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REMOTE SENSING FOR AGRICULTURE, SYNOPSIS OF EXPERIENCE AND RECOMMENDATIONS FOR PROGRAM REVIEW*

I. History and Background -

A. Remote Sensing For Agriculture (Project no 931-1224)

-- PASA agreements governing project negotiated August, 1978 and amended August 1979. The cooperating USDA Agency is the Statistical Reporting Service. (PASA AG/DSB-1224-6-78)

-- Projected termination date December, 1983.

-- Dollar amount authorized by AID through L.O.P., $2,209,500. All available funds projected to be dispersed by December, 1983.

-- At time of P.P. design, major program focus of the Office of Science and Technology was application and use of advanced technology. In this case, technology growing out of the LANDSAT programs. Later phases of the project were to include direct estimation of crop production using satellite imagery and computer technology.

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-- A second priority of the Office was sponsored research. Consequently, the scope of work called for USDA/SRS to develop a "research design" for any work that would be required to adapt this technology to conditions in AID client countries.

The Project was to consist of four phases in cooperating countries:

Phase 1. Construction of area frame for a region or all of the country.

Phase 2. Use of frame for one or more pilot sample surveys with assistance in instrument design, analysis and summary.

(Where Phases I and II were completed:

Phase 3. Direct measurement of crop areas ~~for~~ using LANDSAT imagery.

Phase 4. Agro-meterological (AGROMET) models designed for use in crop yield estimates.

All of these activities are part of USDA/SRS domestic programs and are also used by USDA in making crop estimates for selected foreign countries of strategic, political or commercial importance.

The USDA is the lead department in a joint US Government program for, "Agriculture and Resource Inventory Surveys through Aerospace Remote Sensing (Agri STARS). Participating departments are Commerce, Interior, and NASA. AID is a participant observer.

The research design component was expected to provide a technical scope of work for a follow-on research project that would develop and demonstrate appropriate methodolgy for phase III and IV activities suited for use in low income countries. These differ from developed countries in that fields tend to be smaller, different crops and crop combinations are used and they are for the most part tropical countries. It should be emphasized that phase III and IV activities require functioning statistical services to provide ground truth data and information for sensor calibration.

USDA, with AID concurrance did not prepare a scope of work for this new project for the following reasons:

1. The performance of the early LANDSAT satellites proved to be disappointing and toward the end of the period the satellites were not providing current enhanced imagery. Therefore digital classification would have been difficult if not impossible. Older images were used as base maps for some countries as an aid in stratification only.

2. About 1980, the program focus in the Development Support Bureau shifted from advanced technology application and research toward mission support. Because of the high and growing demand for Phases 1 and 2 activities, USDA was authorized to use PASA funds for additional technical assistance.

II. The Area Frame Approach to Data Collection and Analysis

In brief, the area frame project as implemented by USDA/SRS included the following steps:

1. Basic frame construction using maps, air photos and enhanced satellite imagery;
2. Drawings samples of segments to estimate population parameters;
3. Design and application of survey instruments;
4. Summary and preliminary analysis of results;
5. Application of statistical procedures to estimate confidence intervals and tests of accuracy;
6. Evaluation of utility of data/information by end users; and
7. Training of administrative and field staff.

Before work was initiated, a PASA team member(s) would visit the country to meet with government officials responsible for agricultural sector data collection and analysis to determine their interest in the program and their perceived data priorities.

In each country, a memorandum of understanding (MOU) was negotiated which spelled out the contributions to be made by USDA, the host agency and by USAID if additional funding was provided from a bilateral project. Each MOU specified the disposition of the data obtained. In no case did SRS bring the data back to the U.S. for use by USDA analysts.

Second, a district or region was selected for initial frame construction, one or more surveys were carried out, data were summarized and the results published.

In all countries assisted, hands-on training was carried out. In no case did the USDA staff physically do the necessary work and no data was processed outside the host country. The PASA provided mini-computers to the host country institution, and USDA developed software to facilitate summary of field surveys. As conditions vary substantially, among countries "cook book manuals" were found to have little value, although several guides were developed. SRS is currently working with OICD's International Training Division in the design of two short courses; one targeted at program managers and the second targeted at field level technicians. Both are to be available in FY 84.

Discussions with SRS personnel closely associated with the PASA has brought out a number of points for further analysis.

1. Technology in the area of remote sensing and data processing and management remains highly dynamic and does offer significant opportunities to: a) reduce the costs of data collection without loss of quality; b) substantially increase the quality of data for the same or slightly greater expenditure; and c) offers the only real possibility to monitor trends in the environment at reasonable cost.

