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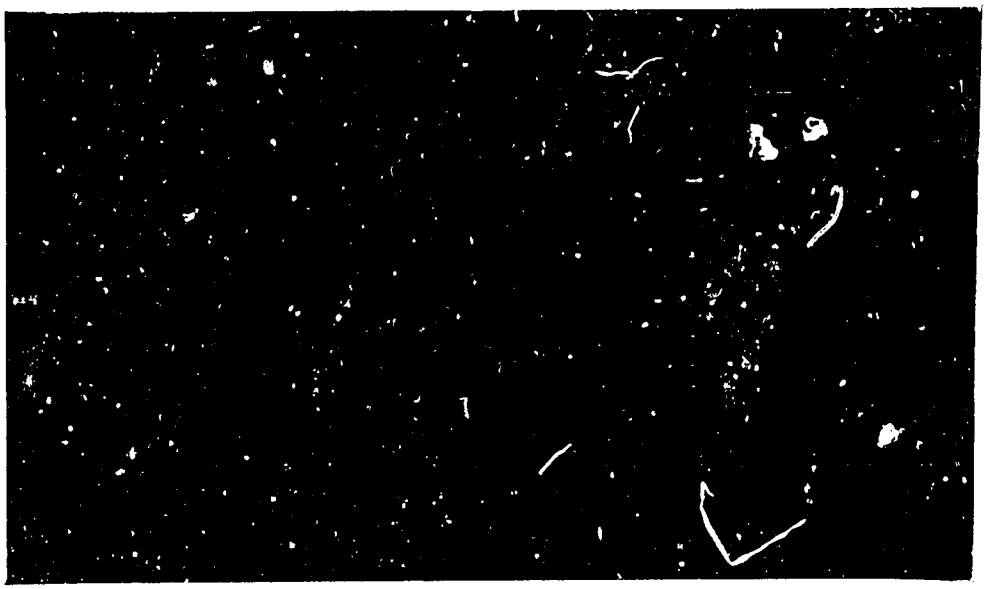

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TABLE OF CONTENTS

		PAGE
I.	Introduction	1
II.	Theoretical Framework	2
	a) The Problem	2
	b) The Objectives of the Study	3
	c) Scope and Method	3
	d) The Model	4
III.	Discussion and Interpretation of the Results	6
	a) Analysis of the Results	6
	(i) All Grain Production	
	(ii) Production of Sorghum and Millet	7
	(iii) Wheat Production	8
	(iv) Maize Production	9
	(v) Rice Production	9
	b) An Attempt at Economic Interpretation of the Results	10
	(i) Capital	10
	(ii) Labor	11
	(iii) Fertilizer	12
	(iv) Weather	13
	(v) Land	13
	(vi) Prices	14
	c) Data Limitation and Problems of Interpretation	15
IV.	Conclusion	16
	References	18
	Appendix 1 (Tables 1, 2, 3, 4)	20
	Appendix 2	24
	Appendix 3	25

I. Introduction

The agricultural sector is the main backbone of Tanzania's national economy. It accounts for about 54 percent of the Gross Domestic Product (World Bank (WB): August 1981, p. 138). Agricultural exports contributed about 80 percent of export earnings between 1973 and 1979 (Marketing Development Bureau (MDB): 1981-82, p. 18). Furthermore, about 88 percent of the population live in the rural area and 83 percent of the economically active population is engaged in the agricultural sector (WB: August 1981, pp. 170 and 172). This high percentage of economically active population in agriculture has to produce enough food for both rural and urban population.

During the first five year plan 1964/65-1968/69, Tanzania pledged to be self-sufficient in food by 1981. This objective has been difficult to attain and the goal seems to be still faraway. It appears, that the set goal was not accompanied by the most plausible course of action to reach it. Within the two independence decades, the country has from time to time been plagued by acute food problems. This vulnerable situation has been exacerbated by the failure to identify timely the main causes of food deficit. As a consequence, apparent incompatibilities between policy objectives and policy implementations have evolved. For instance, since the early to late seventies, the implicit official price policy was to favor the production of food crops. Available price data for both food and cash crops do not seem to agree to this (see Appendix 1, Table 4, Columns 1, 5 and 7).

Between 1961 and 1980, overall food grain production increased, although the performance in individual crops differed (see Appendices 1, 2 and 3). For many Tanzanians, food means grains. The most important of which are: maize (corn), rice, wheat, sorghum and millet.

This paper is a follow-up study of Msambichaka's paper: "Food Grain Shortfalls in Tanzania 1961-1981: A Retrospective Assessment," in which the author discussed various issues related to food grain situations in Tanzania. For ease of continuity, the same grains covered in the previous paper will be discussed. They include: maize, rice, wheat, sorghum and millet.

Part Two and Three discuss the theoretical approach and the analysis of the findings respectively. Part Four presents the conclusion.

II. Theoretical Framework

a) The Problem

Tanzania has during certain years, experienced a surplus production of maize. At the same time, it has permanently remained a net importer of rice and wheat.

During the second half of the seventies, the volume of imported grains has been declining, when the import bill has been rising. For instance, in 1975 and 1980, the country imported respectively about 521 and 315 thousand tons of maize, rice and wheat. The import bill during the years was about 686 and 814 million shillings respectively. An average of about 22.5 percent of export earnings had to be used for importing grains during the respective years (see Green, R. et al., 1980; Malima, F. A., 1981-82).

