SURVEYS OF CROP PRODUCTION IN JAMAICA

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1. INTRODUCTION

The Crop Production Survey was initiated within the Ministry of Agriculture in 1978 because of the need to provide more precise and more objective estimates of the main agricultural parameters (crop production, irrigation use, land utilization, fertilizers, etc.) and to provide a more reliable base for forecasting agricultural production.

It was recognized from the outset that an area sample was more appropriate for this purpose than a list sample, largely because a list sampling frame gets outdated rather quickly. In this regard, attempts were made to utilize LANDSAT imagery for stratifying the country into homogeneous areas for sampling purposes. Examination of a number of LANDSAT frames showed that this was unsuitable for Jamaica because of the following reasons:

(a) the high incidence of cloud cover, and

(b) the relatively poor spatial resolution without the use of expensive electronic equipment.

As a consequence of the above, use was made of recent aerial photographs, taken at an average height of 25,000 ft. above sea level and at a scale of approximately 1:50,000.

The area frame was constructed with the aid of topographic maps and ground truth in the fall of 1978 and reconstructed in the light of subsequent experience in the winter of 1979. The aerial photographs referred to earlier were used during the reconstruction phase, along with topographic maps and ground truth.

A description of the area frame was contained in a paper[1] presented at the Thirteenth International Symposium on Remote Sensing of Environment. The first survey using this frame was made in early October 1979. The main purpose of the survey was to provide estimates of crop acreages and variances 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 using maps, photographs, and questionnaires.

2. SURVEY DESIGN

The area sample frame was stratified by parish and within parish by intensity of cultivated land as well as some consideration of land elevation. The strata within parish were designated by numbers and briefly described as follows:

Stratum 10: Extensively cultivated lowlands

Stratum 20: Foothills, valleys intensively cultivated but primarily above 750 feet elevation

Stratum 30: Less intensively cultivated area and pasture land

Stratum 41: Marginal agricultural land primarily devoted to subsistence farming

Stratum 50: Nonagricultural areas other than populated places

Stratum 60: Populated places

Stratum 70: Water (ponds, rivers, swamps, lakes, reservoirs)

The initial sample was selected in only strata 10, 20, 30, and 41. The sample allocation was based primarily on the relative historical importance of agriculture in the parishes since variances were not available for determining an optimum allocation. A replicated systematic sample was selected within each stratum. A systematic sample was selected to give a geographic dispersion within each stratum. The replicates were used to provide a valid and unbiased estimate of the sampling error using systematic sampling. An average segment size of ½ square mile was used.

The sample for the first survey was selected from each of the 113 parishes in Jamaica. The sample allocation is given in Table 1 and was designed to provide results from a large number of crops, both acreage and production data and other farm-related data primarily at the country level but also estimates for major crops at the parish level. The variances from the first survey by strata were expected to be used to modify the design before increasing the sample size for the country. Pooled variances within strata for several parishes are to be used as a basis for setting sample size for major crops at the parish level. The sample size of 228 segments was considered adequate for this task. However, the sample size was constrained by the limited resources and personnel available in 1979. The strata, frame count units, and sample segments selected for Clarendon Parish are shown in Figures 1, 2, and 3. However, for the first survey only one-half of the segments shown in Figure 3 were used due to limited resources.

3. ACREAGE AND PRODUCTION FORECASTS FOR SELECTED CROPS

Tables 2, 3, and 4 give estimates at the country level which show the estimates and sampling errors for planted acres as of the survey date in absolute and percentage units (coefficient of variation). Tables 5, 6, and 7 show similar results for the parish of Clarendon, which is a major agricultural parish in the south-central part of the country.

Sampling errors in Tables 2 and 3 with coefficients of variation in the 5-15 range were considered satisfactory and probably would require no special design modification. This group includes the land use items: total farm land, pure crop stands, and grasslands. The uses designated ruinate and the catch-all category of woods, waste and roads would probably not receive any special consideration in the design. Among the crops in Table 3, only sugarcane falls within the 5-15 percent range. A number of crops with errors less than 30 percent hold the most hope of improvement through future design modification. This group includes: red peas, peanuts, pumpkin, corn, plantain, sweet potatoes, the yams and, among the permanent crops, bananas, coconuts and coffee.