2. The area frame sampling package is not a turn key operation. It has been introduced into host country agencies of widely differing levels of sophistication. Because the felt need for more and better data bases increases with development (and the cost of poor data becomes absolutely greater) there is a need for programs sponsored by some international entity(s) working to continually up-grade the institutional and individual skill levels of collection/analysis systems. The skill package is not just book learning but, more importantly, the management and integration of data/information systems within public services.
3. In the USDA, there is an appropriate division of responsibility between the Economic Research Service (ERS) and the Statistical Reporting Service (SRS). In principal, ERS (and Congress) determine what data bases, relating to current agricultural information, are required. SRS determines the best methodology to be used and collects, summarizes and publishes the data. ERS, then is responsible for policy analysis and projections and prepares various situation (current) and outlook (future) statements. The same division of labor is recommended for LDC's, at least in concept, and a complete technical assistance package (although not necessarily the same project) would need to provide technical assistance in both data collection and data anaysis.

Three possible program shortfalls have been indentified; 1, it is possible that not adequate attention was given to assist the countries in determining the most constraining data/information base needs. Ministry or

agency officials in all cases determined both subject and regional points of departure. 2, little attention was given to assure that optimum use of the data was made by public and private sector decision makers. In some of the countries assisted, other AID projects were providing assistance in data analysis, use and dissemination. These include Philippines, Cameroon and Botswana and in a new project in Sudan. 3, the Fall 1981 evaluation indicated that greater use could have been made of enhanced satellite imagery in stratification, and more attention should be given to training in this area.

III. Suggestions for Program Review

The program review should examine the original project assumptions (or sets of assumptions) and to the extent possible, identify indicators of the validity of these assumptions.

A. Priority of Improved data/information systems for AID client countries

Modern nation states, regardless of their level or stage of economic development, require some minimum set of statistical data and information at some standard of accuracy, timeliness and coverage. The assumption is that the process of economic growth and the allocation of limited public and private sector resources can be enhanced by improved information. Conversely, there are substantial identifiable costs of not having adequate information available to both the public and private sectors.

The cost of inadequate data tends to become more evident as economies become more complex and in countries with larger (in absolute terms) economies. As its primary application is in the collection of current agricultural and rural information, its relative importance may be greatest in countries where agriculture is the dominant ecomonic sector and/or agricultural exports are a major source of revenue or income instability.

B. Superiority of Area Frame Sampling Approach to other sampling procedures

Area frame sampling is not a new procedure, as it has been in use by USDA/SRS for roughly 40 years. However, most countries continue to rely on list frames rather than area frames as the primary basis for sampling and enumeration.

The assumption is that for the purposes of estimating current agricultural data, the area frame will provide more timely and cost effective estimates than list frame procedures. While for some purposes complete census enumeration or use of list frames may be indicated, most priority data can be estimated using an area frame.

An indication of the range of data sets which are amendable to estimates using an area frame approach are shown in Figure I.

C. Process of technology transfer and institutionalization

Institutions, as well as individuals, develop skills and programs incrementally. One indicator of the value of area frame sampling procedures would be its adoption and use by host country agencies for progressively larger and more sophisticated uses and for a wider range of data sets. More objective indicators would include the timeliness, objectiveness, precision, and reliability, of data collection prior to, and after project implementation. The following can be used as means of verification of these criteria:

a. Timeliness - frequency of publication of survey results, and time lapse from data collection to publication.

b. Objectiveness - make random spot checks to verify accuracy of field data. Evaluate quality control measures employed.

c. Precision and reliability - compute sampling errors, identify possible sources on non-sampling errors, and compare data with other data sources.

The assumption is that countries that have received assistance should either currently, or upon further evaluation, show improvements in these indicators.

D. Extension of state of the art technology to selected AID countries

The original project concept anticipated that rapid progress in state of art technology in remote sensing and computerized systems of data summary would occur, which would lead to their adoption and use in some AID client countries. This technology provides a new tool to more rapidly assess crop acreage and conditions, advancing the date by which reliable crop production estimates can be made. Second, it can be used as an aid in mapping natural resources and monitoring trends in resource use and quality. Area frame sampling is a necessary companion program to provide the "ground truth" to tune sensors and validate results. The assumptions are that:

a) the "state of art" will continue to improve, leading to its use by additional countries and/or regionally based organizations;

b) the uses to which area frame sampling procedures may be applied will expand in number and importance with time and the level of development; and

c) the US will continue to be a leader in this technology and its application.