The government cannot always afford to import enough grains to close the gap between domestic production and demand. In times of foreign exchange problems, the government has to limit importation of food grains. Under these circumstances, the gap between domestic food production and demand has to be closed either by rationing and/or price increase. Gerrard and Roe (1981, p. 37) suggested that the latter has been practiced.

The need for more food in Tanzania is not questionable. What is questionable is the method used to increase food production, the extent to

which the effects of factors of production are known and the appropriateness of the laid down objectives and strategies for stimulating producers to grow more food.

Increase of food production greatly depends upon the increase of productivity and adequate knowledge of factors of production. As the nation grows, the demand for food is increasing. Surprisingly, the relative supply of food to the nation is decreasing. The cause of this problem is not clear.

Msambichaka (1981, p. 4) raised a number of likely causes of food problems, which demanded some quantification. The present paper attempts to evaluate the degree to which different variables influence food grain production in Tanzania.

b) *The Objectives of the Study*

Over the years, food grain shortfalls in Tanzania has been associated with unfavorable weather which entails drought and/or floods. This research study hypothesizes that weather is not the only important determinant of food grain shortfalls in Tanzania. For this reason, an attempt is made to test the effects of some important determinants of food grain production. This study concentrates on: capital, labor, fertilizer, weather, land and prices as independent variables. The impact of each to food grain production will be measured over a period of 14 years (1965-1978). It is anticipated, that more plausible explanations to the cause of food problems will be brought to knowledge. The detection of a fit explanation to food grain shortfalls will hopefully assist policy makers in working out future food policy objectives.

c) *Scope and Method*

The study covers a period of 14 years (1965-1978). However, a number of observations raised in this paper apply to the period 1961-1979. The

data used are either absolute, or relative figures. In all the equations used; capital, labor, fertilizer, weather, land and competing crops are defined as follows:

Capital: Amount of loan disbursed to the agricultural sector by commercial banks. In this case capital includes loans directed toward agricultural production and marketing of agricultural produce.

Labor: Total economically active labor force in the agricultural sector.

Fertilizer: Total consumption of pure plant nutrients (N, P_2O_5, K_2O) in the agricultural sector.

Weather: Actual total amount of rainfall recorded in all regional meteorological stations.

Due to lack of detailed information, the above variables were used in aggregate terms. Disaggregation for each grain was not possible.

Land: Total harvested area and for each grain in hectares.

Competing Products: Food crops are generally thought to be competing with cash crops.

Due to lack of adequate data, cash crops here refer to cotton and tobacco. In this paper, sorghum and millet were thought to be competing for resources with maize, wheat with other food grains, maize with sorghum and millet and cash crops. Rice was thought to be competing with other food grains and cotton. Our curiosity to know the response of producers to price changes lead us to substitute prices for physical units.

d) The Model

For our purpose let us postulate the following food grain supply function:

$$Y^f = y^f [K^f_{(p)}, L^f_{(p)}, T^f_{(p)}, F^f_{(p)} | W^f, Z^f_{(p)}], \; y^f_1 > 0, \; y^f_2 > 0, \; y^f_3 > 0,$$
$$y^f_4 > 0, \; y^f_5 > 0, \; y^f_6 < 0 \quad . \; . \; . \; . \; . \; (1)$$

Where:

Y^f = Physical food grain supply;

K^f = Physical capital stock;

L^f = Labor;

T^f = Land;

F^f = Fertilizer;

Z^f = Supply of other competing agricultural products;

W^f = Weather;

P = Price vector

All variables in time t except where otherwise indicated. In this function K, L, T and F are the choice variables whereas W and Z are given. Equation (1) can be considered as an aggregate supply function which can be disaggregated into individual food grain supply functions as follows:

$$Y^{fi} = \sum_{i=1}^{n} = y^{fi} \; (K^{fi}_{(p)}, L^{fi}_{(p)}, T^{fi}_{(p)}, F^{fi}_{(p)} | W^{fi}, Z^{fi}), \; y^{fi}_1 > 0, \; y^{fi}_2 > 0,$$
$$y^{fi}_3 > 0, \; y^{fi}_4 > 0, \; y^{fi}_5 > 0, \; y^{fi}_6 < 0 \quad . \; . \; . \; . \; . \; (2)$$

Where the superscript i = 1, 2 ... n refer to individual food grains. In our case let i = 1, 2, 3, 4 refer to sorghum and millet, wheat, maize and rice respectively.

