AREA SAMPLING FRAMES FOR AGRICULTURE IN DEVELOPING COUNTRIES

MAY 1981

AREA SAMPLING FRAMES FOR AGRICULTURE IN DEVELOPING COUNTRIES— TECHNICAL ASSISTANCE BY THE ECONOMICS AND STATISTICS SERVICE OF THE UNITED STATES DEPARTMENT OF AGRICULTURE UNDER PARTICIPATING AGENCY SERVICE AGREEMENTS WITH THE AGENCY FOR INTERNATIONAL DEVELOPMENT

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FOREWORD

The Statistical Reporting Service, presently part of the Economics and Statistics Service (ESS) of the U.S. Department of Agriculture (USDA), has used small agricultural areas as sampling units for agricultural estimates for about 35 years. USDA has also done basic research to improve the methodology of area sampling frames and their use, and at present the frames are a tool for the efficient production of a wide array of agricultural estimates in the US.

Funds for the USDA work referred to in this report were provided by the Agency for International Development (AID), under its project on Remote Sensing for Agriculture.

Many people have contributed to the success of this project, but Ronald Steele, Robert Parr, Harold Huddleston, Michael Craig and Ray Luebe should be singled out as having made major contributions.

Special thanks are also due to Charles Paul, the AID project officer for the Remote Sensing for Agriculture project, and to William Kibbler and Charles Caudill, USDA for many suggestions and much encouragement.

Thanks are also due to Joseph Willett for preparing this comprehensive report. The evalutions and recommendations (explicit or implied) contained herein are his personal responsibility. The first 3 sections of this report are a general discussion and summary of the ESS Project and its potential benefits. These sections are followed by a report on each country involved, arranged in alphabetical order.

William Wigton
Project Director

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INTRODUCTION

This report summarizes activities and accomplishments of the Economics and Statistics Service (ESS)[1/] . U.S. Department of Agriculture under contract with the US Agency for International Development (AID) to assist developing countries in preparing and using area sampling frames (ASF) in agriculture. An "area sampling frame" is a breakdown of the land area of a country into units of size and location appropriate for sampling. Aerial photographs and Landsat remote sensing images are used in dividing the land area. (10) The area frames are designed to be used in the collection of information from interview surveys of farmers; they may also be used to sample remote sensing data. Area frame samples are a well-developed, efficient technique for collecting such information.

Participating Agency Service Agreements (PASA's) covering this work were signed in August 1978 and August 1979. After construction of the area frame in a country, USDA/ESS assists the government statisticians, on a limited demonstration basis, in conducting a field survey to gather data from the area frame. Several of the field surveys have been carried out, and others are planned for the near future. ESS is also expected to carry out training activities to transfer the relevant technology to personnel in the countries involved.

The construction of the area frames has been designated as Phase I of a planned multi-phase project, with the field surveys (to include such data as crop acreage, crop yields, number of livestock, farm improvements, irriga-

1/ Formerly Economics, Statistics, and Cooperative Service, as indicated in the PASA's.

tion, etc.) being designated as Phase II. ESS was expecting to draw on its experience in Phases I and II to prepare a feasibility study on Phase III (computerized classification of agricultural areas using remote sensing data) and Phase IV (agricultural crop yield models using weather and other data). However, at the time of this report, it is uncertain whether the feasibility study or Phases III and IV will be carried out.

Under this project ESS has thus far assisted 12 developing countries in the preparation of area frames. National area frames have been constructed in Jamaica, Costa Rica, Tunisia and the Dominican Republic (these were mission-funded projects that were supported in the late stages by this project). Construction of national frames has been initiated, but not completed, in Bolivia, Philippines, Indonesia, Morocco, Sierra Leone, Liberia, Sudan and Ecuador.[1/] After investigation, it was decided that data collection and construction of frames is not feasible at present in Paraguay, primarily because ESS was unable to obtain essential commitments from Paraguay government agencies to work together on the project. ESS decided that without such commitments it would be unwise to proceed.

Under this project, intensive training in area frame construction has been given to key personnel in a number of countries.

Numerous people have contributed to this project. Those who made major contributions to the activities in a particular country are indicated in the following report on that country. William Wigton is Director of the USDA work on the project, assisted by Robert Parr. Charles Paul is the AID project officer.

BACKGROUND AND OVERVIEW

In less developed countries the agricultural sector still dominates the

1/ Work with Sudan on a frame has only begun, and therefore is not covered in this report.

entire economy. In many countries agriculture produces more than half of the total economic output, and requires the labor of two-thirds or more of the labor force. In recent years it has become recognized that high potentials for agricultural development and pressing needs for more agricultural products make it imperative to give higher priority to agriculture in national plans and in international economic aid efforts. Also, many students of development now believe that with appropriate government policies, programs, and information, small farmers can make major contributions to a more productive agriculture as well as to a more equitable and acceptable pattern of economic growth and development. (8) Widespread concern over world food prospects, present malnutrition, and periodic famines in some poor countries have generated support for focusing more attention and resources on agriculture. The major recommendation of the Presidential Commission on World Hunger in its 1980 report was that the US Government make the elimination of hunger the primary focus of its relationships with the developing countries.

While views about the significance of agriculture in economic development have been changing, many observers have become convinced that U. S. agriculture will become increasingly dependent on foreign markets, and therefore will be directly affected by agricultural developments around the world. (5) International trade already takes a major share of the total production of several of the most important US agricultural commodities.

More rapid changes in agriculture will increase the needs for additional, more reliable, and more timely basic information about agriculture. (8) Data on production of crops and livestock products, herd inventories, acreages planted and harvested, yields, prices, and incomes are essential. Information is also needed on potential acreages which could be

planted, labor force size and composition, migration, farm family living conditions, etc.

Such data are needed for decisions in both the private and public sectors, but responsibility for collection and dissemination of basic information about agriculture falls clearly on governments. Farmers and other private entrepreneurs have neither the resources nor the incentives to develop and operate such statistical systems on a wide basis. The US Government must be concerned with the collection and dissemination of better information about agriculture around the world, both because of the increasing integration of US agriculture into world agriculture and because such basic information is essential for US foreign assistance programs. The US. especially in the US Department of Agriculture. has the experience and the technical expertise to make major contributions to the less developed countries in this activity.

