PRODUCTIVITY, EFFICIENCY AND MARKETED SURPLUS IN JAMAICAN AGRICULTURE

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Introduction

The picture drawn by the McIntyre Committee report on the food required to feed the international community is very gloomy in that the food deficit is widening rather than narrowing down as years pass by.[2] Hence the spectre of hunger will be haunting the vulnerable sections of the world economy from time to time in the years to come, owing to the unchecked population growth in the majority of the developing countries and their inability to become self-sufficient in food production. Hence, the increased food production must be given top priority in any agricultural programme of the developing countries.

Obviously, the problem is indeed a complex one. Let us develop a conceptual framework to concentrate on a manageable aspect of this problem.

In the first place, the problem must be looked at from the supply side as well as the demand side. The demand side should investigate the domestic consumption pattern and the deficit areas of the food requirements of the region under consideration. Here, we are concentrating only on the supply side of the problem. The supply can be directed towards the domestic economy or the international economy. In the latter case, the obvious assumption is that the food requirements can be met by imports. Even though a choice of the above alternatives depends on the type of economy under consideration and needs a detailed cost-benefit analysis, we are concentrating only on the problems related to increased food production to meet the domestic requirements.

The major issues aiming at an increased food production for the domestic market can be divided into three important aspects. First, it should look at the economics of production such as the utilization of various inputs and its efficiency, the nature of the technology, etc. Secondly, it should look at the type of soil and climatic factors and identify the feasible crops for production. Thirdly, it should look at the institutional factors such as the land law, the credit institutions and the whole rural setting. Again, we narrow down to the pure economics of food production.

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[1] This paper is a combined and slightly revised version of the "Background Paper for the Case Study of Jamaica" and the "Productivity, Efficiency and Marketed Surplus in Jamaican Agriculture - An Exploratory Note" read at the 13th West Indies Agricultural Economics Conference held in St. Kitts from the 9th - 15th April 1978.
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[2] See Sunday Advocate-News, May 15, 1977, p. 11 and "Towards an International Economic Order", (20) pp.44-49.

This can be analysed under two distinct cases, viz., (i) analysis under the distribution of land remains the same and (ii) analysis under a change in the distribution of land. Even though some of the problems are common for both situations, there are important differences. One such difference is the appropriate size of farm in the case of an increased food production under a change in distribution. Moreover, change in the distribution of land has wide implications in respect of employment creation and in the reduction in the inequality of income distribution, the two most important indicators of development advocated by Seers.[3] The impact of such a programme can only be assessed with the help of the nature of production per unit of land, the proportion marketed and the utilization of capital and labour by size of farm. Even though these issues are extensively debated in the context of land reforms in developing countries, hardly any attempt has been made to investigate these relationships in the Caribbean context.[4] The case study in Jamaica is directed towards some of these issues in detail.

The Data

The data used for this investigation is based on the study, Edwards (9), conducted on small farming in Jamaica and the report, Department of Statistics (7), on production costs and output in large and small agriculture.[5] The sample size in each size of farm on which the whole analysis is based is presented in Table 1.

Table 1. Sample Size by Size of Farm

Size of Farm[(a)] (acres)	No. of Sample
0 - 4.9	10
5 - 9.9	9
10 - 24.9	6
25 - 99.9	2
100 - 499.9	12
500 and over	12

Sources: Table 3.1 of the Report
Table 16 of the Appendix A of the Study
Note: (a) See Appendix A for definition

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[3] See, for a discussion, Seers (18) p.3 and Dorner (8) p.15.

[4] For a summary of the controversy in the Indian context about the production per unit of land, see Sen (19) pp.147-149, about the marketed surplus by size holding, Bhagwati and Chakravarty (5) pp.35-40, and about the efficiency, Bhagwati and Chakravarty (5) p.44.

[5] Hereafter, we refer to Edwards (9) by 'the Study' and the Department of Statistics (7) by 'the Report'.

