

NATIONAL AGRICULTURAL STATISTICS FOR COSTA RICA

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ABSTRACT

The Government of Costa Rica, United States Department of Agriculture, and the U.S. Agency for International Development have worked jointly since 1977 in developing an area sampling frame for current agricultural statistics. The area sampling frame has been completed for approximately forty percent of the land area in Costa Rica. A pilot survey was conducted during August and September of 1978 for the Pacifico Central Agricultural region. Sampling errors for major survey items (coffee, rice, land in farms, cattle, hogs, and poultry) ranged from five to nineteen percent. Sampling frame construction is continuing for the rest of the land area in Costa Rica. Sampling errors at the national level for major agricultural survey items are expected to be on the order of four to twelve percent with a sample that accounts for less than one percent of the total land area. The effort is an example of technology transfer for agricultural statistics. The technology used is remote sensing (LANDSAT-MSS and RBV Imagery and aerial photo mosaics) along with conventional tools such as maps, sample survey design, data collection, editing, summarization, and publication. The technology transfer can supply basic agricultural data in a timely and cost-effective fashion.

METHODOLOGY

Aerial photography obtained from Costa Rica's Instituto Geografico Nacional is visually interpreted using the percentage of cultivated land to define broad land use strata (See Table 1). Within each stratum, the total area is divided into N_h elementary sample units called segments. This collection of area sample units for all strata together is called an area sampling frame. Annual resources required for area frame construction and sampling are listed in Table 2. A simple random sample of n_h units is usually drawn within each stratum. Often substratification is also used where there is reasonably accurate control data. Huddleston^{4/} and Houseman^{3/} provide more detailed and precise definitions and procedures for area frame sampling.

One strict rule in area frame construction is that permanent identifiable boundaries on the ground such as roads, rivers, streams, canals, railroads, etc. are used for strata and sample unit boundaries. Thus, the resolution of any remotely sensed data must be good enough to see these type of boundaries (below 30 meters). Some research is now being conducted by USDA for using false color computer enhanced 1:250,000 LANDSAT MSS images or 1:125,000 black

and white RBV images with clear acetate map overlays at the same scale for broad land use stratification. The maps are the 1:200,000 series from Instituto Geografico Nacional. Research to date is encouraging for broad land use definitions for strata being done on LANDSAT image products with map overlays and will be illustrated in the poster session associated with this paper. However, for further breakdown of strata into sample units, LANDSAT image products do not have sufficient resolution. Perhaps the Large Format Camera system or other future high resolution systems will provide imagery for such an application.

Once a sample of segments is selected, the area devoted to each crop or land use inside the segments is recorded by interviewers during a survey. The interviewer uses an enlarged photograph of a sample segment and by communicating with farm operators delineates the operators land inside the segment and the crop field data. The scope of information collected is much broader than crop area alone and includes items such as intended utilization of crop area, livestock inventory by various weight and age categories, grain storage on farms, agricultural labor and farm economic data. Intensive training of field statisticians and interviewers and the use of photographs and maps helps to minimize nonsampling errors.

The notation used for the stratified random sample is:

Let $h = 1, 2, \dots, L$ be the L land use strata. For a specific crop area (coffee, for example), the estimated total and variance for the country would be as follows.

Let Y = total coffee area (hectares) for Costa Rica

\hat{Y}_{DE} = estimated total of coffee area for Costa Rica

y_{hj} = total area of coffee in j^{th} sample unit in the h^{th} stratum

Then,

$$\hat{Y}_{DE} = \sum_{h=1}^L N_h \left(\sum_{j=1}^{n_h} y_{hj} \right) / n_h$$

The estimated variance of the total is:

$$v(\hat{Y}_{DE}) = \sum_{h=1}^L \frac{N_h^2}{n_h(n_h-1)} \cdot \frac{(N_h - n_h)}{N_h} \cdot \sum_{j=1}^{n_h} (y_{jh} - \bar{y}_h)^2$$

The corresponding coefficient of variation would be:

$$C.V.(\hat{Y}_{DE}) = \sqrt{v(\hat{Y}_{DE})} / \hat{Y}_{DE}$$

PILOT SURVEY

A pilot survey was designed and implemented by Costa Rica's Direccion General De Estadistica Y Censos and USDA for the Pacifico Central Agricultural region. A random sample of eighty-seven segments was selected for the survey. Also the largest farm operators for livestock and rice were selected from a special purpose list frame. Thus, the estimates are really multiple frame results for livestock and rice. Enumerators were trained and the data was collected from August 16 - October 10, 1978. Survey data was edited by DGEC and summarized by DGEC and USDA. The results of the pilot survey were encouraging. A detailed publication (in Spanish) on the methodology and results was published by DGEC (Publication Number 1172-600). Table 3 highlights the major results of the pilot survey.