The raw data collected by surveys must be evaluated and analyzed to be useful. It is likely that in most developing countries for some years the emphasis of these efforts will be concentrated on providing data useful to official policy makers and program managers. But even at an early stage of development, basic information on agricultural prospects can be useful to farmers and agri-business if provided by Extension advisors. As operators in the private sector became more experienced, basic economic information will become increasingly useful to them. Experience has shown that small operators can be efficient producers in modern, dynamic agriculture if they are provided with adequate information and advice.

Agricultural statistics are collected both by censuses, which require the enumeration of a total relevant population, and by samples, which require enumeration of only a small part of a population. Recent develop-

ments in statistical methods have made clear that the enumeration of small samples can greatly reduce the cost of the collection of agricultural statistics while increasing their accuracy. A well designed sample, for which the data are carefully collected, can provide much cheaper statistics than a census and provide more timely information on current conditions. Sampling procedures provide the means for controlling sampling errors as well as non-sampling errors to meet the specific requirements for estimates thus permitting the allocation of resources to those areas and those statistics where the needs for more and improved data are greatest. (2,9) The ability to tailor the accuracy of estimates to specific needs is especially important to developing countries which usually have very limited resources to apply to the collection of agricultural data.

The collection of agricultural statistics can be made most cost effective by division or "stratification" of the populations, which permits the focusing of the resources for collection of data on those geographic areas where the payoff in terms of improved estimates will be greatest. The "area sampling frame" is a tested, well developed method which employs stratification of areas for increasing the efficiency of sampling for agriculture. (4) Under this project AID has contracted for the expert technical knowledge and guidance of the Economics and Statistics Service of the US Department of Agriculture in assisting certain developing countries in establishing such frames.

AREA FRAME SAMPLING

The concepts of area frame sampling are simple. The total area to be surveyed is divided into small geographic blocks, "stratified" in groups that are relatively homogeneous with respect to specified characteristics. A random sample of the blocks (or segments) in each stratum is chosen; the

desired data from the segments are collected; and the estimate of the desired statistics for the entire group of segments in the stratum are obtained by multiplying the sample value by the inverse of the ratio of the proportion of the sample to the total. The "sampling frame" itself is a complete list, or the specifications necessary to establish a complete list, of the sampling units. The samples are designed to minimize the "variance" or sampling errors in the final estimates, taking into account the cost of the samples. (2)

Although the concept is simple, area frame sampling must be done with very great care and precision. Technical assistance by experienced personnel is essential. Complexities arise in practice which require a considerable background of training and experience to solve. (2) Both a thorough knowledge of the underlying principles and a wide experience in applying them are necessary, especially in countries with limited statistical data and inadequate maps.

In the United States small agricultural areas have been used as sampling units as far back as the late 1940's. By the early 1960's, an area sampling frame had been developed for all states. For many years ESS has been using sample survey data to estimate areas of crops, yields, production, livestock numbers, prices, agricultural wage rates, farm numbers, and other items in US agriculture. (1) In the 1950's and 1960's improvements in the methodology of the estimates were made, based on a probability sample enumerated in late May--early June, and early December each year. Land-use area frames, which provide the basic structure for the sample, are based on standardized definitions of land-use strata and of the sampling unit size within each strata. The definitions of the strata refer to the percentage of land cultivated, number of dwellings per square mile, land in open range or wood land, and land in non-agricultural use. (1)

The ASF has been developed to the point that it can be used to produce accurate, timely, objective information. Sampling errors can be reduced to the required level by improving the survey design and/or increasing the sample size. Non-sampling errors can be controlled by use of precise concepts, careful survey procedures, and adequate enumerator training. A well-designed area frame system can measure both sampling errors and non-sampling errors. It can also provide the means for controlling errors. (9) Construction and use of area frames requires an understanding of the concepts, a commitment of adequate resources, experienced assistance, and highly trained people.

Analysis of the economic returns to ASF data in the United States has indicated that very high social and economic benefits are produced, equal to the returns to some of the more successful scientific research which has contributed greatly to US agricultural productivity. (3) There is no doubt that the lack of basic data is one of the most serious obstacles to more rapid agricultural progress in most developing countries. ASF's can make major contributions to overcoming this obstacle.

US foreign assistance programs are expected to make major contributions to the productivity of small scale agriculture in developing countries. It is often difficult to design assistance programs which can effectively contribute to both equity and increased productivity. (6) However, there is every reason to believe that ASF's can make major contributions to better decisions by policy makers, program administrators, agri-business and farmers themselves. In a dynamic agriculture, the needs for good data are critical requirements for improved decisions at all levels.

The ESS of USDA has a unique capacity to contribute to supplying this data because it has more experience with the ASF approach to agricul-

tural statistics than any other group in the world. One leading authority on economic development has pointed out recently that USDA has a "comparati advantage" in the collection of agricultural data. (6) Despite many difficult problems encountered by TDY experts in working with personnel of widely varied backgrounds (indicated in the country reports following), assistance to developing countries in the construction of agricultural area frames can be one of the most productive areas of activities for US foreign aid efforts.

The area sampling frames constructed under this project have been financed under, and designed to support, a broad set of remote sensing activities for agriculture. However, it should be emphasized that the area frames themselves are not a new venture into high technology. Such frames have been used for many years without dependence on remote sensing.

Although area sample frames have been used primarily for the collection of survey data by interviews and questionnaires, they also provide a means for efficient collection and use of remote sensing data on agriculture. Such data is expensive to collect and process, and requires sampling procedures for its efficient economic use. General purpose agricultural area frames can provide a sound basis for the best use of remote sensing data for agriculture when such data becomes widely and regularly available. Area sample frames also can be useful in providing guidance in the research and development stages of remote sensing data collection technology. The prospect of a great increase in both the quantity and quality of remote sensing information when LANDSAT D (or IV), with its "Thematic Mapper", goes up in 1982 makes it even more important to develop operating statistical frames to make effective use of that data.