The selection of sample in each stratum needs some brief explanation. Even though 93 farms are selected at random from 8 types of farming areas for the study on the basis of land use, soil type and climate, only 87 schedules were completed. Owing to non-availability of suitable recorders, it proved impossible to commence weekly recording for more than 68 of the 93 farms. Weekly records were collected for only 48 farms because the recorders abandoned recording. Of the 48 farms, only 27 farms are included in the final analysis because of the doubtful accuracy of the other 21 farms.[6] Edwards (9) establishes the representative nature of the sample by showing the closeness of the networth of the 87 farms and the 27 farms.[7] All farms in the group 500 and above are covered in the survey and the sample in the group 100 - 499.9 is collected by taking a 20 per cent random sample with replacement for each parish, with probability proportional to size (acreage) of farms.[8] Parish level data is used owing to the difficulty in getting the farm level data for farms above 100 acres. Out of 13 parishes, St. Andrew is excluded because of its abnormal values.

Marketed Surplus and Size of the Farm

The relationship between the proportion of output marketed and the size of farm was first discussed by Narain (12) who also attempted to investigate it empirically in the Indian situation. Narain (12) with numerous 'adjustments' due to data limitations, arrived at the conclusion that the distribution of marketed surplus by size of holding is bi-modal.[9] In other words, Narain postulated that the proportion at first decreases and then increases as size of the farm increases. Patnaik (13) questioned the above hypothesis and worked out the proportion marketed according to size of farm and found that the proportion marketed increases with the increase in size of the farm.[10]

The proportion marketed (sales) by size of farm to total production in Jamaican agriculture is worked out and the result is given in Table 2.

Table 2. Proportion of Marketed Surplus by Size of Farm.

Size of Farm (acres)	Marketed Surplus
	Total Production (%)
0 - 4.9	55.27
5 - 9.9	66.23
10 - 24.9	72.13
25 - 99.9	78.45
100 - 499.9	100.00
500 and over	100.00

Sources: Tables 16, 23 and 25 of the Appendix A of the Study
Tables 3.10 and 3.14 of the Report.

[6] See for the methodology, Edwards (9) pp.37--49.

[7] See footnote, Edwards (9) p.48.

[8] See explanatory notes, Department of Statistics (7).

[9] Bhagwati and Chakravarty (5) p.36.

[10] See Patnaik (13) p.90.

Evidently, the proportion increases as the size of farm increases.[11]

Gross Output per Acre and Size of Farm

The productivity by size of farm is essential to investigate the likely impact of any land reform aiming at the disaggregation or aggregation of the farm.[12] It is argued that the relevant productivity for developing countries should be in terms of returns to non-labour resources rather than the abundant labour and the measure of labour productivity is applicable to only the labour scarce economies.[13] If the relevant productivity measure is output per scarce resource, then it is widely known that there is an inverse relationship between the size of farm and output per unit of land in the developing economies.[14] The gross output per acre by size of the farm in Jamaican agriculture is worked out and presented in Table 3.

Table 3. Average Gross Output per Acre by Size of Farm (1965 Price).

Size of Farm (acres)	Gross Output per Acre (J$)[a]
0 - 4.9	54.48
5 - 9.9	39.93
10 - 24.9	21.01
25 - 99.9	14.27
100 - 499.9	11.19
500 and over	21.39

Sources: Tables 16 and 28 of the Appendix A of the Study.
Table 3.1 and 3.11 of the Report.

Note: [a]See Appendix B for methodology.

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[11]The whole debate loses its significance in the case of crops whose on-farm consumption is negligible. For example, above 100 acres, the production is purely for sales from Table 2.

[12]This is an essential ingredient of any land reform. See Lang (11) p.200, for a definition of land reform.

[13]For an interesting discussion, see Lang (11) pp.203-204.

[14]A graphical illustration of this hypothesis using international data, see Dorner (8) pp.120-123 and also for India, Lang (11) pp.204-206 and Bharadwaj (3) pp.91-92.

