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An Agricultural Policy Model for Kenya

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AN AGRICULTURAL POLICY MODEL FOR KENYA

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FOREWORD

The Food and Agriculture Program of IIASA has been developing, as its major task, a global system of national food and agriculture models linked in a general equilibrium framework. The main objective is to analyse, over a 15 to 20 year horizon, the impact of national domestic and trade policies and of international agreements on the distribution and availability of food in the world.

This paper describes the framework of the agricultural policy model for Kenya. The Kenya model provides a prototype for other developing countries especially in Africa. Within the global system of national models, Kenya being relatively small does not have a major impact on the world market. However, the world market conditions have a significant effect on the pace and type of development within Kenya.

The Kenya model has been constructed so as to capture the important and in some sense peculiar features of Kenya. For example the bi-model system of small and large farms as well as informal and formal non-agriculture are explicitly considered. This paper is divided into three main sections. Sections 1 and 2 described the agricultural scene and agricultural policies respectively in Kenya. Section 3 presents the overall framework together with model equations. Various components of the model, for example, supply response, demand system, population and demography etc. have been developed and reported in previous Food and Agriculture Program working papers (see references). At the present time these components are being linked within the overall model and the results of alternative policy analysis will be the subject of a subsequent report.

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Program Leader
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INTRODUCTION

The overall objective of this exercise is to build a computable model for Kenya's agricultural sector, with the requisite links to the nonagricultural sector. The model is constructed so as to capture the important and in some sense peculiar features of Kenya. At the same time, the model has been kept flexible so as to examine issues and constraints which have been less important in the past but which are likely to assume greater significance in the near future. The model methodology has also been constructed to be computable within the availability of existing empirical information, and within a fixed time constraint for the project.

In the first section the major structural features of Kenya's agricultural scene are highlighted. In addition a broad discussion of important constraints likely to emerge in the near future is outlined. Section 2 delineates the major objectives of government policies and policy levers which can be manipulated to satisfy these objectives. The next section describes the methodology and the framework of the model.

1. THE AGRICULTURAL SCENE IN KENYA

Kenya became independent at the end of 1963 and the period up to 1972 was one of impressive growth: GDP grew at about 7% per year. However, inspite of this impressive performance* in growth, development in Kenya has not been satisfactory in terms of the distribution of benefits of development. The conflict between growth, equity and employment has been dramatic even during the period of high economic growth up to 1972. The period from 1973 to the present time has been one of accelerating world inflation including rising oil prices and falling commodity prices. These aspects have led to acute balance of payment problems and slowdown of the Kenyan economy. For example the GDP during the period 1973 to 1980 grew at an average rate of 4.9%. While it was difficult enough to find solutions for unemployment, income distribution and poverty problems under conditions of rapid growth, the slowdown of the economic growth will make it even harder to tackle these issues. The restructuring of the

* "Employment, Incomes and Equity--A Strategy for Increasing Productive Employment in Kenya" ILO, Geneva, 1972.
* "Kenya--Into the Second Decade" The World Bank, Washington, 1975.

economy and formulation-evaluation-acceptance and translation into action programs of appropriate policies will be crucial if Kenya is to succeed in solving the problems of the distribution of benefits of development and maintaining high economic growth.* The Food and Agriculture model of Kenya being developed at IIASA will provide a tool for the formulation and evaluation of relevant domestic and international policies; the latter in the context of the Kenya model linked to IIASA World Food and Agriculture model.

The development strategy in Kenya is based on African Socialism.** Planning is carried out by the Ministry of Economic Planning and Development, together with the operating Ministries. To date four development plans have been produced and the overall objectives have been:

1966-70 Rapid economic growth

1970-74 Rapid economic growth and stress on rural development

1974-78 Same as above and focus on employment creation and improvement in income distribution

1979-83 Alleviation of poverty: majority of population in the rural areas/the agricultural sector

Over the years the focus of the development strategy towards the rural areas and in particular the food and agriculture sector has been strengthened. The agricultural sector forms the backbone of the Kenyan economy in a number of ways.

- Agriculture, which is by far the largest single sector of the economy, accounted for 34.4% of the GDP in 1980. Over the past two decades agricultural production as a whole has doubled, growing at an average rate of 3.5% per annum. Also, the non-agriculture economy has grown at an average rate of 6%. However, this growth (Table 1) has not been sustainable in the less favorable world environment that has resulted from the "oil crises" of 1973-1974.