Information obtained by remote sensing satellites has proved useful

in this project in the construction of agricultural area frames, as supplements to maps and lower level aerial photos. For example, Landsat imagery has recently been used to improve stratification of the area frames in several areas in Tunisia.

Area sample frames also have a potential for an important contribution to the monitoring of "desertification." Major concerns related to desertification are its impacts on agricultural production as well as the economic and social conditions of affected groups. Area frames are useful for collecting such information.

The African Sahelian drought of 1968-73 and its tragic effect on the people of that region drew world attention to the chronic problems of human survival and development on the desert margins. One observer reported in 1975 that the desert had advanced southward in the Sudan by 90-100 kilometers over the preceding 17 years. It has been estimated that, excluding the very cold drylands and the extreme deserts themselves, there is an area of potentially productive but threatened drylands covering 45 million square kilometers or 30 per cent of the world's land surface. These occur so widely that two-thirds of the 150 nations of the world are affected, and therefore desertification is a global problem.

A major concern over desertification is its effect on agricultural production. An initial step in attacking the problem of desertification is the regular monitoring of dryland ecosystems to determine present status, and to identify areas where change is taking place, to provide a basis for the investigation of causes and processes. A UN paper states that "global surveillance of the status of dryland ecosystems and of land use can be achieved most economically through remote sensing powers of specialized orbiting satellites, such as LANDSAT". Well designed area frames would be helpful in monitoring the status of the land.

At several places in this paper, reference is made to digital processing of LANDSAT data. It has been demonstrated in the US that digitally processed LANDSAT data improves ASF estimates of ground covers when a relationship exists between reflected energy and what is on the ground. In order to use LANDSAT type digital data, extensive systematic ground data must be available. In those AID countries where ASF data will be available, digital processing can easily be adopted when the satellite data becomes available.

BOLIVIA

BACKGROUND

Since 1974, AID has had a PASA with USDA for an area frame construction in Bolivia. This work has been carried on in the Division of Statistics in the Ministry of Agriculture. Progress on the construction of the area sampling frame has been slow. A pilot survey based on the frame was made in the Santa Cruz region in June 1977; this survey provided some useful field experience. It was expected that a larger scale sample survey would take place in May 1979; however, these plans were later changed, calling for a full-scale survey of the original Santa Cruz frame in November, 1979. As late as June 1980, however, the data collection had not been completed for Santa Cruz and there were many problems with the processing of the data.

Problems of organization and supervision, lack of training, differences on desirable stratification, and lack of cooperation between departments of the Bolivian government apparently all contributed to the unsatisfactory progress.

In 1979, a new MOU was drafted for signatures by the Government of Bolivia and USDA. The MOU provided that USDA would supply technical assistance to help the government of Bolivia to construct an Area Sampling Frame utilizing remote sensing and other available data. Construction of the frame was to serve as the first of a multi-phase project using satellite remote sensing for estimating agricultural production. However, it was expected that the ASF could be used for agricultural surveys regardless of whether or not the later phases were undertaken. This draft MOU was not signed by the GOB and therefore, none of the funds from the Remote Sensing for Agriculture project have been spent for Bolivia.

CURRENT STATUS

The last trip of TDY personnel to assist with this mission funded project was in mid-1980 at which time the data collection had not been completed for the Santa Cruz pilot survey. "Inaccessible segments and scarcity of gasoline for enumerators" were said to have contributed to the delay. Also, the TDY personnel were not able to get adequate access to the computer or assistance from qualified Bolivian personnel.

At present, technical assistance on this mission funded project has been halted due to the recent military takeover of the government.

TDY PERSONNEL

Raymond Bosecker, Josephine Wallace, Montie Wallace, Lyle Calvin, Manuel Cardenas, Hugh Bynum, Michael Craig, and Bernard Albrecht have made TDY trips to Bolivia to assist in this project.

COSTA RICA

BACKGROUND

Since November 1976, the Government of Costa Rice (GOCR) has been working with USDA and USAID in developing an area frame to produce agricultural statistics for Costa Rica. A pilot area frame survey was conducted in August-September 1978 for the Pacifico Central agricultural region. The outcome of the survey was encouraging in that sampling errors for the major items surveyed, such as coffee, rice, cattle, hogs, poultry, and number of farms ranged from 5 to 19 percent. Non-sampling errors were not estimated.

The initial success and experience acquired in its Pacifico Central pilot survey motivated the government's interest in a nation-wide area frame sample under the USAID "Remote Sensing for Resource Assessment" project. The MOU for the project, signed in the fall of 1979, specifies that the USAID central funds will supplement the on-going mission funded area frame work in Costa Rica. Costa Rican agencies involved include the Directorate General of Statistics and Census of the Ministry of Economy, Industry and Commerce; the Agricultural Sector Planning Office of the Ministry of Agriculture and Livestock; and the National Geographic Institute (IGN) of the Ministry of Public Works and Transport. The project is intended to assist in the development of a national area sampling frame, and then to assist in using the frame in conducting national agricultural surveys.

LANDSAT imagery now available is more current than much of the aerial photography that was utilized for land use determination for the Pacifico Central region frame.

The USAID/W budget for the project originally about $26 thousand, has been increased to $41,000.

STATUS OF PROJECT

In recent years, several changes have been made in Costa Rica's agricultural regionalization. At present the country is divided into 5 regions--Chorotega. Central, Brunca, Huetar Norte. and Huetar Atlantica.

Area frame construction has been done sequentially, with completion of one region before work in another region was initiated to prevent dissipation of manpower resources. Area frame construction has now been completed for all regions in the country. To a large extent. LANDSAT imagery. more recent than available aerial photographs was used in establishing broad geographic areas for the various land use strata. USDA has provided technical assistance in interpreting the imagery in constructing the frames. A sample of about 500 segments has been randomly selected to represent the whole country. Photo enlargements showing the delineated segment boundaries are being obtained. Preparation of field questionnaires is expected to start soon.