Figure I. Types of Surveys and Required Frequency

Type of Survey	Beginning Date	Frequency
Area yield and production of principal cultivated crops	July	Annually
Cattle, birds on feed (type, age, birth, death, slaughter, sales and production)	January/July	Twice yearly
Production and yields of principal crops	January year 2	Annually
Objective yield estimates of principal crops	June year 2	Annually
Quantity, price paid and received by producers; utilization of inputs	June year 2	Annually
Household surveys	year 3	Annually
Labor	year 2	Annually
Cost of production	year 4	5 yr intervals
Food consumption	year 5	5 yr intervals
Land use and ownership	year 5	5 yr interval
Management practices		5 yr intervals
Levels of technology		5 yr intervals
Credit and marketing		5 yr intervals
Energy use		5 yr intervals
Irrigation studies		5 yr intervals
Forest Inventories		5 yr intervals
Income and expenditures		5 yr intervals
Other information as needed		5 yr intervals

IV. Issues for Program Evaluation

A. Range of Application and Use

1. What aspects of the area frame sampling approach to agricultural and rural sector data collection and analysis make it appropriate for use in AID client countries?
   - -- What data/information sets for which AFS is most (least) appropriate?
   - -- Is there imperical information that AFS has proved to be more (less) cost effective than list Frame procedures formerly used?
   - -- Are there indications that human resources (skill training) and materials (equipment) required for AFS can easily be adopted and used when list frame samples are the method of choice?

2. Is there a minimum level of institutional capability (and level of development) below which an AFS approach is not appropriate? Should it be promoted in small, poorly endowed countries, as well as larger, more institutionally sophisticated ones?

3. Use in tropical and low income settings,
   - -- Progress (problems) with its use in arid-semi, arid, mountainous and humid tropical agroecological regions.
   - -- Progess (problems) in frame construction and field identification of segments by field enumerators in each zone.

-- Progress (problems) where very large numbers of small holdings and plots per segment.

B. Institutionalization and Training.

1. Approach to overcoming Constraints to Institutionalization and use of AFS (Examples)

-- Lack of experience with AFS approach and/or commitment to other procedures.

-- Within the agency being assisted, less than desirable data management and processing capability.

-- Low levels of prior training and motivation of staff.

-- Poor quality of base maps, aerial photography and, where used, satellite imagery.

2. Categories and comparitive effectiveness of Technical Assistance modes

a. Resident team:

-- qualified specialists ~~in service~~

-- local support assistant

b. Periodic TDY assistance at critical points in process to complement resident specialists, if any.

c. Relationship between host agency capability, types of data sets to be estimated and optimum mix of resident and TDY assistance.

3. Human resource development - Types of staff development training employed and effectiveness:

a. Hands-on training in-country--learning by doing under specialist guidance.

b. Hands-on training in US (or other country) in agencies with similar programs.

c. Short courses: content and duration matched with job tasks of participants.

d. Training evaluated as being useful by program managers and participants.

4. Administration of Program

-- Advantages/disadvantages of negotiated cooperative agreements between USDA, host agency and AID indicating services to be provided, time frame and budget prior to commencement of project on expanded activities.

-- Advantages/disadvantages of linking US agency with domestic responsibility for collection of current agricultural information with host country agency with similar responsibilities.

-- Responsiveness of USDA/OICD and SRS to AID/W, USAID and host country requests for assistance.

C. Recommendations for Program Continuation

1. Opportunities to leverage transfer of the area frame sampling approach through cooperation with other bilateral donors, FAO and regional organizations:

-- Does the AFS approach, and the data set prioritization to which it applies, meet with the general acceptance of others promoting improved data information packages such as FAO, IICA, etc.?

-- If not, how can cooperation and standardization be improved?

2. Complementary/Cooperation with other AID centrally funded, and bilateral and regional projects and programs

Examples

-- Forestry and related natural resources inventory
-- Soil survey and management
-- Regional remote sensing
-- Agricultural sector assessment and planning
-- Technology transfer, farming systems research
-- National food policy and PL-480 programs
-- Application and use of state-of art technology to L.D.C. development

-- Demographic and social indicators

3. Suggested key elements of new centrally funded project

a. Ongoing and new program

-- Updating LDC national staff in new developments in statistical procedures, data management, etc.

-- Troubleshooting by specialists to overcome methodological or program management problems.

-- Training of new employees as they enter service.

-- Identifying "best" hardware and software packages for use in area frame sampling programs

-- Sponsorship of regional workshops

b. New (or elementary) programs ?

-- Problem identification as a prelude to PID and PP design.

-- Exposure/familiarization of host country staff to area frame sampling methods.

-- Design and presentation of short courses and preparation of instructional manuals and field guides.

-- Refinement of frame construction procedures for difficult environments.

-- Promotion of area frame sampling methods for application to natural resources mapping and monitoring.