We would like to apply the above model to Tanzania. Lack of data availability and differences in environment required some modification to our general model. Due to lack of space, only the final and modified versions of the equations (1) and (2) are presented below.

$$Y^f = y^f \; (K^f, L^f, T^f, F^f | W, P_f/P_c), \; y^f_1 > 0, \; y^f_2 > 0, \; y^f_3 > 0, \; y^f_4 > 0, \; y^f_5 > 0,$$
$$y^f_6 > 0 \quad . \; . \; . \; . \; . \; (3)$$

$$Y^{f_1} = y^{f_1}(K^f, L^f, T^{f_1} \mid W, P_{f_1}/P_{f_3}),\ y_1^{f_1} > 0,\ y_2^{f_1} > 0,\ y_3^{f_1} > 0,$$

$$y_4^{f_1} > 0,\ y_5^{f_1} > 0 \quad \ldots\ldots (4)$$

$$Y^{f_2} = y^{f_2}(K^f, L^f, T^{f_2}, F^f \mid W, P_{f_2}/P_f),\ y_1^{f_2} > 0,\ y_2^{f_2} > 0, y_3^{f_2} > 0, y_4^{f_2} > 0,$$

$$y_5^{f_2} > 0,\ y_6^{f_2} > 0 \quad \ldots\ldots (5)$$

$$Y^{f_3} = y^{f_3}(K^f, L^f, T^{f_3}, F^f \mid W, P_{f_3}/P_f, P_{f_3}/P_c),\ y_1^{f_3} > 0,\ y_2^{f_3} > 0,\ y_3^{f_3} > 0,$$

$$y_4^{f_3} > 0,\ y_5^{f_3} > 0,\ y_6^{f_3} > 0,\ y_7^{f_3} > 0 \quad \ldots\ldots (6)$$

$$Y^{f_4} = y^{f_4}(K^f, L^f, T^{f_3}, F^f \mid W, P_{f_4}/P_f, P_{f_4}/P_{ct}),\ y_1^{f_4} > 0,\ y_2^{f_4} > 0,\ y_3^{f_4} > 0,$$

$$y_4^{f_4} > 0,\ y_5^{f_4} > 0,\ y_6^{f_4} > 0,\ y_7^{f_4} > 0 \quad \ldots\ldots (7)$$

Where:

$$P_f/P_c,\ P_{f_1}/P_{f_3},\ P_{f_2}/P_f,\ P_{f_3}/P_f,\ P_{f_3}/P_c,\ P_{f_4}/P_f,\ P_{f_4}/P_{ct}$$

are defined as relative prices of food crops versus cash crops, sorghum and millet versus maize, wheat versus food, maize versus food, maize versus cash, rice versus food and rice versus cotton. Based on Tanzanian experience, particular relative prices were included in specific equations whenever there was ground to suggest a possibility of resource shift from one activity to another. Moreover, fertilizer does not appear in equation (4) since the variable was not an important input for sorghum and millet at least for the time under review. This has been observed in most African countries (see Christensen, C. et al., 1980, p. 102).

III. Discussion and Interpretation of the Results

a) Analysis of the Results

For each of the equations (3) to (7), eight different regressions were performed. We present below only a sample of results:

(i) All Grain Production:

$$Y^f = 0.273 - 0.584\ P_f/P_c + 0.812\ T^f - 0.175\ K^f - 0.675\ L^f$$
$$(1.141)\ (-0.618) \qquad (3.635) \qquad (-0.162) \qquad (-1.305)$$

$$+ 0.658\ F^f - 0.804\ W \quad \ldots\ldots (8)$$
$$(1.433) \qquad (-0.233)$$

$$R^2 = .946, \quad D/W = 3.089$$

Figures in parenthesis are the t-ratios. Land and fertilizer are the only significant variables. They are also the only variables with the expected signs. Many attempts to improve these results did not prove successful. However, as a result of high correlation between capital, labor and fertilizer a decision to exclude fertilizer and labor was made and the results are presented below as follows:

$$Y^f = -0.161 - 0.102\ P_f/P_c + 0.670\ T^f + 0.961\ K^f - 0.416\ W \quad \ldots\ldots (9)$$
$$(-0.340)\ (-0.110) \qquad (3.512) \qquad (6.790) \qquad (-0.117)$$

$$R^2 = 0.925, \quad D/W = 2.898$$

As expected there is a negligible decline in R^2. However, capital now reverses sign and becomes significant at 99 percent confidence level.

(ii) Production of Sorghum and Millet:

$$Y^{f_1} = 0.140 + 0.556\ K^f + 0.906\ P_{f_1}/P_{f_3} + 0.374\ W - 0.391\ L^f$$
$$(1.375)\ (2.749) \qquad (0.822) \qquad (2.453) \qquad (-1.838)$$

$$- 0.344\ T^{f_1} \quad \ldots\ldots (10)$$
$$(-1.320)$$

$$R^2 = .774, \quad D/W = 3.016$$

In this equation capital, weather and labor are all significant at 95 percent confidence level. However, labor takes an unexpected sign. A number of attempts to improve the results did not succeed. However, the following

interesting observations appear when the variables in equation (10) are divided by T^{f_1} and prices lagged by one period:

$$Y^{f_1}/T^{f_1} = \underset{(-1.080)}{-0.662} + \underset{(0.589)}{0.271}\ K^f/T^{f_1} + \underset{(1.752)}{0.767}\ (P_{f_1}/P_{f_3})_{t-1} + \underset{(1.729)}{0.174}\ W/T^{f_1} - \underset{(-1.293)}{0.330}\ L^f/T^{f_1} \quad \ldots\ldots (11)$$

$R^2 = .589$, $D/W = 1.695$

Only relative prices and weather are significant at 90 percent confidence level. Capital is not significant even in the absence of labor.