A number of problems have arisen in the course of the project. Some of the more important are:

1. Because changes have been made in Costa Rica's agricultural regional boundaries, some of the new agricultural regions have no historical data base.
2. Some of the aerial photography and maps are outdated, with some dating back to 1944. Many changes have occurred due to urban spread, deforestation, newly colonized areas, and changes in crop production. These changes mean that stratification based on old aerial photos is out of date and that sampling based on the frame will provide less precise estimates than could be produced with more recent aerial photos. The use of recent LANDSAT imagery has been helpful in updating the

strata, but detailed aerial photos are needed.

3. The area frame workers did not have sufficient training in interpretation of aerial photos and LANDSAT imagery.
4. In 1978 poor working conditions slowed progress on the project and changes were made in organizational responsibilities for the project in the GOCR.

Intensive training has been given to Orlando Hernandez and Francisco Losia.

FUTURE PHASES

Preparation are well along for beginning Phase II, the field survey. However. training in survey methods is needed. Also, the GOCR area frame team has limited training and background in mathematical statistics and computer processing of data.

For Phase III, computer classification, it was decided that Costa Rica would not be included at this time. Two major problems have been identified in Costa Rica which would probably make this phase experimental rather than operational for a considerable period. The first is the problem of cloud cover during the growing season, making it problematical whether satisfactory Landsat products could be obtained. The second problem involves crop distribution. Many crops are grown on small fields and interspersed with other crops in such a way that satisfactory signatures may not be available with present LANDSAT products.

Relative to Phase IV, agro-met modeling, there has been little or no experience in this area in Costa Rica. Heavy cloud cover during the growing season for most crops will also cause problems in attempts to use LANDSAT imagery in this effort.

TDY PERSONNEL

Michael Craig, George Hanuschak, David Klewenc, Diane Castagnola an Josephine Wallace have made TDY trips to Costa Rica to give technical assistance with this project.

DOMINICAN REPUBLIC

BACKGROUND

Prior to 1970, the Census of Agriculture, taken every ten years, was almost the sole source of agricultural statistics in the Dominican Republic. In 1970, technical assistance in implementing a sampling system was sought by the Secretary of Agriculture of the Dominican Republic from the USAID. An area frame was constructed in 1972. The Dominican Republic was one of the first developing countries to utilize area frame sampling to generate national agricultural statistics. However, the survey procedure currently being implemented in the country has limitations. Sources of possibly significant sampling and non-sampling errors have been identified. The same segments have been ennumerated quarterly since 1972, which may have generated a conditioning bias. Many segment photos and maps are in poor condition. There have been important changes in the geographic location of agriculture since 1972. The current ASF has performed well in estimating coffee, rice, and livestock production, but it appears that it may be less useful in estimating plantain, cassava, sweet potatoes, corn and beans because these are more isolated and rare items.

Under AID's "Remote Sensing for Resource Assessment" project a MOU was signed in mid-1979. In the MOU, the Government of the Dominican Republic was represented by the Secretariat of State for Agriculture.

The project is intended to provide improved agricultural information for the Dominican Republic. It is also expected to develop expertise within Dominican Agencies in area frame construction and survey management. It is expected that new techniques, including the use of LANDSAT imagery as well as recent aerial photographs, will contribute to more precise and efficient

crop production estimates.

The U.S. budget for the first year of the project through September 1980 was $55 thousand.

STATUS OF PROJECT

A land use map based on LANDSAT and aerial photos had been prepared under an earlier Comprehensive Resource Inventory and Evaluation System (CRIES) project. This map was used in restratifying the existing ASF count units to create a more current frame for sampling. Other sources of information included recent low level photos, field visits, and enumerators' knowledge of the areas. The restratification was based on a set of strata definitions which divided intensive agricultural areas by major crops (rice, coffee, cocoa, sugarcane and other crops).

Frame restratification of the pilot area selected was delayed by changes in the North Region. With the addition of the Salcedo province, this region was sub-divided into two new regions, and two new regional offices were formed. By the end of September 1980, restratification of the new North Central Region had been completed and restratification of the North Region was nearing completion.

Intensive training has been given to Gustavo A. Tirado, Director of SIEDRA; Ramon E. Jio, Head of Wildlife Studies; Jose Achecar, Chief of Statistics Division, SEA; and Eddy Soto, Analysis Section, SEA.

FUTURE

The 1979 MOU covers only the construction of area frames for the Dominican Republic and assistance with an initial survey. However, this may be followed by the later phases of the AID project, which include assistance with computer classification of LANDSAT information, and agro-met modeling.

In preliminary discussions, officials expressed interest in these phases. The fact that sugarcane is produced in relatively large fields in the Dominican Republic should be an important factor in a computer classification effort. Also, the Dominican Republic has had some previous work done on agro-met models for sugarcane.

TDY PERSONNEL

Michael Craig, Carol House and Harold Huddleston have made TDY trips to the Dominican Republic to give technical assistance with this project.

ECUADOR

BACKGROUND

In the latter part of 1979. a MOU was signed with the Government of Ecuador (GOE), represented by the National Institute of Statistics and Census (INEC). The project is to be completed within two years after the agreement was signed, and includes the following activities:

1. Construction of an ASF for one sub-province, later selected by the GOE as the province of Pichincha;
2. Conducting a pilot survey in this province using an area sample selection from the ASF;
3. A joint evaluation of the pilot survey; and
4. Providing agreement bet ween the parties that the previous activities indicated practical and feasible means to develop an ASF, construction of an ASF for the major agricultural areas of Ecuador.

USDA funding for the first 3 activities is $9,300. If the 4th activity is undertaken--construction of an ASF for the major agricultural areas of Ecuador--an additional $34.250 is to be provided, giving a total budget of $43,550.

