AGRICULTURAL AND RESOURCE ASSESSMENT IN JAMAICA USING AN AREA SAMPLING FRAME*

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ABSTRACT

The paper presents a technology for using remote sensing in implementing an information system in a country with limited resources and known agricultural data needs. Specifically, Landsat imagery and infrared photography are obtained along with conventional topographic maps to develop an area sampling frame to inventory crop acreages, production and related agricultural information.

1. INTRODUCTION

The primary goal is to develop crop acreage and production information for many short-season food crops as well as some long-season or permanent crops. Two types of information are desired: (1) Factual information on what has been harvested, and (2) forecast information for the next 6-9 months. In order to satisfy these needs, small area sampling units are to be visited periodically during the year to obtain from the growers information on crop planted, harvested, and to be planted by fields within the area units. A staff of field enumerators would obtain this information from the growers, or if need be, could observe the crops planted. If growers were unable or unwilling to supply information on yields, objective yield forecasting techniques might need to be employed. After the system is working satisfactorily, a number of other potential data needs relating to land resource assessment and household information would be secured.

2. FEATURES OF AREA SAMPLING

Conceptually, an area sampling frame is always current and complete with regard to any definition of a reporting unit. For example, an area sampling frame of farms is a sample of farms as they are defined and exist at the time of the survey. In other words, if a random sample of one-fifth of all segments in the population is selected, the sample of segments is "expected" to contain one-fifth of the reporting units in the population regardless of how the

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reporting units are defined. (The word "expected" is used in the sense of mathematical expectation.) To further clarify the point, consider the estimator $\frac{N}{n}\Sigma x$. The number of segments, N, in the population and the number, n, in the sample are known. The sample total, Σx, is the total of characteristic X for all reporting units associated with the sample of n segments. Hence, the sample can be expanded regardless of how a reporting unit is defined. Notice that one does not need to know the number of reporting units in the population in order to apply area sampling. In fact, from an area sample, one can estimate the number of reporting units found in the sample of n segments.

An area frame does not become out-of-date in terms of coverage of a population, unless the population extends into areas not covered by the frame. Changes in land use, or number and location of reporting units, have a bearing on the sampling variance but do not introduce bias. Some boundaries of sampling units will lose identity as time passes, which could increase the potential for bias as a result of greater ambiguity about boundary locations. There are two possible reasons for updating an area frame: (1) To maintain or achieve improvements in sampling efficiency, or (2) to introduce updated or new maps to achieve better boundaries of sampling units. Parts can be updated as needed.

Possible uses of area sampling are unlimited. The survey population could be composed of reporting units that are households, persons, farms, plants, animals, cotton gins, suppliers of agricultural inputs, tractors, tracts of land, grain storage facilities, processors of agricultural products, or any other definable reporting units that can be uniquely associated with segments. Adaptability to particular uses, and versatility, are strong attributes of area sampling. Many needs for information have been filled where area sampling was the only means available for selecting a probability sample.

3. CONSTRUCTION OF AREA SAMPLING FRAME

An area sampling frame was developed for each of the 13 parishes in Jamaica. The total land area was subdivided into land use strata based on available infrared photographs, Landsat images and topographic maps. Due to cloud cover problems (Illustration 1), Landsat did not provide any useful information as shown by the mosaic of three Landsat images for Jamaica. Consequently, NASA 1971 infrared photographs and topographic maps were used. The source material used consisted of the latest topographic maps (1968) at a scale of 1:50,000 and NASA infrared photographs for 1971 at a scale of approximately 1:60,000. Strata were identified on the photographic mosaics. These strata were then transferred to the maps with minor changes so the boundaries would correspond to features identifiable on the ground. The land area in each strata was subdivided into smaller contiguous areas of land called "count units" for sampling purposes. The stratification is designed to make the sampling more efficient. The count units within strata are designed to reduce the costs of subdividing the frame into the area sample units (segments) by restricting this task to only those count units actually selected by the random process. A series of slides (Illustration 2) summarize pictorially some of the steps in frame construction. The strata and count units for the parishes are digitized (Figures 1 and 2) to permit registration to Landsat imagery which might be obtained later and incorporated into the estimation method by using the classified pixels for a crop or land use as an auxiliary variable. The boundaries for the small area sampling unit (segments) used for data collection are shown in Figure 3. A photograph or an enlarged photograph is used to control nonsampling errors and provide a basis for registering the field or land use within the segments to Landsat (Illustration 3). The small size of the segment makes the sampling more efficient in the sense that the cost of data collection for a fixed error level is minimized. The variation between segments may also be reduced because the range in acreage values for individual crops is limited to the total acreage in the segment and the segment acreage (i.e., size) is held nearly constant.