CONCLUSIONS

If there is a sincere commitment by the host government and the technical assistance from U.S.D.A. and U.S. - A.I.D., then area frame sampling is a low cost transferrable technology for collecting current agricultural statistics in Central America. The rate of speed in area frame construction is highly dependent on the personnel, space, and material resource commitment of the host country. Once the area sampling frame is constructed, samples may be drawn and rotated for nearly a decade before the frame would need rebuilt or restratified. Once the area sampling frame is built and survey data is being routinely collected, then further statistical developments such as multiple frame sampling and objective yield models can be implemented.

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TABLE 1

| <u>Land Use Stratum</u> | <u>Definition</u> |
|-------------------------|--|
| 1 | <u>60-100 percent cultivated</u> for crop production. Target, about 80 percent. Include tree crops. Other crops will include sugarcane, rice, beans, corn, vegetables, etc. |
| 2 | <u>30-60 percent cultivated</u> for crop production. Include tree crops. Other crops will include sugarcane, rice, beans, corn, vegetables, etc. |
| 3 | <u>1-30 percent cultivated</u> for crop production. Will include pasture (grazing) land and land with a low (target 15) percent of cultivation. |
| 4 | <u>Non-Agricultural Land</u> . No visible cropland or agricultural of any kind (including grazing). Examples would be coastal marsh, swamps, lava fields, mountains above tree lines, canyons, national parks and military land where no agriculture is permitted. |
| 5 | <u>Cities and Towns</u> . Population density of <u>50</u> or more dwellings per square kilometer. This would be determined from either quad maps or the photographic mosaics. The size would be usually <u>12</u> or more city blocks. There should be no agriculture in this stratum or else the town would go in the agricultural urban stratum (6). |
| 6 | <u>Agricultural Urban</u> - Land with the required population density and number of city blocks but can also contain some agricultural land. |
| 7 | <u>Water</u> - Lakes, natural and man made, major rivers. |

TABLE 2

Resources per year required for Costa Rica are as follows:

| <u>Host Government</u> | | <u>USDA</u> | |
|-------------------------------------|--|------------------------------|---------------------------------------|
| Project Director | 1/2 year | Mathematical Statistician | 4-6 weeks TDY |
| Supervisor | 1 year | Agricultural Statistician | 4-6 weeks TDY |
| Frame Construction Team - 4 Persons | 1 year | Data Processing Statistician | 2-4 weeks TDY |
| Math Stat | 3 mos. | Area Frame Construction | 3-4 months TDY |
| Maps | \$150 | LANDSAT, RBV Images | \$1000 |
| Photo Mosaics* | \$20,000 | Acetate Map Overlays | \$500 |
| Space & Supplies | \$5,000 | Travel | \$14,000 |
| Total | 5.5 Person Years + \$25,150 | Total | 7 Person Months + \$15,500 |

*Complete Expense (Not Annual) over 5-10 years.

TABLE 3

| <u>Survey Item</u> | <u>1978 Area Frame Estimate</u> | <u>C.V. of 1978 Area Frame Estimate</u> | <u>1973 Census Estimate</u> |
|-----------------------------|---------------------------------|---|-----------------------------|
| Number of Farms | 14,240 | 20.4 | 11,384 |
| Area in Farms | 242,375 hectares | 5.6 | 209,132 hectares |
| Winter Rice | 12,920 hectares | 16.6 | 10,489 hectares |
| Winter Corn | 6,135 hectares | 28.5 | 5,503 hectares |
| Coffee | 19,408 hectares | 18.9 | 12,966 hectares |
| Pasture | 151,274 hectares | 9.5 | 104,603 hectares |
| Total Number of Cattle | 137,615 | 14.1 | 114,464 |
| Total Number of Hogs & Pigs | 23,627 | 18.4 | 22,823 |
| Total Number of Poultry | 771,382 | 6.6 | 763,580 |