A TDY trip to Ecuador in January 1979 revealed that the GOE was seeking AID financing for a project on Natural Resources in the Environment. This work, if approved, would be carried out by the new Center for the Integrated Study of Natural Resources by Remote Sensing (CLIRSEN) and was expected to use satellite imagery in the preparation of thematic maps. It was also found that the Office of Scientific Research (ORSTOM) in the Ministry of Agriculture has a list frame of farm units developed under a French-sponsored

project. Using the list frame, a survey covering area and production of crops was carried out in 1975. A full report of the survey was not available in January 1979, but a report on methodology had just been released. The TDY report judged that the methodology in establishing the list frame was good but suffered from the general inadequacies of any list frame, with a neccesity for continual updating. It was observed, however, that the members of ORSTOM "seemed quite content with the list frame."

At the same time, other members of the Ministry of Agriculture (MA) expressed a strong interest in the area frame. The TDY report judged that the ORSTOM activities "were enough tangential to the main thrust of the Program for Natural Regionalization (PRONAREG) in the MA that their reluctance would not be a deterrent to the Ministry of Agriculture participating fully in the construction and use of the area frame." At that time, it had not been decided which group would have responsibility for the activities under the MOU. The TDY report observed that "it would appear now that CLIRSEN as well as PRONAREG might be well involved in the first phase..." It was judged that CLIRSEN "has acquired well-qualified people and is ready to move fully into remote sensing activities. They have a good relationship with the Ministry of Agriculture and it appears that cooperation between the two groups would be excellent...sufficient mapping and aerial photography is available for them to start on such a project."

The January 1979 TDY report said, however, that neither adequate scale maps nor aerial photography is available for the entire country. "The U.S. Air Force took aerial photos during the 1960's and these would have to be used for part of the country. The Military Geographic Institute has two planes and has been taking aerial photos for the past two years, which has helped to update the older photography but still does not provide 100

percent coverage. Nearly 50 percent of the country has been topographically mapped at a scale of 1:25.000. Fortunately, much of the country that has been mapped is the productive agricultural land. This means that additional mapping and additional air photography would have to be carried out to successfully complete an area frame." The same report refers to difficulties with cloud cover over the coastal regions.

STATUS OF PROJECT

In March 1980, a team of USDA employees met with personnel from the INEC and CLIRSEN. Decisions were made as to appropriate strata for the test province, and assistance was given in the stratification.

The Director General of INEC, his assistant, and the Vice-President's staff were briefed on the project. A time-table of future assistance and activities was set up. The pilot survey was to be completed by the end of June, and in July Ecuadorian personnel were to be trained in using micro-computers for summarizing the pilot survey results.

In May 1980, a TDY trip was made in connection with the project. It was found that all strata had been divided into count units, with the exception of the cities. Approximately one-fifth of the count units had been planimetered. Construction of the city count units was completed, definition of the sub-strata were decided, and planimetering and segment selection was completed by May 14. A sample was selected. However, "difficulties in obtaining funds resulted in photo coverage for only one count unit being ordered."

A list of photography needed for strata was also completed by May 14. Photos were to be ordered and the count units divided into segments. It was planned to conduct a survey in June, with a final report to the Vice President of Ecuador by the middle of July.

Due to political boundary discrepancies, the original boundary of Pichincha was altered.

In October 1980, a trip to Ecuador resulted in tentative agreement on the following schedule of surveys:

Type of Survey	Beginning Date	Frequency
Area, yield and production of principle cultivated crops	July 1981	Annually
Cattle, birds on feed (type, age, birth, death, slaughter, sales and production)	July 1981	Twice yearly
Production and yields of principle crops	January 1982	Annually
Objective yield estimates of principle crops	June 1982	Annually
Quantity, prices paid and received by producers; utilization of inputs	June 1982	Annually
Household surveys	1983	Annually
Labor	1982	Annually
Cost of production	1984	5 yr intervals
Food consumption	1985	5 yr intervals
Land use and ownership	1985	5 yr intervals
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	1986	5 yr intervals
Other information as needed		

TDY PERSONNEL

Harold Huddleston, Nick Ciancio, Gary Lockowandt and William Wigton have made TDY trips to Ecuador to give technical assistance with this project.

INDONESIA

BACKGROUND

In mid 1979, a MOU was signed with the Government of Indonesia, represented by the Central Bureau of Statistics (CBS). The agreement specified that area frame sampling would be used to make estimates of paddy, rubber, and coconuts. An Area Sampling Frame (ASF) was to be constructed for a part of a province and a pilot survey using a sample from the frame was to be made. After evaluation, construction of an ASF for the major agricultural areas of Indonesia was to be completed by the end of two years after the beginning of the project.

USDA, with AID/W funding, agreed to supply technical services, equipment and supplies (including satellite images) amounting to an estimated total of $105,000 if it were decided to construct the ASF for the major agricultural areas. The CBS agreed to provide the services of the project leader, Area Frame Technicians, and Field Enumerators as well as secretarial and statistical-clerical support, office and storage space, and maps and aerial photos.

STATUS OF PROJECT

Although the MOU provided that the site of the pilot project area would be in Central Java, the site was later shifted to Lampung, Sumatra. The Secretary General of the Central Bureau of Statistics had indicated that he was most interested in estimation of small farmer's "estate" type crops (rubber, coffee, peppers and cloves). Due to time constraints, LANDSAT imagery could not be used in the construction of the frame, and therefore, aerial photography was used alone.

There was some initial confusion over administrative arrangements in

the U.S. Embassy. There was also conflict with a high priority census of population which was to be taken at about the same time as the sample for agriculture. Problems arose with regard to the repair of bicycles for transportation for the data collectors. There was an unsuccessful attempt to obtain copies of land use maps for the pilot area in time for the TDY personnel to field check the maps.

There was considerable delay in construction of the area sampling frame as a result of poor quality base maps. When the land use maps were finally obtained, they were judged to be inadequate, and resort was made "to an innovative approach of working primarily with the geographically unrectified aerial photography." The pilot area sampling frame was completed on April 18, 1980 and a random sample of 24 segments was made. Training materials were prepared and training for the enumerators took place in April. Data collection for the planted crop areas and production of rice, corn, cassava, sweet potatoes, rubber, coffee, pepper, and cloves was undertaken in May, 1980.