  The performance of the agriculture sector has a strong impact on the overall economy through the effect on the agricultural population's demand on manufacturing and other sectors as well as the availability of raw materials for agro-industries. Investment in agriculture and agriculture based industry in the rural areas promises a relatively high return as expressed in the low incremental capital output ratio for this sector.

- More than 80% of the population derives its livelihood from this sector. In 1979, the total population of 15.3 million comprised of 87.5% in the rural areas and 12.5% in the urban areas. Within the rural areas, 87.5% of the male labour force and 97.9% of female labour force were employed in the agricultural sector. Between 1976 and 1995§ the rural and urban labor forces are likely to increase from 4 to 11.2 million and from 1 to 3.1 million, respectively. Many of these new "entrants" into the labor force will have to be absorbed into the primary and processing activities within agriculture.

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* C.S. Slater, G. Walsham and M.M. Shah. (1977) KENSIM--A Systems Simulation of the Developing Kenyan Economy. Westview Press, Boulder, Colorado, USA.

** "African Socialism and its Application to Planning in Kenya", Sessional Paper No. 10 of 1965, Republic of Kenya, Nairobi.

§ M.M. Shah and F. Willekens, "Rural-Urban Population Projections for Kenya and Implications for Development", RM-78-55, IIASA, Austria, Nov. 1978.

- The agricultural sector accounted for about 64.2% of the total exports in 1979. The most important primary commodities, namely coffee and tea, accounted for 70.1% of all agricultural exports. This foreign exchange is essential for importing many non-competitive goods which are crucial for the rapid development of non-agricultural as well as the agricultural economy in Kenya. Furthermore, the balance of payments problem in Kenya is critical. In 1973, 40% of the coffee and tea export earnings were necessary to finance petroleum imports, whereas in 1979, the corresponding figure was 84%. The solution of the long-term balance of payments problem in Kenya will require an increase as well as diversification of agricultural exports. For example about a third of Kenya's domestic agricultural production is sold abroad. During the last decade, there has been a large change in relative prices as a result of recession coupled with inflation abroad. The result has been a continuing decline (except in the "coffee boom" period) in Kenya's international terms of trade (Figures 1 - 3).

  Kenya has encouraged small farmers to cultivate exportable cash crops. Sometimes, this policy has been criticized as one that may have reduced rural welfare by reducing the availability of food in rural areas, even though small farm incomes may have increased. Tables 2a and 2b give relevant data on these aspects* and simple calculations show:

  (a) the strategy of exploiting comparative advantages and promoting export cropping has been a good one. The value of all food imports in 1961 as well as 1975 could have been financed by less than 20% of the export earnings of four main cash crops in the corresponding years;

  (b) over the period 1961-1975, small farmers appear to have gained in real terms by participating in the Kenya export cropping strategy.

- The availability of agricultural land in Kenya is limited. Considerable potential** exists for agricultural production, especially for particular crops through improvements in technology and changes in cropping patterns. In some areas soil erosion and nutrient leaching have reached disquieting proportions. The soil of Kenya is an irreplaceable stock resource and will need to be carefully preserved, conserved, and enhanced to support the population of the future (Table 3).

- The food and nutritional status of Kenya's population is an area of growing concern since the increase in food production has to keep pace with the annual population growth rate of about 4% as well as take account of distributional aspects. Estimates of the number of people with insufficient food intake in the rural and urban areas in 1975 was of the order of 39% and 42%, respectively (Table 4). With development, there has been a tendency to move from "inferior" food crops, e.g. sorghum and millet to "superior" food crops, e.g. wheat. From the viewpoint of the ecological potential* in Kenya, sorghum and millet are certainly "superior" to wheat (Table 3).

- Agriculture in Kenya has a dual character in that the bulk of the farming population are small farmers, producing staple food crops for subsistence as well as food and cash crops for the market. On the other hand, there are about 3,000 commercial large farms which are highly developed. Relevant data on the resource use and production in these two farm sectors is given

* M.M. Shah. 1981. The Kenyan Agricultural Model. In: Food for All in a Sustainable World: The IIASA Food and Agriculture Program. K. Parikh and F. Rabar (editors), SR-81-2, Aug. 1981. IIASA, Austria.

** M.M. Shah and G. Fischer, "Assessment of Food Production Potential. Resources, Technology and Environment—A Case Study of Kenya", WP-81-82, March 1981, IIASA, Austria.

in Table 5a and 5b.