Seven primary land use (and water) strata were defined. The number of strata defined depend on the source materials being used in the frame construction and the expected uses. Strata 1, 2, and 3 are the principal strata defined to make the frame efficient for agricultural samples. The populated areas (stratum 6) were defined to permit the number of sampling units assigned to be strictly controlled. These areas were further subdivided into three categories: 61 = metro areas, 62 = parish capitals, and 63 = other populated areas. These populated areas are defined to permit: (1) A more efficient allocation of the sample (for agricultural needs) to several of the other strata, and (2) the frame to be used for sampling households in urban as well as rural areas by employing a different allocation. Several of the other strata are also defined with a dual type of efficiency in mind (efficient allocation of the sample for agricultural purposes and to permit a different allocation for other users). The strata used are as follows:

(1) Intensively cultivated lowlands

(2) Foothills, valleys intensively cultivated primarily above 750 feet

(3) Extensively cultivated crops and pastures

(4) Subsistence or noncommercial agriculture
  (41) marginal agriculture land
  (42) mountaintops and forests

(5) Nonagricultural areas other than populated places

(6) Populated places
  (61) metro areas
  (62) parish capitals
  (63) other populated places

(7) Water ponds, rivers, lakes, reservoirs, swamps

4. AGRICULTURAL INFORMATION

The sample segments are to be visited periodically (usually every quarter) throughout the year to collect data on crop acreage, land use, livestock and households. Consequently, Landsat III images can be combined with the information from the segments nearest the date of the imagery for analysis purposes. Thus, it will be possible to detect changes over time and assess the impact on agriculture as well as other resources of interest. The area sampling units are post-stratified (classified after selection) by Landsat images for estimation purposes. The potential benefits from employing Landsat technology with area sampling are that the data needs and the resources required for large areas can be used to obtain results for smaller areas within an image simultaneously.

The food crop information is to be secured at the beginning of each quarter and summarized in a series of tables. For all food crops the following type of information is secured.

(1) For the past quarter - acres harvested, production, and price at farmgate for any quantities sold.

(2) For the current quarter - (a) acres planted earlier which remain for harvest, and the quarter in which this acreage will be harvested, and (b) new acreage to be planted this quarter and the quarter in which this acreage will be harvested.

(3) For the next quarter which follows - acres to be planted.

(4) For the second quarter which follows - acres to be planted.

All acreage and harvested production are secured separately for crops planted solo and interplanted.

The harvested crop data and preliminary forecasts are shown in Tables I-III for short-season food crops. The procedure used in preparing the preliminary forecasts is to employ the yields for each crop for the past quarter for pure and mixed stands with the acres intended. The initial assumption will be that the actual yield information for the past quarter along with the growing conditions which have just occurred provide the best basis for the users to interpret the information. Future growing conditions are expected to lead to departures from the preliminary forecasts. The crop production forecasts are to be made by parish and possibly for the major crop strata within the parish. A parish strata map would be included so that the location of the potential forecasted crop production would be known approximately for persons seeking to acquire supplies. To obtain total production by quarters, a fourth table is needed to summarize the information in Tables II and III.