(iii) Wheat Production:

Total wheat production reacted better with lagged prices as follows:

$$Y^{f_2} = \underset{(-2.180)}{-0.859} - \underset{(-2.240)}{0.110}\ K^f + \underset{(1.677)}{0.326}\ W + \underset{(4.521)}{0.116}\ T^{f_2} + \underset{(2.266)}{0.438}\ F^f + \underset{(2.618)}{0.231}\ (P_{f_2}/P_f)_{t-1} \quad \ldots\ldots (12)$$

$R^2 = .797$, $D/W = 2.384$

All the variables are significant at 90 percent confidence level or higher. However, capital takes an unexpected sign. The inclusion of labor does not improve our results, although labor does well in the yield regression particularly when capital and fertilizer are excluded and prices lagged.

$$Y^{f_2}/T^{f_2} = \underset{(-1.513)}{-0.998} + \underset{(1.855)}{0.663}\ W + \underset{(4.384)}{0.309}\ L^f/T^{f_2} + \underset{(1.274)}{0.227}\ (P_{f_2}/P_f)_{t-1} \quad \ldots\ldots (13)$$

$R^2 = .805$, $D/W = 2.192$

Prices are no longer significant.

(iv) Maize Production:

Maize reacted very peculiar compared to other food grains. All but one of the eight attempts did not produce any encouraging results. We present below the best results:

$$Y^{f_3}/T^{f_3} = -0.156 + 0.593\ {}^{P_{f_3}}/P_f + 0.886\ {}^{P_{f_3}}/P_c - 0.364\ W + 0.241\ {}^{K_f}/T_{f_3} \quad \ldots\ldots (14)$$

$$(-2.170)\quad (2.206)\qquad (3.756)\qquad (-1.158)\quad (5.357)$$

$$R^2 = .911, \quad D/W = 2.365$$

With an exception of weather, all the other variables are significant.

(v) Rice Production:

Regressing total rice production gives the following results:

$$Y^{f_4} = 0.584 + 0.183\ {}^{P_{f_4}}/P_f + 0.915\ {}^{P_{f_4}}/P_{ct} + 0.645\ W + 0.880\ T^{f_4}$$

$$(2.930)\quad (2.064)\qquad (2.392)\qquad (0.376)\quad (7.615)$$

$$+ 0.259\ F^f - 0.139\ L^f + 0.474\ K^f \quad \ldots\ldots (15)$$

$$(1.525)\quad (-2.843)\quad (1.013)$$

$$R^2 = .980, \quad D/W = 2.636$$

With an exception of capital and weather, the rest of the variables are significant at 90 percent confidence level or more. Furthermore, all the variables except labor have expected signs. The exclusion of labor and fertilizer presented the following results:

$$Y^{f_4} = 0.225 + 0.230\ {}^{P_{f_4}}/P_f + 0.359\ {}^{P_{f_4}}/P_{ct} - 0.154\ W + 0.764\ T^{f_4}$$

$$(0.679)\quad (0.236)\qquad (0.932)\qquad (-0.065)\quad (5.164)$$

$$+ 0.255\ K^f \quad \ldots\ldots (16)$$

$$(2.558)$$

$$R^2 = .949, \quad D/W = 2.162$$

Here capital and prices have reversed their degree of explanatory power. Capital becoming significant and prices insignificant. As in equation (15), weather is still insignificant but its sign has changed against our expectations. All other attempts did not improve results; although the exclusion of labor and fertilizer produced peculiar observations on yields, when prices are lagged.

$$Y^{f_4}/T^{f_4} = \underset{(5.977)}{0.131} - \underset{(-0.020)}{0.138}\,(P_{f_4}/P_f)_{t-1} - \underset{(-0.194)}{0.403}\,(P_{f_4}/P_{ct})_{t-1} - \underset{(-1.481)}{0.197}\,W$$

$$+ \underset{(4.064)}{0.418}\,K^f/T^{f_4} \qquad \ldots\ldots (17)$$

$$R^2 = 0.816, \quad D/W = 2.284$$

All variables but capital have taken on unexpected signs. Moreover, both weather and capital are significant at 90 percent confidence level or more.

b) An Attempt at Economic Interpretation of the Results

(i) Capital:

Capital reacts positively to total production of sorghum and millet, but does not have any significant effect on yield of these grains. This may imply, that producers of sorghum and millet use their capital more for extensive than intensive cultivation.

Capital reacts negatively to total production of wheat, but does not have any significant effect on yield. Since state farms contribute a significant amount of total production, this observation may imply one or both of the following: that there is already enough capital in the state farms or that the available capital is not used productively. Msambichaka (1981) noted that wheat state farms in Tanzania are not efficient in their use of capital.

Capital reacts positively to maize yield but does not have any significant impact on total production of maize. This may imply that maize

producers use their capital more for intensive than extensive cultivation. Lastly, but not least, capital reacts positively to both total production of rice and yield. Thus rice producers use their capital both for extensive and intensive cultivation.