Historically, policies were formulated for the benefit of this commercial sector, but since *Uhuru* policies have increasingly focussed on the needs of the small farmers. However, inspite of these policies there continues to be a wide gap between the use and availability of resources, (e.g. fertilizers) between small and large farmers. The potential of increased agricultural productivity and production among the small farmers in Kenya is large and this potential will be crucial in fulfilling the future national food needs and industrial raw materials and export demands.

- Another pressing problem in Kenya is that of income distribution and growth. Not only is there a wide disparity between average incomes in rural and urban areas, but also the distribution is highly skewed within the two areas (Table 6). Equity and growth of incomes in the future will very much depend on the development path of the agricultural sector.

The above set of interacting issues calls for an integrated multi-objective planning/policy approach to agricultural development in Kenya. The basic needs and aspirations of a young and rapidly increasing population have to be realized within the constraints of a land and resource scarce country. The objectives of government policy and the instruments are discussed in the next section.

2. OBJECTIVES OF GOVERNMENT POLICY

The broad objectives of agricultural policy can be described as:

- growth
- equity and alleviation of poverty
- self-reliance and stability
- ecological sustainability

The policy instruments (not an exhaustive list) to realize the above objectives, together with details of the agriculture sector in Kenya are given in Table 8. The policy instruments, classified by the principal objectives behind it, are interacting in that they have positive as well as negative effects within the agriculture as well as the overall economy. A central feature of the development of the Kenya model is to analyze the interactive effect and to quantify the effects of various alternative policy packages.

The model* of Kenya described below is structured in such a way to enable analysis and evaluation of policy instruments with particular reference to the food and agriculture sector.

3. THE MODEL METHODOLOGY

The model is a dynamic behavioral cum simulation model in which outputs, prices and incomes are determined endogenously. It is a "closed loop" model.

There are four broad production sectors--large farm agriculture, smallholder agriculture and nonagriculture formal and informal. The rural vs urban location of nonagricultural production is specified exogenously.

Land by agro-ecological zone is split between large farmers, smallholders and urban high income groups. Purchase of land by urban high income groups**

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* M.M. Shah. 1981. The Kenyan Agricultural Model. In: Food for All in a Sustainable World: The IIASA Food and Agriculture Program. K. Parikh and F. Rabar (editors), SR-81-2, Aug. 1981. IIASA, Austria.

** P.Collier and D. Lal "Poverty and Growth in Kenya", World Bank Staff Working Paper No. 389, World Bank, Washington, May 1980.

is purely for speculation and/or retirement. Land is therefore both a factor of production and asset.

The model is reasonably disaggregated. There are 18 agricultural production commodity groups. Large and small farm holders decisions of allocation of inputs are endogenous. Large farmers maximize profits, whereas smallholders maximize profits but with some constraints on "maximum admissible loss".

International trade of both agricultural and nonagricultural products is permitted. The model examines the tradeoff between resources used in export and food crops on the production side and the tradeoff between emerging food imports and other imports through the balance of payments constraint.

Income distribution is endogenized. It is affected by the distribution of land, quality of land, and the selected technique of production. Capital is allowed to move freely between large holder production and formal nonagricultural production, so that returns to capital between these two sectors are equalized.

Utility maximization determines private consumption, given income levels and relative prices, which in turn are determined in the model. Food prices are consciously controlled through imports.

Wages in the formal nonagricultural sector are not market clearing. Real wages are made a function of prices relative to other prices and real value added per worker. Labour union strength viz a viz employers is implicitly assumed to be constant. Informal non-agricultural sector wages follow market clearing rules.

Population projections for Kenya are based on the methodology of multiregional demography. The rural and urban populations are projected simultaneously.

Rural-urban migration is a function of nonagricultural formal and informal wage rate and average smallholder income levels. Remittances from migrants are allowed and these supplement agricultural incomes.

The government sector imposes tariffs and subsidies. The government also collects direct and indirect taxes and allocates resources in different production sectors. It also determines the food-price level in the economy.

The model is solved sequentially from period to period. But in order to examine policies which have medium-long term effects a 15-20 year time horizon is proposed. A schematic outline of the overall model is given in Figure 4. We now describe different modules of the overall model.

GOVERNMENT MODULE G

The basic objectives of the government are:

(1) Growth

(2) Redistribution

(3) Selective Self Reliance

(4) Stability and Ecological Sustainability

Policies and instruments which affect these broad objectives of government policy are determined in this module. The most important instruments which this module quantifies are:

(1) Level of investment including expenditure on services

(2) Level of food prices in the economy
(3) Tax rate structure
(4) Tariff and Quota Structure
(5) Land redistribution
(6) Land extension, and soil conservation
(7) Location of Non-agricultural production
(8) Wages and income policy
(9) Fuel and fertilizer subsidies to agriculture
(10) Price support policies

These instruments form the core of policy concern in Kenya.