This finding is in agreement with the existing hypothesis, viz., the lower the farm size, the higher will be the productivity.[15]

This inverse relationship can be attributed to the price structure of the products produced by different size groups, or to the few sample points in each stratum. But there exists some evidence to suggest that this is not the case. The Department of Statistics (6) observes that 'a noteworthy feature of the changing characteristics of number and acreage of farms over the period (1954-68) is that despite the increase and the subsequent decreases in the number of large farms accompanied by an increase in the small farms, the average contribution per farm to GDP (at current prices) increased over the period'.[16]

In the debate on inverse relationship between gross output per acre and size of farm among the Indian farms, Sen argued that the inverse relationship can be due to the 'plausibility of an inverse relationship between size and fertility arising from population growth, subdivision and sales'.[17] This assumes that the first settlement on land was purely on the basis of its fertility. But this assumption is not valid in the Jamaican situation because the fertile land was occupied by large farms (plantations) and the poor quality land was given to small farms owing to historic reasons.[18]

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[15] This finding is similar to the one for Brazil as shown in Dorner (8) p.121. The hypothesis is consistent if the argument is confined either to <500 acre farms or to the farms excluding the middle farms (10-499.9). The increase in output per acre in ≥500 acre farms over the size group 100-499.9 is to be judged along with the following findings:

(1) The utilization of land is, on the average, higher for ≥500 acre farms than the farms in the size group 100-499.9 (see Table 5 of this Note).
(2) The 500 acre farms sell about 62% of their output directly to the manufacturers and 37% to the distributors and the respective percentages, for the size group 100-499.9, are 57% and 36% (Table 3.11 of the Report) and hence a possible over-estimation of the gross output of ≥500 acre farms due to the inclusion of the value added from distribution.
(3) The entire population is covered for ≥500 acre farms and only 20% of sample is covered for the farms 100-499.9.
(4) The product mix of the output of the two size groups given in the Report could not be broken down to assess the influence of relative price in arriving at the gross output.

[16] Department of Statistics (6) p.11.

[17] See Sen (19) p.148.

[18] See the reasons for low quality of small farms, Beckford (4) pp.23-24, Edwards (9) p.27. 'Norton and Cumper found a distinct correlation between the census-revealed occupancy pattern of plantations with the geological boundary of the alluvial deposits and of peasant farms with lower and less precipitous hills, slopes and accessible river', quoted from Beckford (4) p.24. A further evidence to the poor quality of small farms is the land acquired by Government for settlement during 1929 and 1949. According to Beckford (4), only 4% of such settlements were of the most fertile land.

The 'statistical-illusion' explanation put forward by Rao (15) and Rudra (16), the former in a mild form and the latter in a strong form, to explain the inverse relationship between farm size and gross output per acre is tested using farm level data for farms of size 99.9 acres and below.[19] A double log function is fitted for 27 farms and the regression equation is presented below:

$$\log O = \underset{(0.31)}{4.4} + \underset{(0.14)}{0.35} \log N, \quad R^2 = .19;$$

where O is the gross output per acre and N, the size of the farm.[20] The coefficient of log N is significantly less than unity and the upper limit of 99% confidence interval is also less than unity. Hence there is no evidence to believe that the relationship is due to any averaging bias in the aggregation process.*

Therefore, the only explanation to put forward to this relationship is that the small farmers try to maximize the output by applying more labour, at which the marginal product is equal to or close to zero and the large farms combine the factors of production (land, labour, capital) in such a way that the profit is maximized.[21]

Factors of Production and Size of Farm

It is held that the small farmers in Jamaica are inefficient compared to large farmers.[22] The reasons put forward are the use of hand methods for cultivation, the low quality of land, the limited access to the supply of resources and the lack of proper managerial function.[23] Some of the above statements are tested by working out the input requirements and input proportions by size of farm in Table 4.

Some broad conclusions can be drawn from Table 4 (ignoring the middle two groups, viz. 10-24.9 and 25-99.9). On the average, farms above 100 acres use about 233% more land, 86% less labour hours, and 135% more capital than that used by farms (0-9.9) to produce J$100's worth of output. A look at the labour and capital requirements on a per acre basis indicates that large farms above 99.9 acres save both capital and labour compared to farms below 10 acres.