(ii) Labor:

Labor reacts negatively to total production of sorghum and millet, but does not have any significant effect on yields of these grains. This may imply, that there is more labor force in areas under sorghum and millet production than is required, suggesting that some kind of structural (hidden) underemployment may be in existence. Navarrete, and Navarrete (1977) suggested this as the type of underemployment that is typical of backward economies. They indicated that this "becomes more acute with the introduction of new techniques in primary production, when the other sectors of the economy fail to step and expansion is uneven" (pp. 342-343). In the case of Tanzania, the coexistence of a slow expansion of the modern sector and the use of traditional equipments in agriculture could lead to this type of underemployment even in the presence of an increase in agricultural labor force. This is because the use of traditional equipments has an eventual limit to agricultural expansion. In the case of wheat yields, labor reacts positively, but does not have any significant impact on total wheat production. We do not seem to have a sound explanation for these results. Moreover, its impact on either total or maize yields was not significant. This implies that total maize production is at its maximum and does not increase or its increase, if at all, is negligible. Theoretically this means that marginal product is either/close to zero. This may be a result of underutilization of existing rural labor force and/or the use of traditional tools of production. The result is a serious loss of human resources. As regards rice, labor had a significant reaction to

total production but not to yields. However, its impact to total production was negative. The economic interpretation of this has already been discussed in the case of sorghum and millet.

(iii) Fertilizer:

Fertilizer was excluded in the sorghum and millet equations for reasons already specified. It had however a positive impact on total wheat production but not on yields. Ideally the application of fertilizer is meant to improve yields. The results are, therefore, surprising. A look at Tanzanian statistics indicate that state farms apply more fertilizer to their farms than small-holders. However, data on yields indicate that the latter has higher yields than the former at least for the period 1975-1978 (see Msambichaka 1981, Appendices 4 and 5). This may imply a misuse of fertilizer on the part of state farms, although some other factors may be responsible for this low yield. We are, therefore, inclined to suggest that a significant positive relationship between fertilizer and total wheat production in our findings is a mere coincidence.

In the case of maize, fertilizer did not have any significant impact on either total production or yields. This may be due to the fact that small-holders use a negligible amount of fertilizer, particularly in food production. Small-holders contribute approximately 99 percent of all maize produced in Tanzania. The influence of fertilizer which is mainly applied in state farms, is thus greatly reduced in the total production. Lastly, the impact of fertilizer on rice was significant on total production but not on yields. State farms use more fertilizer than small-holders. At the same time, available data indicate that state farms have higher yields than small-holders (see Msambichaka 1981, Appendices 4 and 5). Since state farms contribute only about 8 percent of total rice production, the effect of fertilizer on yields is reduced. As we have indicated, small-holders use a negligible

amount of fertilizer. The significant effect that fertilizer has on total rice production does not seem to have a clear cut explanation; particularly in this case where small-holders contribute about 92 percent of total production.

(iv) Weather:

The amount of moisture plays an important role in both total production and yields of sorghum and millet. Irrigation programmes in drought resistant producing areas could be one way to either stabilize or increase production of these crops. Similarly, the amount of moisture leads to an increase of both total production and yields of wheat. The implication here is the same as in sorghum and millet. However, neither total production nor yields of maize seem to be significantly influenced by the amount of moisture. This may suggest that maize producing areas receive enough rainfall. If this observation is true and given the limited resources, Tanzania is better off concentrating her irrigation programmes on wheat and drought resistant crops.

In the case of rice, we observed no significant impact on total production, although a negative impact was indicated on yields. Among the plausible explanations are that: (a) in the highland areas excessive rains may accelerate the process of washing away the soils, (b) in the lower areas excessive rains may cause water logging of the soils. Both effects cause a decline in rice yields. Precautionary measures could include developing better drainage facilities for lowland areas and the use of contours, farm yard manure and avoiding deforestation in highland areas.

(v) Land:

Land did not show any significant impact on total production of sorghum and millet. The finding agrees with data on harvested land. A quick look

at the available data indicate that harvested land did not significantly increase, if at all, before 1975. This agrees with our earlier observation on labor in drought resistant producing areas that the use of traditional tools by small-holders does not significantly affect both land expansion and yields. Furthermore, repetitive cultivation of a given piece of land for a long period causes a decline on yields. Both of these factors may lead to observed fluctuations of total production (see Appendix 1, Table 2).

As regards total wheat production, the impact of land is significant. The contribution of the ongoing Hanang Wheat Complex can therefore be awaited with optimism. Assuming that wheat is not a high cost crop compared to other grains[1/] an encouragement to small-holders to produce more could help to solve the problem of wheat shortage. This is particularly true since small-holders have been observed to have higher wheat yields than state farms. Land does appear to have a significant impact on total rice production. If in Tanzania rice is a low cost grain, as Gerrard and Terry claim, then it makes sense to encourage both state and small-holders to increase their farm size. State farms could then be given priority in this particular case, since the available data indicates that they have higher yields than small-holders.

(vi) Prices:

Prices of drought resistant crops have a significant impact on yields but not total production. However, the impact is a delayed one, that is, yields react to price changes with a one period lag. This may imply that producers of sorghum and millet tend to work more intensively rather than extensively as a result of price changes. Furthermore, drought resistant crops and maize compete for resources as a result of price changes. Pricing policy of the two crops will thus depend on government's priority as to

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1/ *Gerrard and Terry (1981, p. 43) have observed that in Tanzania, wheat, compared to other grains, is a high cost crop in relation to world prices.*

which of the two, emphasis is to be placed on. Available data show that pricing policy has generally favored drought resistant crops rather than maize (see Appendix 1, Table 4).