The total level of investment is the sum of domestic and foreign savings.

$$INV = DS + FS$$

INV = Level of investment in economy
DS = Domestic savings
FS = Foreign savings

The government cannot alter the total private domestic savings rate in the economy. It can only alter the share of domestic savings controlled by the government through higher taxation or through public borrowing so as to direct the allocation of investment toward satisfying its basic objectives. The government can increase foreign savings FS (or the available investment funds) through increased foreign borrowings or through its ability to negotiate increased foreign aid. Foreign borrowing is however constrained by the future stream of debt payments.

The government operates under two basic constraints a domestic resource constraint and a foreign exchange constraint.

A. The Domestic Resource Constraint is Represented as Follows:

$$\bar{t}_p^{AG} \cdot Y_{AG} + \bar{t}_D^{NAG} Y_{NAG} + t_{ID} \sum P_i X_i + \Delta PB + FAID \cdot ER + EXPT$$
$$+ \Delta FB \cdot ER - GC - i_D \cdot PB - i_f FB \cdot ER - SBS = GINV$$

where

$\bar{t}_D^{AG}$ = tax rate on agricultural income
t_D^{NAG} = tax rate on nonagricultural income
t_{ID} = indirect taxes
ΔPB = new public borrowing
FAID = foreign aid
ER = exchange Rate
ΔFB = new foreign borrowing
GC = government consumption
I_D = interest rate - nominal
PB = outstanding public debt
i_f = interest rate on foreign loans

SBS = government subsidies nominal

EXPT = export tax

GINV = Government investment

Taxation through inflation brought about by deficit financing is not modeled into the system. The model does not contain monetary assets.

B. Foreign Exchange

The second major restriction on government activities in a regime of controlled exchange rates is the foreign exchange constraint.

This constraint can be represented as follows:

$$FAID + \Delta FB - i_f \cdot FB + P_i^m EX_i / ER - P_i^m IM_i + FEXCH = FEXCH^*$$

where

FEXCH = total foreign exchange available

FEXCH* = targeted foreign exchange reserves

The exchange rate is fixed at base year levels.

C. Government Consumption

$$GC = g_c (\sum Y_i P_i) + \overline{GC}$$

Government consumption is a simple function of total income (net domestic product) in the economy. The government only consumes nonagricultural products.

D. Net Foreign Borrowing (ΔFB) and Foreign Aid (FAID)

are specified exogenously. Alternative levels of these are simulated through the model.

E. Net Public Borrowing (ΔPB)

is also specified exogenously. Public borrowing reduces capital available for private investment in the nonagricultural sector, but does not affect interest rates in the economy. In effect changes in public borrowing simply divert capital towards priorities fixed by the government in the sectoral allocation of capital from the nonagricultural sector.

F. Subsidies SBS

The government provides three basic subsidies:

1. *Fuel subsidy to agriculture: FUS*

$$FUS = (PF^M - PF^D) \cdot FU^{AG}$$

where

PF^M = international fuel price inclusive of transport charges

PF^D = fuel price prefixed for domestic agriculture

FU^{AG} = fuel use in agriculture

2. *Fertilizer subsidy: FRTS*

$$FRTS = (PFRT^M - PFRT^D) \cdot FRT^{AG}$$

where

$PFRT^M$ = international fertilizer price

$PFRT^D$ = fertilizer price prefixed for domestic agriculture

FRT^{AG} = commercial fertilizer use in agriculture

3. Food subsidy: FODS

$$FODS = (P_i^m - P_i^*)\, IM^i \qquad i = \text{food items only}$$

where

P_f^m = world import price of food

P_i^* = target domestic food price

IM_i = import of food items only

FACTOR MARKETS

Land—Module LD

The distribution of land between large and smallholders is assumed to remain the same as in the base year. Land in the large estate sector can increase through land purchase by the urban rich. Land in the small holder sector can increase either through land extension into marginal areas, or through land redistribution. Alternative runs with

(a) physical land distribution

(b) land tax, leading to some breakup

of large holders and reduced purchase of land as asset are also specified.