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[19] See Sen (19) pp.148-149.

[20] The farms above 99.9 acres are not included in the analysis because of the difficulty in getting farm level data. The values in parenthesis are standard errors of estimates. A similar study for Indian farms, see, Saini (17) and Jamaican farms, Pushpangadan (14).

[21] See Pushpangadan (14) for this point and Bhagwati and Chakravarty (5) p.41.

[22] Edwards (9) p.28 and IBRD (10) p.13.

[23] Edwards (9) p.27.

*Editors Note: The arguments advanced here are rather puzzling.

Table 4. Amount of Resources Used to Produce J£100's Worth of Gross Farm Output - Size of Farm (1965 Price).

Size of Farm (acres)	Average Inputs Used to Produce J£100's Worth of Gross Output				Labour-Land Ratio	Capital-Land Ratio
	Land (acres)	Capital[c] (J£)	Other Costs[d] (J£)	Labour[e] (hrs.)		
	(1)	(2)	(3)	(4)	(5)	(6)
0 - 4.9	1.84	154.15	13.54	1152.22	842.41	83.98
5 - 9.9	2.50	193.05	15.70	1182.44	470.23	77.09
10 - 24.9	4.76	266.21	13.07	1392.64	292.01	55.93
25 - 99.9	7.01	136.57	33.11	1523.98	218.47	19.49
100 - 499.9	8.91	405.77	10.47	166.50	18.69	49.60
500 and over	4.67	231.58	8.43	199.30	42.70	51.42

Sources: (1) Same as in Table 3 above.
(2) Tables 3.1, 3.2, 3.12, 3.13 and 3.14 of the Report.

Notes: [c,d,e] See Appendix C for definitions.

Table 5. Efficiency Index, Intensity of Cultivation, Labour Manager Ratio for Farms Above 100 Acres, by Parish.

Parish	Efficiency Index[f]		Labour-Manager Ratio		Intensity of Cultivation	
	100 - 499.9	500 and over	100 - 499.9	500 and over	100 - 499.9	500 and over
St. Thomas	3.33	5.43	2	18	66.49	65.76
Portland	6.38	7.57	6	17	26.32	47.29
St. Mary	4.61	6.29	16	19	70.46	77.73
St. Ann	4.44	4.86	15	15	57.06	51.39
Trelowny	7.22	6.43	-	40	30.23	44.97
St. James	7.56	5.57	15	30	25.74	44.17
Hanover	7.33	5.71	-	11	20.06	45.99
Westmoreland	5.22	6.00	3	36	27.11	58.78
St. Elizabeth	4.78	8.00	-	98	57.43	32.21
Manchester	5.56	6.29	-	14	48.56	44.73
Clarendon	6.89	8.29	16	268	48.69	45.66
St. Catherine	5.33	7.29	8	37	61.64	54.04

Source: Table 1.1, 2.1, 2.14 and 1.14 of the Report

Note: [f] See Appendix D for methodology.

The efficiency of farms at a parish level and the role of management are examined by constructing efficiency indices for farms in the group 100-499.9 and 500 and over and the result is summarised in Table 5. Since land utilization is very important in the context of increased production, the intensity of cultivation

$$\left(\frac{\text{Acre cultivated}}{\text{Total area of the farm}} \times 100\right)$$

is also calculated and the summary is given in Table 5.

The land utilization is maximum in St. Mary for both groups of farms, followed by St. Thomas and the lowest in St. Elizabeth for 500 and above and in Hanover for the farm size 100-499.9. The intensity of cultivation ranges from 32% to 78% for the large farm (500 and over) and for the medium farm (100-499.9) from 20% to 70%.