Comparison of the estimated acreage of crops based on the response of the farmers with estimates made by planimeter indicate a significant difference for half of the major crops. However, the differences were not always in the same direction. This strongly suggests that area sampling frames and the use of planimeters could provide much better estimates of crop acreage than are presently available in Indonesia.

The pilot area survey covered only a small region because of the lack of good aerial photographs for much of Lampung. It has been recommended that the project should be expanded to cover an entire provice and CBS has selected West Java province. It is hoped that the use of LANDSAT imagery, together with more intensive frame construction procedures will overcome the

drawbacks from a lack of good photographs and maps.

Machin Ervin, Head of Cartographic Section of CBS was sent to Manila for training.

TDY PERSONNEL

Ronald Steele, Duane Skow, Robert Parr and William Wigton have made TDY trips to Indonesia to assist in this project. Kathryn Milford is a resident and has contributed significantly to the project, working directly with CBS personnel.

JAMAICA

BACKGROUND

Since 1978 USAID has sponsored technical assistance by USDA to Jamaica in area frame sampling. An area sampling frame was constructed with the aid of topographic maps and other information in the fall of 1978 and revised in the light of subsequent experience in the winter of 1979. Aerial photographs were used in the revision along with topographic maps and ground crews. Attempts were also made to utilize LANDSAT imagery for stratifying the country into homogenous areas for sampling purposes. However, since high resolution aerial photography was available use of LANDSAT imagery was limited.

A MOU with the government of Jamaica, represented by the Ministry of Agriculture, was signed in August of 1979. whereby USDA was to provide technical assistance to help construct an area frame for agriculture. This project is expected to provide improved agricultural information in the form of estimates derived from area frame sampling. This project included the following activities: (1) construction of an area sampling frame for the entire island, (2) conducting a pilot survey, using an area sample selected from the frame and (3) a joint evaluation of the pilot survey. An amendment to the MOU was signed in the spring of 1980 to initiate new work. The project title was changed to "Remote Sensing for Agriculture Area Sampling". New work covered by the new MOU includes objective yield modeling for crop forecasting.

The U.S. budget under the original MOU provided for estimated expenditures of $26 thousand. The amendment increased this to $56,000. The MOU and its amendment also describe the contribution from the government of Jamaica in terms of personnel and support facilities, but no dollar figure

is given.

STATUS OF PROJECT

The survey for the third quarter of 1979 was the first survey to use replicated sampling. Results of the work in 1979 were presented in a Joint Jamaican Ministry of Agriculture - USDA paper (by Roy Russell and Harold Huddleston) presented by Roy Russell at the United Nations Seminar during the 14th International Symposium on Remote Sensing of Environment in San Jose, Costa Rica, April 9, 1980. The paper presents the results obtained from the crop production survey of October 1979 which was based on the area frame completed in 1979. The main purpose of the survey was to provide estimates of crop acreages and variance for determining the final sample size at the country and parish levels. In addition, the survey was expected to provide the staff with insight and experience with the concepts needed to implement a crop survey.

The paper gave estimates at the country level, and also for the parish of Clarendon, which is a major agricultural parish in the south-central part of the country. Sampling errors with co-efficience of variation in the 5 to 15 percent range were considered satisfactory and probably would require no special design modification. However, among the crops, only sugarcane falls within this percent range. A number of crops with errors less than thirty percent hold the most hope of improvement. Design modification may improve estimates of a number of crops with sampling errors less than 30 percent.

Many problems were encountered in the field due to lack of transportation. The enumerators did not have personal transportation and had to rely on public transportation in rural areas. This resulted in many inefficiencies in completing segment work and the scheduling of appointments or call-backs to growers. The lack of personal transportation also limited the quality

control efforts of supervisors to resolve inconsistencies in the questionnaires.

It was anticipated that objective measurement of yields would be started on a continuing basis for at least three crops (sugarcane, bananas, and yams) during 1980.

On-the-job training and assistance has been given in survey data processing using a micro-computer system. Also, technical assistance was given in developing crop yield forecasting work.

Since 1980. Jamaica has run quarterly surveys and published results before the next survey was taken. This country has demonstrated the capacity to handle all aspects of ASF technology.

PERSONNEL

Ronald Steele, Wayne Gardner. Raymond Luebbe, Harold Huddleston, George Hanuschak and Kathy Morrissey have made TDY trips to Jamaica to provide technical assistance with this project. Not all have been funded with RS funds.

LIBERIA

BACKGROUND

A MOU with the government of Liberia, represented by the Ministry of Agriculture, was signed in November 1979.

There are unique problems in construction of an area sampling frame in the rain forest environment of Liberia. In order to determine whether an ASF is feasible for Liberia, and to find solutions to problems that might exist, it was decided to work in a pilot test county before preceeding to construction of the ASF for all of Liberia. Lofa County was selected as a pilot area, primarily because good infrared aerial photography exists for the entire county.

Total expenditures are projected at $49,206 for USDA.

STATUS OF PROJECT

A TDY trip to Liberia was made in October 1980. Orientation and classroom working exercises were conducted with enumerators and statistics personnel. Segment boundaries were established on the photo maps. Stereo pairs were made to aid in accurately locating the segment and its physical boundaries.

A meeting with some Ministry of Agriculture officials indicated a lack of operational plans for the project without an intent to try to develop them. Also, the officials indicated that they were not sure that they want to construct an area frame. Their comments were: "too costly, no benefits, could not see that it would improve quality".

Intensive training has been given to Reginald Jannah and Soni Sherman in the Agricultural Statistics Department, MOA.

Dominic Ballayan has recently been appointed head of the Statistics

Division. It is expected that he will be able to improve management of the project in Liberia. William Bolton, USAID direct hire, has been instrumental in pushing this project. The Liberia project is expected to be successful in spite of an uncertain start.

TDY PERSONNEL

William G. Hance, Paul Blackwood and Nick Ciancia traveled to Liberia to give technical assistance with this project in 1980.