For the parish of Clarendon the land use items (Table 5) are estimated with more consistency than at the country level even though the errors are larger. The largest error corresponds to a coefficient of variation of 35 percent. Among the crops, only sugarcane is estimated with acceptable accuracy at the parish level. The next level of errors for crops is in the 40 percent range. These are tomatoes, sweet potatoes, other yams, cassava, and coffee. At the parish level, a group of five or six major crops is about the maximum number for which the error level can be lowered to near 15-20 percent with the resources which can be expected in the near future. It is proposed to evaluate each of the 13 parishes to identify the major crops which can be expected to have acceptable errors at the parish level of 15-20 percent and be consistent with the country objective of having errors of 5-10 percent for major crops and land use categories. It is expected that a more attainable goal will be to have sampling errors of 5-10 percent for major crops at the country level and errors at 15-20 percent level for the major crops for five or six of the most important agricultural parishes. The remaining parishes would be combined into two regional groups for estimation and design considerations.

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 forwarding of completed segments to Kingston had to be accomplished by the field supervisors arranging to pick up finished segments directly from the enumerators. The lack of personal transportation also limited the quality control efforts of supervisor to resolve inconsistencies in the questionnaires.

4. SUMMARIZATION PROCEDURES

The survey data was summarized by a Horizon II microcomputer system[2] with questionnaire data being entered on diskettes through two-user terminals. The data were entered on a farm-tract basis and each section of the questionnaire was screened. That is, consistency checks are made by the computer software for reasonableness. A message is immediately sent via the terminal to the person entering the questionnaire data of any discrepancies. The discrepancies must then be corrected or the operator can indicate that the value(s) is acceptable and wishes to continue with the next section of the questionnaire.

There are 34 tests for consistency of the questionnaire data made during data entry for each tract. The following are examples of the consistency checks made for a tract:

(a) Land use items for tract must sum to the total acreage in tract. If not, an error message is printed on the operator's terminal.

(b) For an individual crop, acres to be harvested plus acres to be planted must be less than the land available as pure stands, mixed stands, in grass or in fallow. If not, an error message is printed on the operator's terminal.

(c) For an individual crop, the areas to be harvested or planted as pure stands plus mixed stands must be equal to the total area to be harvested or planted. If not, an error message is printed on the operator's terminal.

In each situation where an error message is printed, the operator has several options:

(1) change one or more of the data values entered;

(2) accept the values already entered; or

(3) quit processing the tract and ask the supervisor to review questionnaire.

In addition to the consistency checks: (a) yield per acre and prices are examined to see if they fall within acceptable ranges and (b) production is also converted to pounds (using standard conversion factors) for most crops if reported in other units. For corn the values used were:

Crop Code	Yields		Prices		Standard Unit	Conversion Factor to Standard Unit				
	Upper Limit	Lower Limit	Upper Limit	Lower Limit		Lbs	Hund/ Wt	Tons	Qt to Lbs	Other to Lbs
501	2400	500	.27	.09	lbs	1	100	2000	2	0

After all the tract questionnaires for an area segment are entered, a segment software program adds the individual farm tracts to the segment level. If some tracts are missing, the segment program permits adjusting the reported tract data for missing tracts based on either the number of tracts missing or the acres in the tracts missing. When all segments for a parish are entered, an ANALYSIS program makes the estimates and computes the sampling errors. For the country there were 228 segments in the pilot survey and data were entered for a total of 1,750 tract questionnaires in approximately 15 working days. However, there were several days in which data could not be entered because of waiting for questionnaires to be forwarded to Kingston from the field. No information for plots of land not used for agriculture (nonfarm plots) was summarized.