On the other hand, total wheat production reacted to price changes whereas yields did not. Moreover, the reaction was not instant but a delayed one. Results also showed that wheat and other food grains compete for resources as a result of price changes. Gerrard and Roe (1981, p. 32) found that wheat competes for resources with maize.

Total maize production did not react to price changes. However, maize yields reacted to price changes and instantly. Furthermore, other food grains and cash crops compete for resources with maize as a result of price changes. Lastly, rice price changes affected total production but not yields. The reaction was instant. In addition, rice competes for resources with other food grains and cotton as a result of price changes.

c) Data Limitation and Problems of Interpretation

The empirical analysis covers the period 1965-1978. This is because data for tobacco prices were not available for years before 1965. A more rigorous assessment of the data is needed as regards to production and the use of input. This is especially needed to allow for changes in any dynamic economy. Furthermore, a study of this nature requires accommodation of such important factors as inflation and devaluation. Our study falls short of this. Furthermore, all measurements and units of particular variables had to be converted into a single denominator. In addition the inability to obtain all the necessary data for the required years, forced us to use some mathematical formulations, to estimate the missing figures. Both of these might have led to some degree of inaccuracy.

IV. Conclusion

1. Production of sorghum, millet, maize and rice react positively to capital. Wheat production appears to react negatively. In general there is a tendency of shifting resources from one food grain to the other and from food grains to cash crops. Although this observation in general agrees with Gerrard and Roe (1981), our available data do not seem to agree with their contention that there is a change in the terms of trade in favor of food grains, resulting into a decline of export crop production (see Appendix 1, Table 4, Columns 1, 5, 6).
2. Generally, the production of wheat and rice react positively to labor. Sorghum and millet react negatively. Maize does not seem to react to labor.
3. Production of rice appears to be positively related to the application of fertilizer. Maize production does not seem to react to the application of fertilizer.
4. Sorghum, millet and wheat have a positive relationship to moisture. Production of maize does not seem to react to changes in the amount of soil moisture. Rice reacts negatively to increases of soil moisture.
5. In general, wheat and rice react favorably to increase in land. Sorghum, millet and maize did not appear to react to land expansion.
6. Generally, food crops react to price changes. The degree of reaction varies from one crop to another. Maize and rice react instantly whereas sorghum, millet and wheat react with a delay (lag). This is consistent with Gerrard and Roe findings.

Thus, different grain reactions to various variables can be summarized as follows:

Variable	Sorghum and Millet	Wheat	Maize	Rice
Capital	Positive	Negative	Positive	Positive
Labor	Negative	Positive	None	Positive
Fertilizer	--	Peculiar	None	Positive
Weather	Positive	Positive	None	Negative
Land	None	Positive	None	Positive
Prices	Positive	Positive	Positive	Positive

References

Bank of Tanzania: Economic and Operations Report, June 1980.

Chama Cha Mapinduzi: Sera ya Taifa ya Tija, Mapato na Bei (no year, but around 1979-1980).

Christensen, C. et al.: Food Problems and Prospects in Sub-saharan Africa: The Decade of the 1980's, Foreign Agricultural Research Report No. 166, United States Department of Agriculture, Washington, D.C. 20250, 1981

FAO: Annual Fertilizer Review 1965-1977, Rome 1966-1978.

FAO: Fertilizer Yearbook 1978, No. 23, Rome 1979.

FAO: Production Yearbooks 1972-1979, Rome 1973-1980.

Gerrard, Chris and Terry, Roe: Tanzanian Food Grain Policy and External Trade, Paper presented at the Eighth Annual Spring Symposium on Food Problems in Africa, University of Illinois, Urbana-Champaign, pp. 20-24, 1981.

Green, R. H., Rwegasira, D. G., Van Akardie, B.: Economic Shocks and National Policy Making: Tanzania in the 1970's, Institute of Social Studies, Research Report Series No. 8, The Hague 1980.

Malima, K. A.: Introducing the Economic Survey for 1980-81 and the Annual Plan for 1981-82 on June 18, 1981, Government Printer, Dar es Salaam, 1981.

Malima, K. A.: The Economics of Cotton Production in Tanzania: Some Theoretical and Policy Discussion, E.R.B. Paper 70-20.

M.D.B.: Price Policy Recommendations for the 1981-82 Agricultural Price Review, Summary and Proposals, Ministry of Agriculture, Dar es Salaam, September 1980.

Ministry of Agriculture: Hali ya utekelezaji wa mpango wa tatu wa miaka mitano katika sekta ya mazao ya chakula 1976/77-1980/81 (unpublished).

Msambichaka, L.A.: Food Grain Shortfalls in Tanzania 1961-1981: A Retrospective Assessment, ERB Seminar Paper, August 18, 1981.

Msambichaka, L.A.: State Farms in Tanzania: Their Economic Viability, Paper prepared for a seminar held on November 5, 1981, at the Department of Agricultural Economics, University of Illinois, Urbana-Champaign.