MOROCCO

BACKGROUND

In Mid 1979, a MOU was signed with the government of Morocco (GOM), represented by the Ministry of Agriculture (MA). USDA agreed to provide technical assistance to the MA for construction of an area sample frame (ASF), integrating satellite remote sensing data to estimate production of major crops. The project is to be completed within two years after the agreement was signed, and includes the following activities:

1. Construction of an ASF for one province or area selected by GOM;
2. Conducting a pilot survey, using an area sample selected from the ASF;
3. A joint evaluation of the pilot survey; and
4. Providing agreement between the parties that the previous activities indicated practical and feasible means to develop an ASF, construction of an ASF for all of Morocco.

The Morocco MA has the overall responsibility for completing the ASF. USDA will provide satellite image products and necessary technical assistance, equipment and supplies.

The estimated USDA budget for completion of all 4 activities listed above was $47 thousand.

In mid-1979, an amendment to the MOU was signed, revising the scope of work and resources committed. The planned coverage of the project was changed from all of Morocco to "areas of Morocco selected by GOM." The estimated total USDA expenditures were increased to $97 thousand.

Under the amendment, the MA of the GOM will provide a project director, full-time employees for ASF, survey enumeration, a mini-computer programmer.

secretarial and statistical-clerical support, maps and aerial photos, office and storage space, and in-country transportation for project purposes.

STATUS OF PROJECT

In October 1979, the government of Morocco chose Kenitra Province as the pilot study area. This province is one of the most agriculturally important provinces in the country and contains most of the major crop types of the country as well as a large quantity of irrigated land. The Province was divided into three sub-regions and seven strata. The stratification, count unit selection, and sample selection were completed for four of the strata in November 1979. Some of the maps used were out of date, and LANDSAT imagery was used in construction of the pilot frame.

In the work on the pilot frame, there soon arose problems concerning (1) size of sample, (2) size of segments, (3) approach to open and closed segments, and (4) organization of survey material. The sample size, chosen by the GOM, was reduced to 78 from 159 segments. The GOM was then concerned about the large area of some of the segments, because of their view that an impractical number of operations would be required to enumerate such large segments. It was decided that division of certain "problem" segments into smaller units was appropriate.

The GOM prepared an enumerators' manual. Differences arose between the GOM personnel and the USDA advisors over the best approach to "open" segments.

In February 1980, it was planned to complete the pilot study in late August to mid-September. At that time, it was tentatively agreed by GOM/MA to begin construction for the rest of Morocco at a future undetermined date.

Additional problems encountered in the frame construction and the pilot survey concerned (1) survey planning and field operations, (2) area frame stratification, (3) difficulties with farm definition and open-segment data.

(4) livestock reporting, and (5) objective yields and crop-cutting procedures. Many of the survey problems arose from insufficient time for preparation of the sample frame, questionnaire, survey instructions, etc. It is expected that these problems will be corrected for the 1981 surveys as a result of the experience gained in the pilot survey.

Despite the various difficulties, the total effort by the MA was judged to have been quite good. The various problems were resolved in time to complete the work in an acceptable manner. The commitment of the MA to the project was excellent.

A report on the pilot survey of Kenitra Province, in October 1980, concluded that the survey was a success. Sampling errors for major items were at acceptable levels, and non-sampling errors were largely attributed to first time start-up problems. It was expected that most of these problems would be corrected in the 1981 survey as a result of the experience gained. The MA expressed willingness to make modifications needed to improve the 1981 survey. The MA also hired additional full-time personnel to assist in the construction of the frame for the rest of the country.

TDY personnel in December 1980 gave guidance and assistance in: (1) designing the sample for the new provinces that would be included in the surveys for 1981, (2) restratifying the province of Kenitra and determining a new sample allocation, and (3) discussing a sample for the provinces of Fes and Taounate in which the World Bank has a project underway.

Intensive training was given to Mr. Serighini, Director, Econ/Stat, MOA; Bouzafour Seghir, Statistician, Econ/Stat, MOA; Benlemira Driess and Statistician, MOA.

TDY PERSONNEL

The following TDY personnel have contributed to the project thus far:

Robert Parr	Bernie McCullough
Charles Miller	Diane Castagnola
Harold Huddleston	Naomi Klaus
Roland Albert	Abdelmajid Sahnoun

Melissa Cable, resident, has contributed a substantial effort to the project. William Wigton and David Simonett were involved in activities prior to initiation of this project.

PHILIPPINES

BACKGROUND

In Mid 1979, a MOU was signed with the Government of the Republic of the Philippines, represented by the Ministry of Agriculture.

The MOU specified assistance with the following:

1. Construction of an area sample frame for one province;
2. Conducting a pilot survey, using random sample segments selected from the ASF for that province;
3. Completion of a joint evaluation of activities 1 and 2;
4. Construction of an ASF, on a province-by-province basis. for 3 regions covering a large part of the most important agricultural areas in the country, and conducting surveys on a regular periodic basis.

Work under the MOU is being done by the Bureau of Agricultural Economics (BAEcon) and USDA. The US budget estimated for the project is $52 thousand. This is expected to be increased by an amendment outlining increased activities, training and equipment.

STATUS OF PROJECT

An ASF has been developed for the province of Pangasinan. Landsat imagery. aerial photography and topographic maps were used in developing the ASF. Since the photography was 10-15 years old, the Landsat imagery was useful in providing an overview of current land use. The province was divided into land use categories, and seventy-two segments, approximately 25 hectares in size, were randomly selected to represent the entire province. Data Collection teams visited these segments, observed the standing crops, made objective measurements of crop area, and interviewed farmers to determine crop production in the previous six month period. Data collection was

conducted during February and March 1980, and a second round in July and August. Palay (rice) and corn area and production data from the first survey was summarized and evaluated in April and May.

The estimates obtained from the pilot area frame survey are compared in the following table with the estimates from BEAcon's Rice and Corn Survey which utilizes a sample selected from a "list frame" (list of farmers).