The formula used in making the estimates by strata within parish is as follows:

$$\hat{Y}_h = \frac{N_h}{n_h} \sum_{i=1}^{n_h} X_i = \frac{N_h}{n_h} \sum_{i=1}^{m_h} \sum_{j=1}^{k_h} X_{ij} = N_h \bar{X}_h$$

where $\hat{Y}_h$ = estimated acres for the crop or land use category.

The variance[3] of the estimate is calculated based on either simple random sampling or replicated systematic sampling within a stratum. The operator must indicate which type of sampling has been employed.

$$V(\hat{Y}_h) = \frac{N_h - n_h}{N_h} \frac{N_h^2}{n_h} \sum_{i=1}^{n_h} (X_i - \bar{X}_h)^2 \div (n_h - 1) \text{ for SRS}$$

and

$$V(\hat{Y}_h) = \frac{N_h - n_h}{N_h} \frac{N_h^2}{m_h} \sum_{r=1}^{m_h} (\bar{X}_{rh} - \bar{X}_h)^2 \div (m_h - 1) \text{ for replicated samples}$$

(this formula is alternative version of that shown in reference (3) which was based on expanded replicate totals rather than means)

where X_i = segment value for i^{th} segment in stratum of an item under SRS,

X_{ij} = segment value of j^{th} segment in i^{th} replicate in stratum for an item under replicated systematic sampling,

and $\bar{X}_{rh}$ = segment mean for an individual replicate in stratum for an item.

$$\bar{X}_h = \sum_{i=1}^{n_h} X_i / n_h \quad ,$$

and N_h, n_h refer to segments in frame and in sample for strata,

M_h, m_h refer to replicates in frame and in sample for strata,

$$k_h = \frac{N_h}{M_h} \quad \text{also} \quad n_h = m_h \cdot k_h \quad .$$

For the parish the estimate and variance of an item are:

$$\text{Estimate for Parish} = E_p = \sum_{h=1}^{L} \hat{Y}_h$$

and $$\text{Variance for Parish} = V_p = \sum_{h=1}^{L} V(\hat{Y}_h) \quad .$$

For the country the estimate and variance of an item are:

$$\text{Estimate for Country} = E = \sum_{p=1}^{13} E_p$$

and $$\text{Variance for Country} = V = \sum_{p=1}^{13} V_p \quad .$$

5. FUTURE MODIFICATIONS

The first survey indicated that the sample design and allocation will need to be revised for the specific crops for which it is considered necessary to control the sampling errors. This will probably mean that sampling errors for the other crops will be larger than desired in most cases. However, the larger the number of crops contained in the group for which their errors are controlled, the larger the sample size will become unless some improvements in the stratification can be made. For example, stratum 41 contains a significant acreage of oranges and other crops which indicates that restratification is needed. Some sample segments are clearly in the wrong strata based on an inspection of the aerial photographs. Reallocation of the sample may be expected to be effective for improving the efficiency of the ground provision group. The other crops will need to be handled on an individual basis.

The prospects for an improvement based on a new allocation which will lower the sampling errors to acceptable levels for all parishes are very unlikely. Error levels for five or six parishes can be reduced while trying to satisfy the crops most important for the country through a reallocation of the present sample. The distribution of the additional segments will be done after a careful evaluation of the October 1979 survey and a review of the frame strata.

The survey field staff will shortly be increased from 29 (26 enumerators and 3 supervisors) to 67 (52 enumerators, 13 parish supervisors and 2 regional supervisors). As a result, the sample will be increased from 228 segments to approximately 500.

Also, objective measurement of yields will be started on a continuous basis for at least three crops during 1980 (sugarcane, bananas, and yams) if resources permit. The yield surveys will be used to improve the estimates of production, and forecasts of the crops mentioned.

6. REFERENCES

1. Huddleston, Harold F. and Russell, Roy, "Agricultural and Resource Assessment in Jamaica Using an Area Sampling Frame," Thirteenth International Symposium on Remote Sensing of Environment, Ann Arbor, Michigan, April 1979.

2. Luebbe, Raymond C., "Jamaica Microcomputer Data System for Crop Production Surveys," U.S. Department of Agriculture, Washington, D.C., December 1979.

