier, the inavailability of a responsible economic analysis proving significant benefits from improved foreign crop production forecasting was a major factor in the suggestions to the Senate Committee on Appropriations.

If inadequate economic analysis is not going to continue to prove a hinderance in remote sensing research and development, a number of improvements need to be made. First, the key decision makers have to be convinced of the importance of economic analysis. The examples in this paper show the importance placed by the legislative branch on cost/benefit analyses. The approval of the Congress is required for these programs and they are increasing their degree of oversight.

Therefore, some type of cost/benefit analysis should be available for each new program. Such an analysis need not always be detailed, but should answer the following questions:

- What is the cost of the proposed system or development effort?
- What is the performance of the current system?
- What is the possible or probable range of performance achievement of the new system?
- How will improved information be used? And what benefits will accrue?

Another important aspect is the selection of the group to do the cost/benefit analysis. Ideally, the independence of the economic evaluators should be beyond challenge. A leading NASA official confided his opinion that there was little use in contracting a cost/benefit analysis because they always strongly support the proposed program. The true usefulness of economic analysis is derived from thorough evaluation of the assumptions and methods employed. Where the analysis is too complex or detailed for all the end users

to evaluate, it is incumbent upon the sponsoring agency to provide for meaningful evaluations. The LACIE Economic Evaluation was probably an ideal structure, since the Economic Research Service of USDA did not have a vested interest in remote sensing. If the analysis had been completed and then critiqued by outside consultants or contractors, it could have clarified the important issue of benefits from improved foreign crop production forecasting.