Table 1: Comparison of estimates between Rice and Corn Survey (RCS) and Area Sample Frame (ASF) July - December 1979 and Jan - June 1980

CROP	RCS		ASF	
	Jul- Dec 79/Jan-Jun 80		Jul-Dec 79/Jan-Jun 80	
Rice				
Harvested Area 1/	134,240	23,485	172,220	29,322
(CV-Percent)	(6.9)	(11.9)	(7.9)	(27.6)
Production 2/	6,073,057	1,010.687	7,182.640	1,706,421
(CV-Percent)	(7.7)	(11.2)	(6.6)	(34.4)
Corn				
Harvested Area 1/	4,441	7,983	406	4,371
(CV-Percent)	(35.6)	(21.5)	(20.0)	(71.4)
Production 2/	39.979	97,358	3,641	54,553
(CV-Percent)	(27.1)	(21.6)	(33.5)	(68.2)

1/ hectares

2/ 50-kilogram sacks

The general opinion within the Ministry of Agriculture, BAEcon and the AID Mission is that BAEcon's rice estimates from the RCS are very conservative. The ASF estimate of harvested area of rice was 28% higher than the RCS in the July-Dec 79 period. The estimate of production was 18% higher. The very great difference in the corn estimates apparently was caused by the small sample and possibly by large non-sampling errors.

Supervisors of the project have concluded that:

1. Area sampling, while not without problems and difficulty, is feasible for the Philippines:
   (a) BAEcon has the expertise and technical skills necessary for successful area frame surveys;
   (b) Results from the rice pilot survey show that sampling errors can be maintained at reasonable levels (less than 10%) for rice during the time of year when area harvested is reasonably homogeneous).
   (c) Review and analysis of the rice pilot survey data has revealed no significant biases due to area sampling and data collection procedures.
2. Results of the pilot survey strongly support continuation of the project:
   (a) Some changes to increase statistical efficiency are possible and can be easily made;
   (b) Stratification into general land use categories is adequate, but could be improved with better and more current aerial photography and the use of multitemporal Landsat imagery.

Intensive training has been given to David Besia, Agricultural Statistician, BAEcon.

TDY PERSONNEL

Ronald Steele, Robert Parr, Charles Caudill and Dennis Fenley have made TDY trips to the Philippines to provide technical assistance with this project. Resident Bruce Graham has given good support to this project.

SIERRA LEONE

In early 1980, a MOU was signed with the Government of Sierra Leone (GOSL), represented by the Ministry of Agriculture and Forestry (MAF). USDA agreed to provide technical assistance to help the GOSL in constructing an area sampling frame (ASF) utilizing remote sensing and other available data. It was also planned that the Food and Agriculture Organization/United Nations Development Program (FAO/UNDP) will assist the MAF through their joint Agricultural Data Collection System.

The purpose of this project is to develop area frame sampling to provide improved agricultural information in the form of area and production estimates of rice, coffee, cocoa, cassava and oil palm. During the two years in which the MOU is in effect, it is anticipated that the following activities will be undertaken: (1) construction of a ASF for Kenema District (Eastern Province), and Northern Integrated Agricultural Development Phase II Project boundary selected by the GOSL, (2) conducting a pilot survey in Kenema District, using an area sample selection from the ASF above, (3) a joint evaluation between the parties to this MOU of the pilot survey described above, and (4) if all the items above proceed satisfactorily this MOU will be amended to provide for input to construct an ASF for the major agricultural areas of Sierra Leone and conduct a national survey.

The MAF, in collaboration with FAO/UNDP, Agricultural Data Collection System Project, has the overall responsibility for completing the ASF pilot study described in the preceding paragraph. USDA will provide satellite image products and necessary technical assistance by means of short-term assignments of statisticians and area sampling frame construction experts.

Intensive training has been given to Hector Vila, S.M. Saidn, and O.L.A. Gordon.

Total funding for USDA for the first 3 activities described above is estimated at $30,326.

TUNISIA

BACKGROUND

The Tunisian Government began developing an ASF with assistance from the USAID Mission and USDA in 1974. An ASF for all of Tunisia has been used as a basis for collecting survey data, which has been published since 1976. Several objective yield surveys for wheat as well as surveys on the cost of production for cereals have also been conducted.

A MOU for the Remote Sensing for Agriculture project with the government of Tunisia, represented by the Ministry of Agriculture, was signed in early 1980. The purpose of the present project is to assist Tunisian officials in considering updating the present ASF for possible gains in sampling efficiency and/or cost reduction based in part on use of LANDSAT information. The project is also intended to provide training in the use of micro-computers to edit, summarize and analyze data from surveys and other sources. It is expected that the use of micro-computers will help to overcome present time lags between the collection of data and the published reports.

STATUS OF THE PROJECT

Under the 1980 MOU two regions are to be selected and restratified using visual methods with LANDSAT images. Also, work will be done using digital LANDSAT information to restratify the existing ASF. Survey data already collected from the old ASF will be compiled and analyzed using the new strata. Comparison of variances and costs and results of the different methods will be made.

The purpose of the project is to provide improved agricultural information: first, in the form of estimates of major crops derived from an updated ASF based on a revised area stratification, sample allocation and

sample size; and second, through integration of rapid data collection and more rapid summarization and analysis to provide more timely agricultural estimates.

The project, scheduled to be completed within two years, will include the following activities:

1. Updating existing ASF for two regions of Tunisia.
2. Using national survey data, compute variance of estimates for selected crops as input to a decision on the need for an update of the ASF.
3. Training of two Tunisians at USDA, Washington, D.C., in the use of a computer for the processing and digitalization of ASF data and segment locations as shown on maps and photos.
4. Depending on outcome of 1, 2 and 3 above, develop a complete new ASF using restratification based on LANDSAT products and other available data.

A team recently returned from Tunisia reported that LANDSAT pictures were very useful in the restratification process.

USDA will fund the purchase of satellite image products from US suppliers and Telespazio, Rome, Italy, and provide necessary equipment and supplies, technical assistance to use the products with existing materials, and assistance in development of computer capability. Estimated USDA budget for the project is $91,471 ($34,102 for activities 1, 2 and 3 above, with an additional $57,369 for developing a completely new ASF).

TDY PERSONNEL

Harold Huddleston, Ron Fecso, Jean Meyer-Roux and Ray Luebbe made TDY trips in June-July 1980 and early 1981 to give technical assistance with this project.

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