3. Huddleston, Harold F., "A Training Course in Sampling Concepts for Agricultural Surveys," SRS No. 21, U.S. Department of Agriculture, Statistical Reporting Service, Washington, D.C., April 1976.

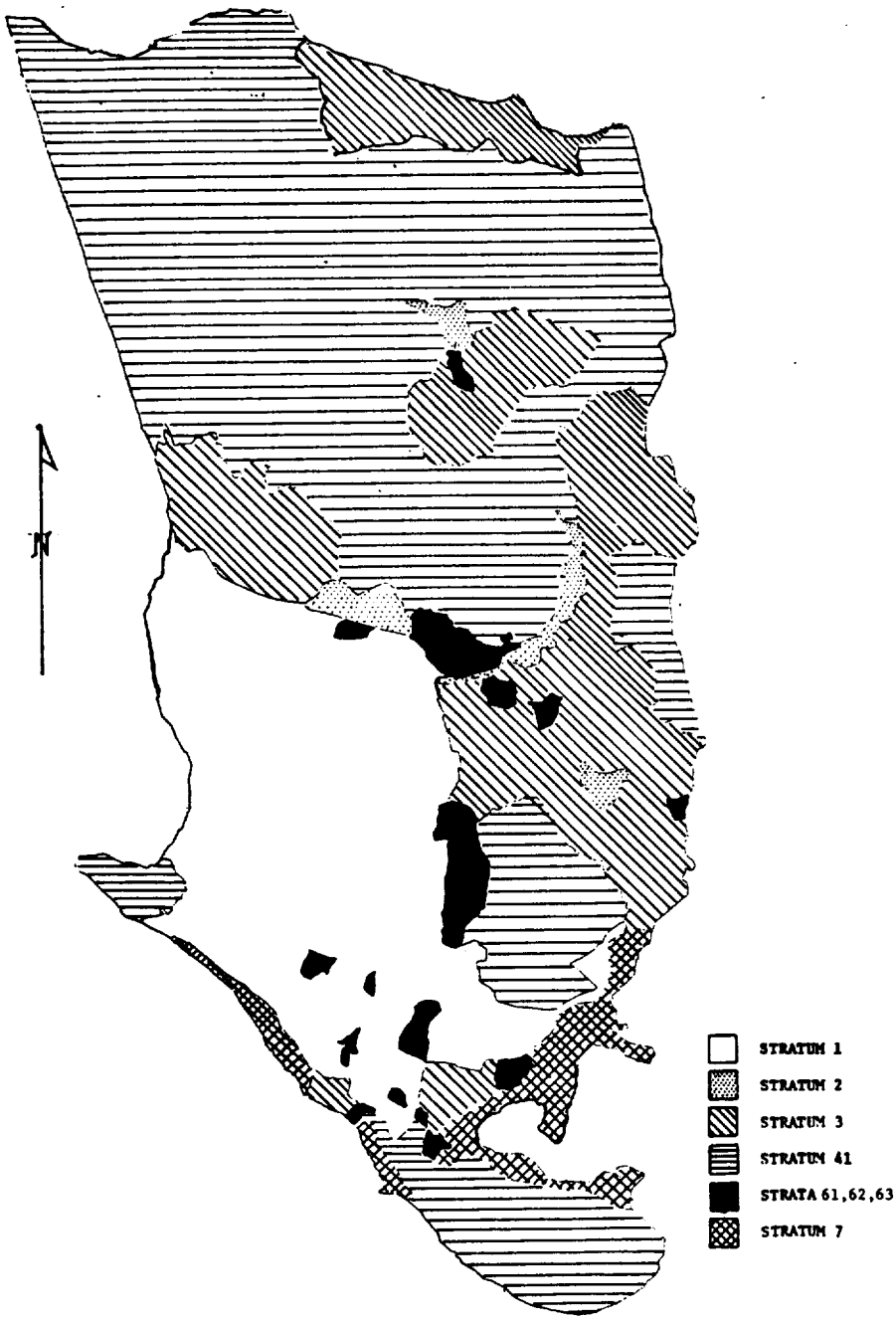

FIGURE 1. STRATA BLOCKS - CLARENDON PARISH, JAMAICA