The land is divided into 4 agro-climatic zones. The distribution of land by agro-climatic zones between large and small holders is specified exogenously. Within the small holder sector the distribution of land is specified through a log normal distribution. The parameters of the log normal distribution are specified by the following relationships.

$$E(x) = \exp(U + \frac{1}{2}\sigma^2) \tag{1}$$

$$Var(x) = (\exp \sigma^2 - 1) \cdot \exp(2U + \sigma^2) \tag{2}$$

where x is the average farm size in the small holder sector and U and σ are the mean and standard deviation of the log normal distribution. Over time σ may remain constant or change (government policy on land distribution) and U adjusts to take into account the growth of small holder population and land extension.

Labour—Module LB

The labour market does not follow the usual neo-classical assumptions. The market is differentiated into 4 sub markets with different wage rates in each submarket. The 4 sub markets are:

(a) workers in urban formal sector

(b) workers in urban informal sector

(c) workers in large estates

(d) workers in rural informal sector and in small holder agriculture.

(a) Urban Formal Sector:

Wages are determined by three factors, the ability of firms to pay which is determined by the real value added per worker,* the strength of labour unions and the cost of living index. Assuming the stength of labour unions to remain constant we can conceptualize real wages to be determined by the following empirically estimated relationship.

$$W_{UF} = W^{\gamma} (VA^{\gamma}_{w}, CPI_{w-1})$$

where

W_{UF} = nominal wage rate in urban formal sector

VA^{*}_{w} = value added per worker in urban formal sector

CPI^{U}_{w-1} = Consumer price index of urban workers lagged.

The exact nature of the lagged relationship between CPI and W^{γ}_{UF} depends on government policies regarding wage adjustment and on the strength of labor unions and can be estimated empirically.

Since a major component of the workers expenditure is on food alone, we may substitute food prices in place of the CPI.

(b) Urban Informal Sector:

Wage rate in the urban informal sector is determined through a market clearing process. The supply of labour (labour availability) is determined in 2 stages:

(1) First, the rural-urban location of population is made by determining net rural-urban migration (see Module M)

(2) The urban labour force is calculated from the urban population using appropriate participation rates. From the total urban labour force so estimated, the urban formal workforce is deducted to give the urban labour force in the informal sector.

Algebraically, this procedure is defined by the following relationships.

$$POP^{U} = POP^{U}_{-1} (1 + \gamma^{UP}_{g}) + NM$$

$$LS^{U} = POP^{U} \cdot PRT^{U}$$

$$LS^{U}_{IF} = LS^{U} - LD^{U}_{F}$$

where

POP^{U} = urban population

γ^{UP}_{g} = natural rate of growth of urban population

NM = net rural urban migration

LS^{U} = labour supply--urban

PRT^{U} = labor participation rate--urban

LS^{U}_{IF} = labour supply informal--urban

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* Domestic protection increases the ability to pay higher negotiated wages.

(c) Large Estate Workers:

Wage rates are once again determined institutionally. In our model we specify the wage rate to be determined through the following relationship.

$$W_{RL} = W_{UF} * \frac{CPI^{R}_{w-1}}{CPI^{U}_{w-1}}$$

where

W_{RL} = Wage rate in large estates

CPI^{R}_{W} = Consumer Price Index for Rural Workers

(d) Rural Informal and Smallholder

A market clearing process once again determines wages in the rural informal and small holder sector. The residual workforce, i.e., after deducting labour supply in the other three sub markets is assigned to this submodel.

$$POP^{R} = POP^{R}_{-1} (1 + \gamma^{\gamma}_{g}) - NM$$

$$LS^{R} = POP^{R} * PRT^{R}$$

$$LS^{R}_{IFS} = LS^{R} - LD^{R}_{L}$$

where

POP^{R} = rural population

γ^{γ}_{g} = rate of growth of rural population

LS^{R} = labour supply rural

PRT^{R} = participation rate rural

LS^{R}_{IFS} = labour supply-rural-informal and small holder

LD^{R}_{L} = labour demand-rural large estate

These fourfold disaggregation captures the essential features of the labour market in Kenya and the wage determination process.

DEMOGRAPHIC AND POPULATION MODULE–POP

The urban and rural populations are projected simultaneously, using the multiregional growth model*

$$\begin{Bmatrix} K_u(t+1) \\ K_r(t+1) \end{Bmatrix} = G(t) \begin{Bmatrix} K_u(t) \\ K_r(t) \end{Bmatrix}$$

where

$K_u(t)$is a vector of the number of people by age coherts in the urban area,

$K_r(t)$is a vector of the number of people by age coherts in the rural area,

G(t) is a generalized Leslie matrix*

Fertility and mortality rates and changes over time for rural and urban areas are specified on the basis of Kenyan demographic data.** Details of the methodology and results are given elsewhere†.