Msambichaka, L.A.: The Role of Public Agricultural Enterprises in Tanzania with Reference to State Farms, Paper prepared for a conference on "The Role of Public Enterprises in Development", Nairobi, Kenya, November 4-7, 1980.

Navarrete A., Jr., de Navarrete, I.M.: Underemployment in Underdeveloped Economies, in Agarwala, A.N., Singh, S.P. (editors), The Economics of Underdevelopment, Oxford University Press, 1977.

U.R.T.: Background to the Budget, An Economic Survey, 1966-67 and 1968-69, Government Printer, Dar es Salaam, 1966 and 1968.

U.R.T.: Quarterly Statistical Bulletin, Vol. XXV, No. 2, December 1974, and Vol. XXIX, No. 1, December 1978, Bureau of Statistics, Dar es Salaam.

U.R.T.: Statistical Abstracts 1962-1973, Bureau of Statistics, Dar es Salaam, 1962-1977.

U.R.T.: The Economic Survey and Annual Plan, 1970-71, Government Printer, Dar es Salaam, 1970.

W.B.: World Development Report 1981, Oxford University Press.

Appendix 1: Production, Choice Variables, Weather and Prices

Table 1. Harvested Area in 1000 Hectares

	Total Grain Area T^f	Sorghum and Millet T^{f_1}	Wheat T^{f_2}	Maize T^{f_3}	Rice T^{f_4}
1961	1112	380	8	642	82
1962	1146	340	18	705	83
1963	1648	340	22	1171	115
1964	1324	390	25	833	76
1965	1342	439	23	829	51
1966	1963	402	34	1400	127
1967	1576	309	31	1132	104
1968	1426	250	34	1014	128
1969	1411	237	31	1014	129
1970	1430	215	49	1015	151
1971	1434	215	51	1015	153
1972	1785	260	70	1300	155
1973	1186	497	55	503	131
1974	832	235	27	471	99
1975	1836	550	56	1100	130
1976	2025	535	50	1300	140
1977	2055	550	45	1300	160
1978	2120	570	40	1300	210
1979	2087	570	50	1300	167

Source: *Computed from: Msambichaka, L.A., Food Grain Shortfalls in Tanzania 1961-1981: A Retrospective Assessment, Economic Research Bureau seminar paper, 1981 (unpublished), p. 35.*

FAO: Production Yearbooks 1972-1979, Rome 1973-1980.

Table 2. Production in 1000 Tons

	Total Grain Output Y^f	Sorghum and Millet Y^{f_1}	Wheat Y^{f_2}	Maize Y^{f_3}	Rice Y^{f_4}
1961	868	325	6	448	94
1962	936	310	18	466	104
1963	1251	328	25	723	183
1964	976	246	27	577	120
1965	876	266	23	503	84
1966	1617	296	39	1127	140
1967	986	292	31	549	114
1968	1150	340	44	664	136
1969	944	236	39	525	144
1970	1234	368	61	637	182
1971	1022	245	62	530	185
1972	1241	367	98	984	185
1973	1325	161	80	800	150
1974	1371	314	68	758	163
1975	2236	172	46	941	186
1976	2075	490	58	897	172
1977	2650	366	62	968	194
1978	2770	748	55	1041	260
1979	3373	1151	65	900	200

Source: *Computed from: Msambichaka, L.A., Food Grain Shortfalls in Tanzania 1961-1981: A Retrospective Assessment, p. 13 and 36.*

FAO: Production Yearbooks 1972-1979, Rome 1973-1980.

Ministry of Agriculture: Hali ya utekelezaji wa Mpango wa Tatu wa miaka mitano katika sekta ya mazao ya chakula 1976/77-1980/81 (unpublished).

Table 3. Choice Variables and Weather

	Labor (L)[1] * in 1000	Capital (K)[2] in mil. Tsh.	Fertilizer (F)[3] in metric tons	Weather (W)[4] Total rainfall in mm.
1961	4254	--	2723	18372
1962	4329	120	2380	13530
1963	4406	189	3100	17243
1964	4484	194	3900	13163
1965	4489	244	7000	13443
1966	4568	318	8800	12444
1967	4649	293	8700	15356
1968	4731	293	9000	16160
1969	4853	380	11000	11968
1970	4969	452	15000	14495
1971	5057	479	17400	12312
1972	5147	628	16028	15815
1973	5238	657	19937	12407
1974	5331	1094	31144	11717
1975	5429	1150	29670	11463
1976	5525	1296	31747	12445
1977	5617	1376	37424	14952
1978	5715	1670	44082*	16376
1979	5818	3236	--	--

Source: * *Computation of unavailable data was based on compound projection formula:* $A = P_0 (1 + r)^t$, *A = Projected value,* P_0 *= Base year, r = Rate of growth, t = Period.*

1/*FAO: Production Yearbooks 1972-1979, Rome 1973-1980.*

2/*Bank of Tanzania: Economic and Operations Report, Dar es Salaam, June 1980.*
United Republic of Tanzania (U.R.T.): Background to the Budget: An Economic Survey 1966-68 and 1968-69, Dar es Salaam.
Meambichaka, L.A., The Role of Public Agricultural Enterprises in Tanzania with reference to state farms. Conference paper on "The Role of Public Enterprises in Development", Nairobi, Kenya, November 4-7, 1980, p. 24.