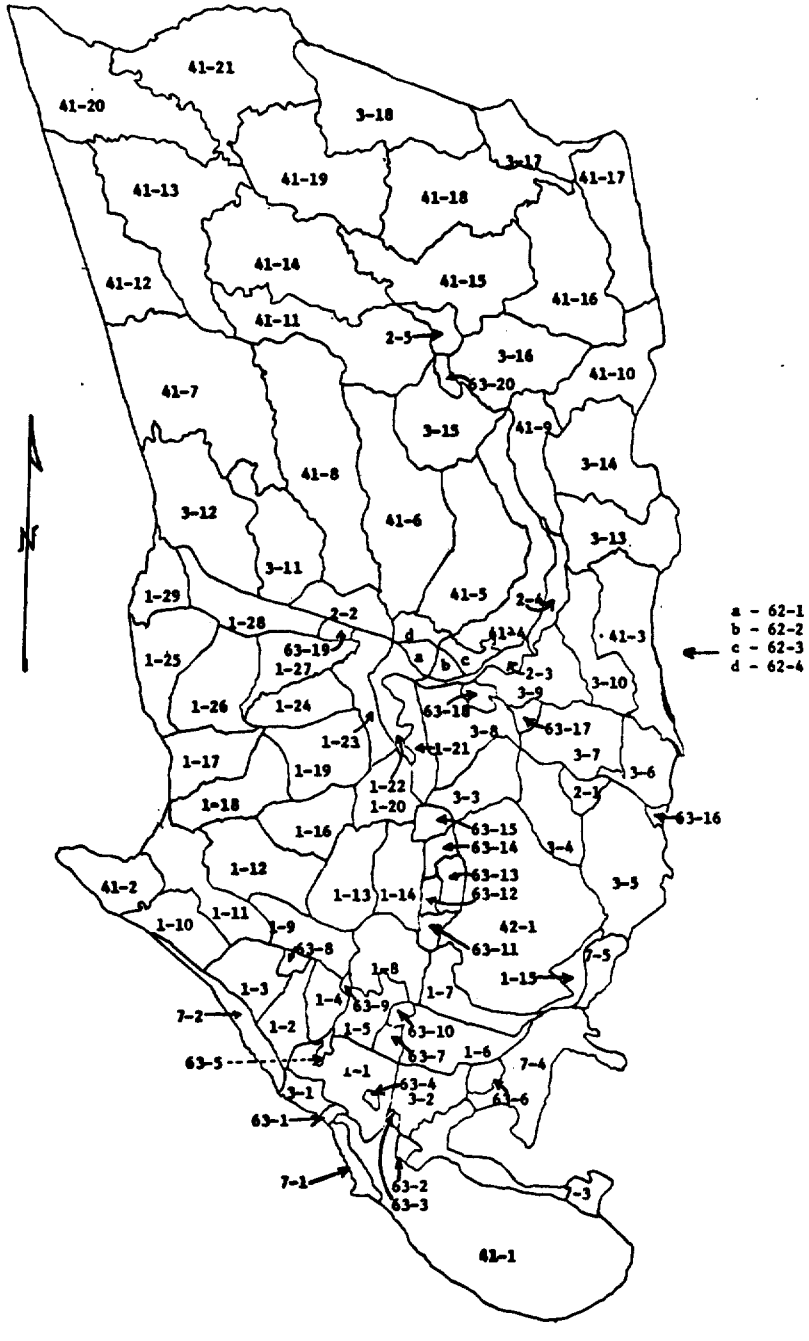

FIGURE 2. COUNT UNITS - CLARENDON PARISH, JAMAICA

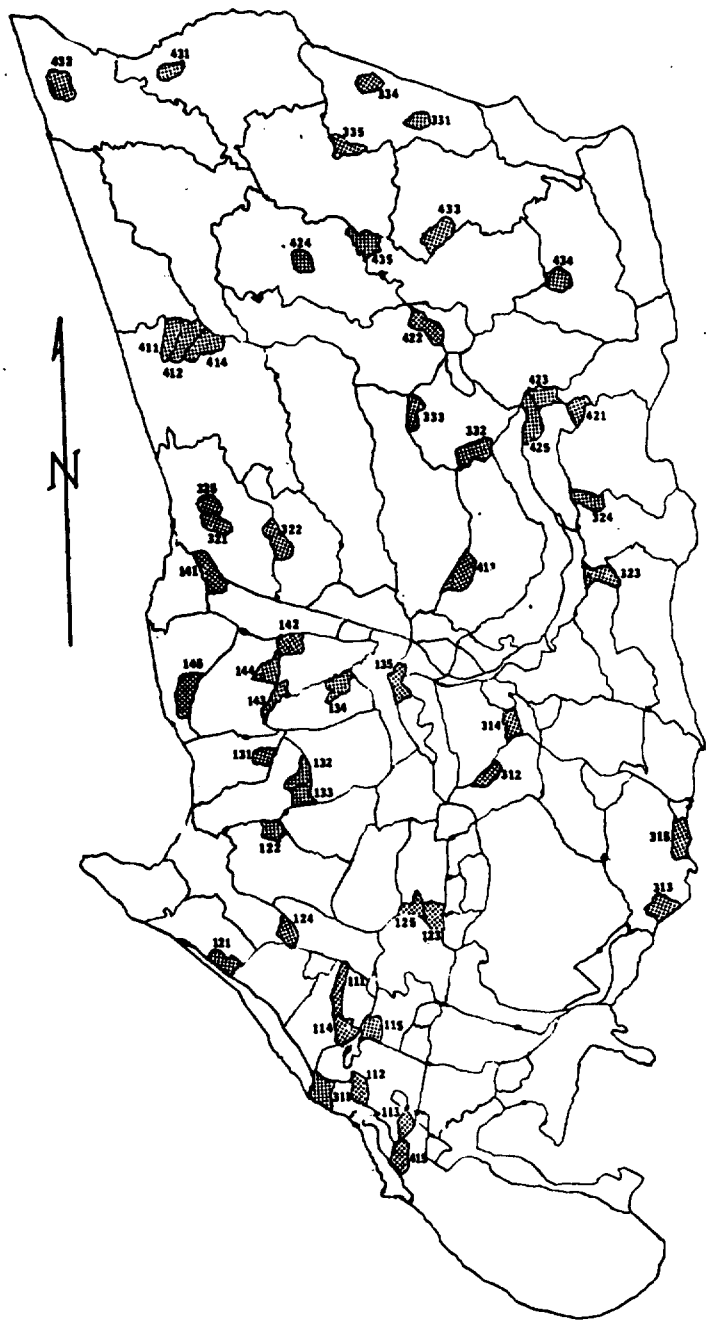

FIGURE 3. SELECTED SEGMENTS - CLARENDON PARISH, JAMAICA

Table 1. Segment Allocation by Parish and Strata

Parish	Strata				Total
	10	20	30	41	
St. Andrews	0	0	0	12	12
St. Thomas	2	4	2	4	12
Portland	2	0	6	8	16
St. Mary	0	6	6	4	16
St. Ann	1	0	8	12	21
Trelawny	2	0	9	2	13
St. James	2	0	2	6	10
Hanover	4	0	6	2	12
Westmoreland	6	0	6	6	18
St. Elizabeth	4	0	16	6	26
Manchester	0	0	12	9	21
Clarendon	12	0	9	6	27
St. Catherine	8	2	6	8	24
Country	43	12	88	85	228