5. REFERENCES

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Table I. Harvested Acres, Quantity and Price for Last Quarter

Crop name	Type of stand	Tracts reporting harvested area	Harvested area	Quantity harvested	Average farmgate price per unit
			Acres	Pounds	Cents
Red peas	Pure				XXXX
	Mixed				XXXX
	Total				
Tomatoes	Pure				XXXX
	Mixed				XXXX
	Total				

Table II. Acres Planted in Previous Quarter; This Quarter and Forecast of Production for Short-Season Food Crops

Crop name	Type of stand	Acres planted in a previous quarter and remaining for harvest	Acres expected to be harvested by quarter		Forecasted production for	
			This quarter	Next quarter	This quarter	Next quarter
					Tons	Tons
Red peas	Pure					
	Mixed					
	Total					
Tomatoes	Pure					
	Mixed					
	Total					

Table III. Acres to be Planted by Quarters and Expected Harvest by Quarters for Short-Season Food Crops

Crop name	Type of stand	Acres to be planted		Acres to be harvested		Forecasted production for	
		This quarter	Next quarter	Next quarter	Following quarter	Next quarter	Following quarter
						Tons	Tons
Red peas	Pure						
	Mixed						
	Total						
Tomatoes	Pure						
	Mixed						
	Total						

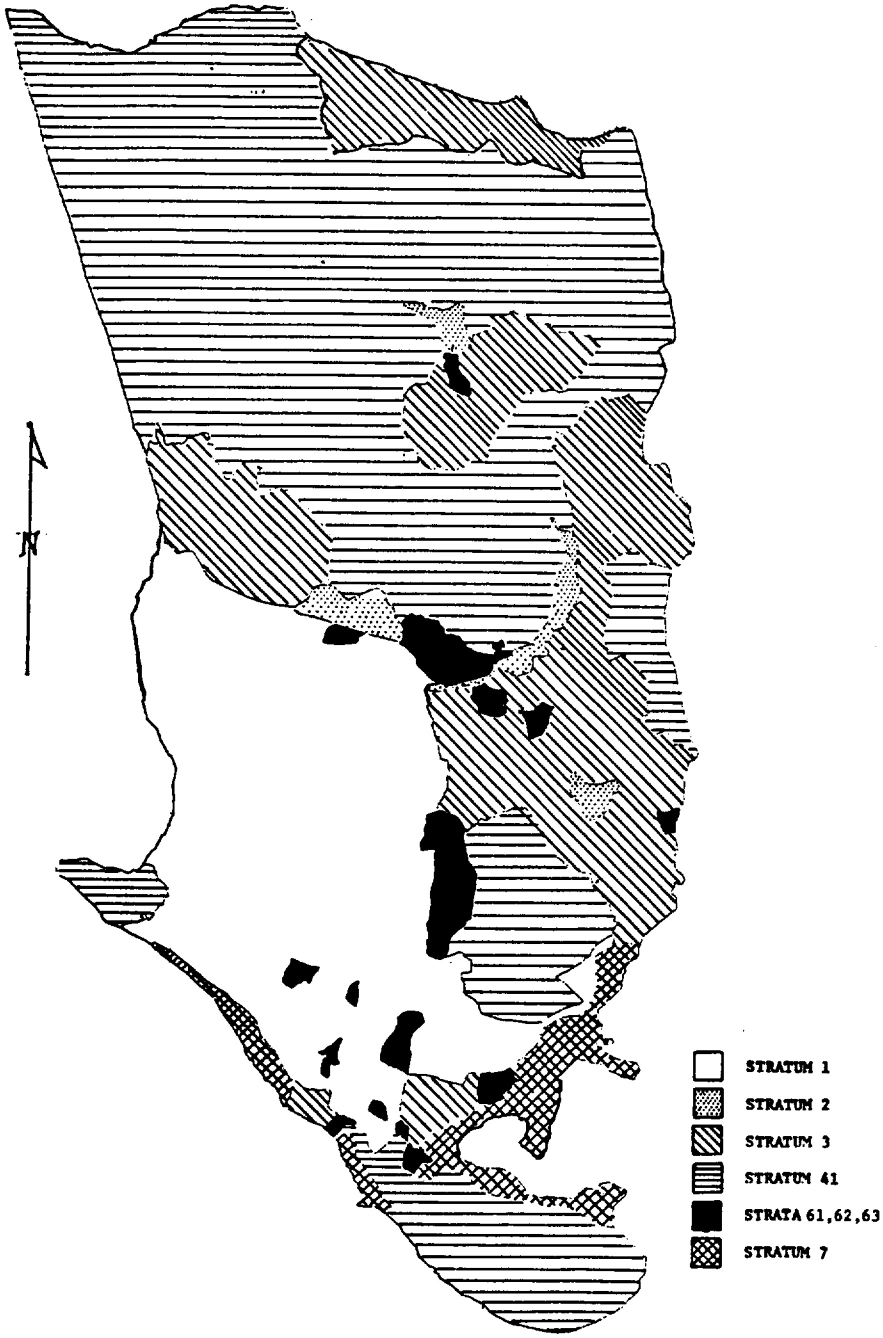

FIGURE 1. STRATA BLOCKS - CLARENDON PARISH, JAMAICA

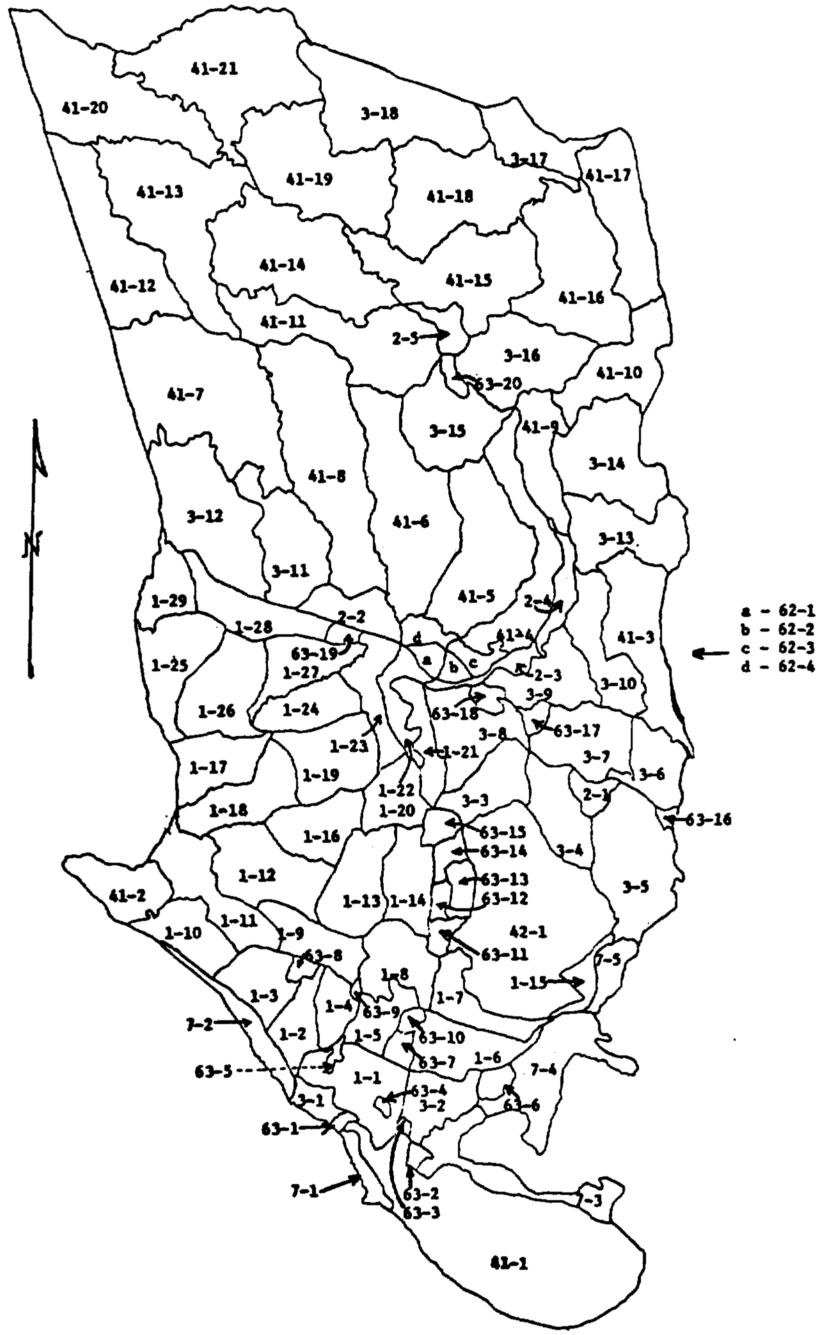

FIGURE 2. COUNT UNITS - CLARENDON PARISH, JAMAICA

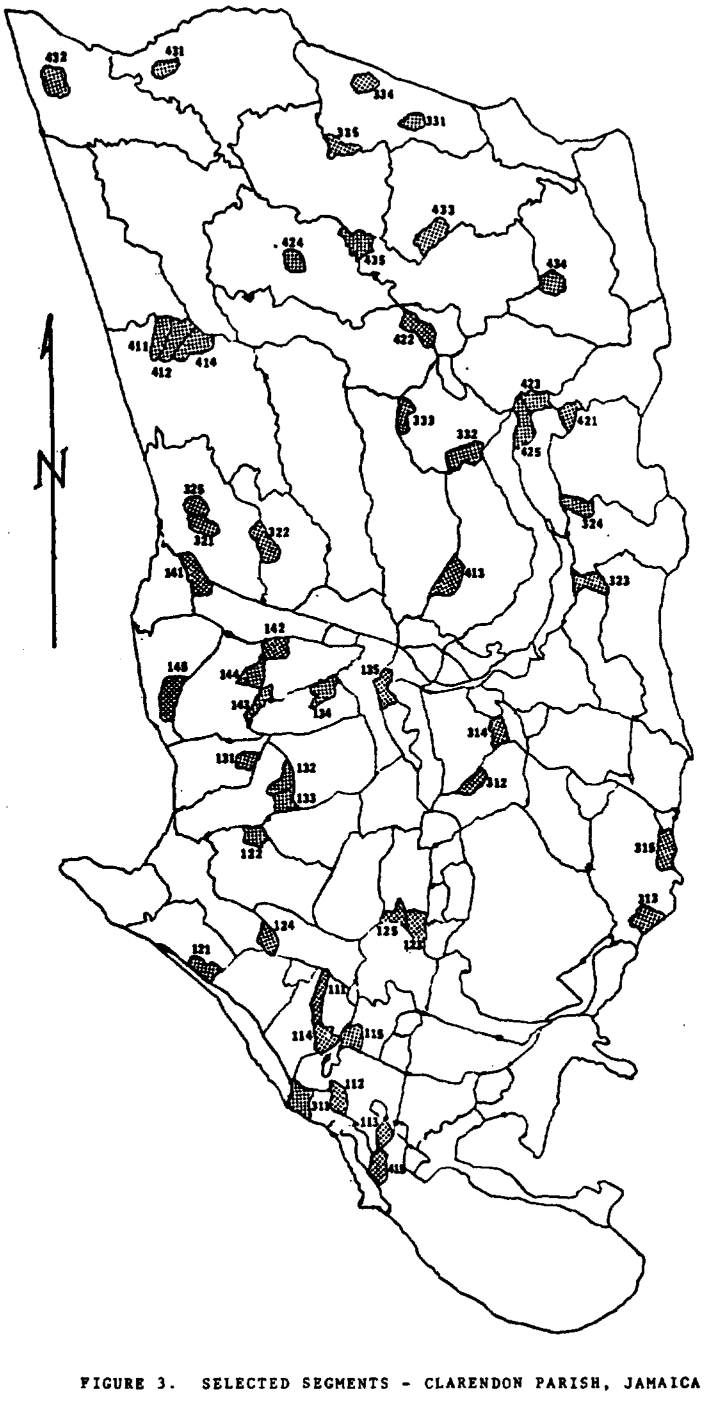

FIGURE 3. SELECTED SEGMENTS - CLARENDON PARISH, JAMAICA