The efficiency index is constructed in such a way that the efficiency is inversely related to the value of the index, i.e., the lower the value of the index, the higher will be the efficiency. The efficiency medium farm (St. Thomas) has the minimum labour-manager ratio, but this is not clear for large farms except at the bottom of the efficiency ladder. The least efficient large farms (Clarendon and St. Elizabeth), according to this criterion, have the highest labour-manager ratios. Correlation analysis confirms that the efficiency index is positively correlated with labour-manager ratio in 500 and over acre farms and negatively correlated with intensity of cultivation in 100-499.9 acre farms.[24]

Conclusion

The marketed surplus as a proportion of total output increases with the size of the farm. The productivity per acre is inversely related to the size of farm. Neither the fertility based explanation nor the statistical-illusion explanation has any validity for this inverse behaviour between output per acre and size of farm. The large farms save both capital and labour on a per acre basis. The best efficient medium farm (100-499.9) has the minimum labour-manager ratio, and the least efficient large farm (500 and over) has the highest labour-manager ratio. Efficiency index is significantly associated with labour-manager ratio in 500 and over acre farms. Intensity of cultivation and the efficiency index are negatively correlated in 100-499.9 acre farms.

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[24] See Appendix E for the findings.

Appendix A

The size of the farm is slightly different from that used by Edwards (9). To keep a more homogeneous definition for all the farms included in the table, the size of the farm is the size of the farm at the beginning of the survey, ignoring the seasonal variation.

Appendix B

To express all the estimates in current prices, a price index is constructed as follows:

In order to construct the price index, we have to consider the time of the data collection for the Study and for the Report. The data collection for the Study started in May 1954, Edwards (9), p.46 and, for the Report, it was completed in 1968, Department of Statistics (7), p.(i). In a personal interview with the Director of the Department of Statistics, the author was told that the records examined for the Report were up to the accounting year 1964-65. Therefore, the price index is constructed from 1954 to 1965 in the following way, in three steps. In Step I, the price rise from 1954 to 1955 is constructed as the arithmetic mean of the price indices of food and non-food items from Adams (1), Table 1, p.2 which worked out to be 3.5 per cent.

In Step II, the retail price index of Kingston and of rural areas in 1965, from the base 1955, are obtained from the Bank of Jamaica (2), Table 21. The two indices are combined using a weight of .25 to Kingston index and .75 to rural index as done by Adams (1), p.2.

In Step III, an adjustment is made to the price index obtained in Step II to get the final index (inflated by 3.5 per cent).

Appendix C

The following terms are defined to give the maximum homogeneity possible throughout the samples. The definition of capital in the large farms, above 99.9, includes both fixed capital including livestock and expenditure on building, land, livestock and material consumption. Other expenses in the large farm are defined as the sum of the expenditure on service, miscellaneous costs, warehouse and marketing. The labour hours for the large farms are worked out by miltiplying the number of employees by standard working hours per year (35 x 52).

Appendix D

The following quantities are worked out for each parish for medium and large farms; the intensity of cultivation, gross output per unit of cultivated area (C.A.), wages per C.A., consumption of materials per C.A., services, miscellaneous costs including warehouse and marketing per C.A., land and building expenditure per C.A., expenditure on vehicle and livestock per C.A., value added per C.A. Rank numbers are assigned from 1 to 12 (number of parishes) for each item according to ascending order if it is a cost item and descending order otherwise. The efficiency index is the arithmetic mean of the eight ranks. The labour-manager ratios are rounded to nearest integers.

Appendix E

Product-moment correlation is calculated between efficiency index and labour-manager ratio, between efficiency index and intensity of cultivation, and between the intensity of cultivation and labour-manager ratio for 100-499.9 acre and 500 acre and over group and the results are given in the table below:

Size of Farm (acres)	Correlation Coefficient		
	Efficiency Index and Labour-Manager Ratio	Efficiency Index and Intensity of Cultivation	Intensity of Cultivation and Labour-Manager Ratio
100 - 499.9	0.41	-0.74*	0.16
500 and over	0.67*	-0.39	-0.40

Source: Table 5 of this paper.

Note: *Significant at 5% level.

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