Table 2. Use of Farm Land, 4th Quarter 1979 - Jamaica

Farm Land Uses:	Estimated Acres (1)	Error in Estimate (2)	Relative Error (%) (2) ÷ (1) (3)
Total Farm Land in Current Use	1,189,940	64,200	5.3
In Pure Crop Stands	349,689	28,790	8.2
In Mixed Crop Stands	100,188	23,240	23.2
In Grasslands	294,095	28,240	9.6
In Fallow	44,757	28,650	64.0
In Ruinate	241,566	39,430	16.3
In Building Sites	51,833	25,933	50.0
In Wood, Waste, Roads, etc.	109,234	18,544	17.0
Number Farm Tracts in Samples	1,724		
Number Farm Tracts Not Interviewed	146		

Table 3. Estimated Acres Planted or To Be Planted for Principal Crops 1/
4th Quarter 1979 and 1st Quarter 1980 - Jamaica

Crop Group	Crop	Standing on Oct. 1			To Be Planted		Total Area 2/ Available for Harvest Between 10/1/79&7/1/80
		Estimated Acres	Standard Error		Oct.-Dec.	Jan.-Mar.	
			Acres	Pct	Estimated Acres	Estimated Acres	Estimated Acres
Pulses	Red Peas	1,405	276	19.6	3,782	3,607	8,794
	Gungo Peas	8,143	2,562	31.4	1,390	2,188	11,721
	Cow Peas	815	389	47.7	312	525	1,652
	Peanuts	1,545	429	27.8	2,240	3,326	7,111
Vegetables	Cabbage	1,419	1,039	73.2	1,209	649	3,277
	Tomato	664	240	36.1	1,002	405	2,071
	Pumpkin	1,014	226	22.3	711	593	2,318
Cereals	Corn	7,296	2,012	27.6	2,835	5,052	15,183
Plantain	Horse	11,819	1,906	16.1	388	947	13,154
Ground Prov.	S. Potato	7,332	2,142	29.2	4,065	1,446	12,843
	Yellow Yams	8,247	1,714	20.8	855	2,964	12,066
	Negro Yams	3,561	1,023	28.7	526	1,722	5,809
	Other Yams	10,346	2,465	23.8	343	5,204	15,893
	Cassava	6,151	2,074	33.7	2,016	2,700	10,867
Permanent Crops	Banana	83,665	20,857	24.9	1,676	5,271	83,665 3/
	Sugarcane	192,129	21,839	11.4	1,142	23,765	192,129 3/
	Coconut	51,813	11,918	23.0	1,325	399	51,813 3/
	Coffee	21,422	5,714	26.7	442	452	21,422 3/
	Oranges	32,413	18,910	58.3	104	350	32,413 3/

1/ Includes only crops with 1,500 acres or more planted or to be planted.
2/ Acres standing plus acres to be planted by 4/1/80.
3/ New plantings of permanent crops will not be harvested because of long-growing periods required for these crops.

Table 4. Estimated Acres and Production To Be Harvested for Principal Short-Season Crops 1/ During 4th Quarter 1979 and 1st Quarter 1980 - Jamaica

Crop	Area Standing Oct. 1, 1979 (acres)	Expected To Be Harvested		Historical 2/ Yield (short tons)	Expected Production 3/	
		4th Q/79 (acres)	1st Q/80 (acres)		4th Q/79 (short tons)	1st Q/80 (short tons)
	(1)	(2)	(3)	(4)	(5)	(6)
Red Peas	1,405	1,123	269	.48	539	129
Gungo Peas	8,143 4/	2,094	6,563	.30	628	1,969
Cow Peas	815	633	182	.34	215	62
Peanuts	1,545	1,138	315	.35	398	110
Cabbage	1,419	585	491	2.50	1,463	1,228
Tomato	664	460	193	3.00	1,389	579
Pumpkin	1,014	465	436	2.50	1,163	1,090
Corn	7,296	3,260	3,762	.44	1,434	1,655
Horse Plantain	11,819	4,490	4,738	2.50	11,225	11,845
Sweet Potato	7,332	2,148	4,186	2.44	5,241	10,214
Yellow Yam	8,247	3,304	4,344	2.43	8,029	10,556
Negro Yam	3,561	2,137	701	2.45	5,236	1,717
Other Yam	10,346	3,069	5,461	2.24	6,875	12,233
Cassava	6,151	1,455	1,200	2.20	3,201	2,640

1/ Individual crop listed in Table 2 excluding permanent crops.
2/ Based on previous survey reports by growers.
3/ Columns 2 and 3 multiplied by column 4.
4/ Multiple harvesting of acres is a common practice.