3/*FAO: Annual Fertilizer Reviews 1965-1977, Rome 1966-1978.*
FAO: Fertilizer Review 1978, Rome 1979.

4/*U.R.T. Quarterly Statistical Bulletins, Vol. XXV and XXIX, No. 1 and 2, December 1974 and 1978, Bureau of Statistics, Dar es Salaam.*
U.R.T. Statistical Abstracts 1962-1976, Bureau of Statistics, Dar es Salaam 1962-1977.

Table 4. Relative Prices

	Food/ Cash	Sorghum-Millet/ Maize	Wheat/ Food	Maize/ Food	Maize/ Cash	Rice/ Food	Rice/ Cotton
	p^f/p^c	p^{f_1}/p^{f_3}	p^{f_2}/p^f	p^{f_3}/p^f	p^{f_3}/p^c	p^{f_4}/p^f	p^{f_4}/p^{ct}
1961	--	.97	1.33	.97	--	1.33	.40
1962	--	1.13	1.24	.90	--	1.29	.42
1963	--	1.23	1.41	.89	--	1.14	.38
1964	--	1.36	1.68	.90	--	.97	.27
1965	.26	1.58	1.68	.67	.21	.97	.31
1966	.32	1.53	.96	.26	.25	.47	.27
1967	.25	1.48	1.77	.70	.21	.94	.29
1968	.24	1.39	1.71	.68	.20	.97	.29
1969	.21	1.36	1.69	.60	.16	1.83	.47
1970	.42	1.69	1.06	.33	.21	1.22	.72
1971	.26	1.70	1.60	.51	.18	1.72	.66
1972	.24	1.15	1.84	.26	.20	1.93	.64
1973	.20	1.67	2.59	.79	.20	1.97	.66
1974	.28	1.10	1.79	.86	.31	1.63	.60
1975	.20	1.07	2.13	2.50	.31	2.27	.67
1976	.39	1.16	1.24	1.05	.32	1.15	.67
1977	.30	1.76	1.47	1.52	.30	1.50	.69
1978	.37	1.76	1.20	.89	.30	1.24	.67
1979	.30	1.50	1.22	1.12	.27	1.42	.70

Source: *Bank of Tanzania: . . . op. cit., June 1980.*

U.R.T.: Economic Survey and Annual Plan, 1970-71, Dar es Salaam, 1970.

Marketing Development Bureau: Price Policy Recommendation for the year 1981-82, Agricultural Price Review, Dar es Salaam, September 1980.

Malima, K.A.: Economics of Cotton Production in Tanzania, Economic Research Bureau (ERB), Paper 70-30.

Chama Cha Mapinduzi: Sera ya Taifa ya Tija Mapato na Bei, Dar es Salaam, no year given but around 1979-80.

Appendix 2: Grain Production Per Active Labor Force in Tanzania Agriculture (in tons)

	Total Grain	Maize	Rice	Wheat	Sorghum & Millet
1961	.204	.105	.022	.001	.076
1962	.216	.108	.024	.004	.072
1963	.284	.164	.042	.006	.074
1964	.218	.129	.027	.006	.055
1965	.195	.112	.019	.005	.059
1966	.354	.247	.031	.009	.065
1967	.212	.118	.025	.007	.063
1968	.243	.140	.029	.009	.072
1969	.195	.108	.030	.008	.049
1970	.248	.128	.037	.012	.074
1971	.202	.105	.037	.012	.048
1972	.241	.191	.036	.019	.071
1973	.253	.153	.029	.015	.031
1974	.257	.142	.031	.013	.059
1975	.412	.173	.034	.008	.032
1976	.376	.162	.031	.010	.089
1977	.472	.172	.035	.011	.065
1978	.485	.182	.045	.010	.131
1979	.580	.155	.034	.011	.198

Source: *Computed from: FAO: Production Yearbooks 1972-1979, Rome 1973-80.*

Appendix 3: Trend of Grain Yields in Tanzania (Tons/Ha)

	Total Grain	Maize	Rice	Wheat	Sorghum & Millet
1961	0.78	0.70	1.15	0.75	0.86
1962	0.82	0.66	1.25	1.00	0.91
1963	0.76	0.62	1.59	1.14	0.96
1964	0.74	0.69	1.58	1.08	0.63
1965	0.65	0.61	1.65	1.00	0.61
1966	0.82	0.81	1.10	1.15	0.74
1967	0.63	0.49	1.10	1.00	0.94
1968	0.81	0.66	1.06	1.29	1.36
1969	0.67	0.52	1.12	1.26	1.00
1970	0.86	0.63	1.21	1.24	1.71
1971	0.71	0.52	1.21	1.22	1.14
1972	0.70	0.76	1.19	1.40	1.41
1973	1.12	1.59	1.15	1.45	0.32
1974	1.65	1.61	1.65	2.52	1.34
1975	1.22	0.86	1.43	0.82	0.31
1976	1.03	0.69	1.23	1.16	0.77
1977	1.29	0.75	1.21	1.38	0.67
1978	1.31	0.80	1.24	1.38	1.31
1979	1.62	0.69	1.11	1.30	2.02

Source: *Computed from: FAO: Production Yearbooks 1972-1979, Rome 1973-1980.*