Table 5. Use of Farm Land, 4th Quarter 1979 - Clarendon Parish

Farm Land Uses:	Total Acres (1)	Error in Estimate (2)	Relative Error (%) (2) ÷ (1) (3)
Total Farm Land in Current Use	93,445	20,188	21.6
In Pure Crop Stands	60,085	16,206	27.0
In Mixed Crop Stands	2,457	208	8.5
In Grasslands	11,819	2,511	21.2
In Fallow	4,185	648	15.5
In Ruinate	1,441	330	22.9
In Building Sites	1,121	371	33.1
In Wood, Waste, Roads, etc.	12,337	4,299	34.8
Number Farm Tracts in Samples	168		
Number Farm Tracts Not Interviewed	10		

Table 6. Estimated Acres Planted or To Be Planted for Principal Crops 1/
4th Quarter 1979 and 1st Quarter 1980 - Clarendon Parish

Crop Group	Crop	Standing on Oct. 1			To Be Planted		Total Area 2/
		Estimated Acres	Standard Error		Oct.-Dec.	Jan.-Mar.	Available for Harvest Between 10/1/79 & 7/1/80
			Acres	Pct	Estimated Acres	Estimated Acres	Estimated Acres
		(1)			(2)	(3)	(4)
Pulses	Gungo Peas	1,336	735	55.0	53	632	2,021
	Cow Peas	314	311	99.0	60	278	652
	Peanuts	321	242	75.4	1,013	1,269	2,603
Vegetables	Tomatoes	108	52	48.1	329	168	605
Cereals	Corn	610	358	58.7	139	315	1,064
Ground Prov.	Sweet Potatoes	462	178	38.5	444	372	1,278
	Yellow Yams	625	472	75.5	36	69	730
	Negro Yams	658	567	86.2	95	582	1,335
	Other Yams	572	245	42.8	33	11	616
	Cassava	250	111	44.4	174	168	592
Permanent Crops	Banana	4,439	3,063	69.0	69	0	4,439 3/
	Sugarcane	32,154	4,558	14.2	0	0	32,154 3/
	Coffee	1,818	832	45.8	211	21	1,818 3/
	Oranges	18,939	17,741	94.5	104	0	18,939 3/

1/ Includes only crops with 500 acres or more planted or to be planted.
2/ Acres standing plus acres to be planted by 4/1/80.
3/ New plantings of permanent crops will not be harvested because of longer growing periods required for these crops.

Table 7. Estimated Acres and Production To Be Harvested for Principal Short-Season Crops 1/ During 4th Quarter 1979 and 1st Quarter 1980 - Clarendon Parish

Crop	Area Standing Oct. 1, 1979 (acres)	Expected To Be Harvested		Historical 2/ Yield (short tons)	Expected Production 3/	
		4th Q/79 (acres)	1st Q/80 (acres)		4th Q/79 (short tons)	1st Q/80 (short tons)
	(1)	(2)	(3)	(4)	(5)	(6)
Gungo Peas	1,336 4/	226	1,068	.30	68	320
Cow Peas	314	306	8	.34	104	3
Peanuts	321	164	157	.35	57	55
Tomatoes	108	92	16	3.00	276	48
Corn	610	230	230	.44	101	101
Sweet Potatoes	462	231	170	2.44	564	415
Yellow Yams	625	259	322	2.43	629	782
Negro Yams	658	305	154	2.45	747	377
Other Yams	572	258	86	2.24	578	197
Cassava	250	26	179	2.20	57	394

1/ Individual crop listed in Table 2 excluding permanent crops.
2/ Based on previous survey reports by growers.
3/ Columns 2 and 3 multiplied by column 4.
4/ Multiple harvesting of acres is a common practice.