* Rogers, A. "Introduction to Multiregional Mathematical Demography" Wiley, New York, 1975.

** Kenya Population Census, 1969 and 1979, Republic of Kenya, Nairobi.

† Shah M.M. and F. Willekens, "Rural-Urban Population Projections for Kenya and Implications for Development" RM-78-55, IIASA, Austria, Nov. 1978.

RURAL URBAN MIGRATION MODULE–MIG

Net Rural urban migration is postulated to be a function of the ratio of the average urban wage income to the income in small holder agriculture.

$$NM = a_i \left\{ \left[\frac{LD_F^U \cdot W_{UF} + LS_{IF}^U \cdot W_{UIF}}{LD_F^U + LS_{IF}^U} \right] / y_{AGS}^{cap} \right\}^{\gamma}$$

where

W_{UIF} = wages in urban informal sector derived through a sub-market clearing process in Module LB

Y_{AGS}^{cap} = per capita income in smallholder agriculture

γ = elasticity of net migration with respect to income differences

CAPITAL MODULE K

This module tracks the sources of capital formation and its subsequent movement across different sectors of the economy.

On the private account there are four major resource flows across sectors.

Private Resource Flows

(a) Net surplus of large estate agriculture into formal nonagriculture

(b) Remittances from formal nonagriculture into small holder agriculture

(c) Remittances from informal nonagriculture into small holder agriculture

(d) Savings of wage incomes and profits in formal nonagriculture into informal nonagriculture.

The entire net surplus, of large estate agriculture after deducting for depreciation and maintenance and expansion is assumed to flow into formal nonagriculture.

Of the total formal and informal nonagricultural wage bill, 20% is remitted into smallholder agriculture. This percentage (and the shares of formal and informal) is changed in an alternative run.

Public Capital.

Government capital formation is composed of government savings, net public domestic borrowing, net foreign borrowing and foreign aid. Government savings is the difference between government income from taxation minus subsidies and government consumption (see Module G).

$$GINV = GS + \Delta FB \cdot ER + \Delta PB - i_D PB - i_f FB \cdot ER + FAID \cdot ER$$

$$GS = GY - GC$$

$$GY = \text{Direct tax} + \text{indirect tax} + \text{import tax} + \text{export tax}$$

Government investment across the four sectors: small holder agriculture, large estate agriculture, non-agriculture formal, and non-agricultural informal is specified exogenously

$$GINV = GINV_{AGS} + GINV_{AGL} + GINV_{NAGINF} + GINV_{NAGF}$$

Capital Formation in Smallholder Agriculture

$$K_{AGS} = K_{AGS-1}\,(1 - \delta_{AGS}) + GINV_{AGS}$$

where

K_{AGS} = capital stock in smallholder agriculture

NS_{AGS} = net surplus of smallholder agriculture

$$NS_{AGS} = Y_{AGS}\,(1 - t_{DAG}) - PC_{AGS} + RMT$$

where

Y_{AGS} = income of small holder agriculture

PC_{AGS} = private consumption of smallholder agricultrue

RMT = remittances

δ_{AGS} = Rate of depreciation in smallholder agriculture

Capital Formation in Formal Nonagriculture

$$K_{NAGF} = K_{NAGF-1}\,(1 - \delta_{NAGF}) + GINV_{NAGF} + NS_{AGL} - NF_{INF} + NS_{NAGF} - \Delta PB$$

where

K_{NAGF} = capital stock of non-agriculture formal sector

δ_{NAGF} = depreciation rate of non-agriculture formal sector

NS_{AGL} = net surplus transferred from large estate agriculture

$GINV_{NAGF}$ = government investment into formal nonagriculture

NF_{INF} = net flow into nonagriculture informal

$$NS_{NAGF} = Y_{NAF} - W_{UF} \cdot LD_F$$

Capital Formation in Informal Nonagriculture

$$K_{NAGINF} = K_{NAGINF-1}\,(1 - \delta_{NAGINF}) + GINV_{NAGINF} + NF_{INF}$$

K_{NAGINF} = capital stock of non-agriculture informal sector

$GINV_{NAGINF}$ = government investment in nonagriculture informal sector

NON-AGRICULTURE OUTPUT MODULE—NA

Output of formal and informal nonagriculture are based on profit maximization, given expected prices and production functions. The production function for the formal and informal sectors are specified separately although the product is not differentiated. The rural-urban location of formal and informal production is specified exogenously. Government policies can manipulate the location of increments in production to reduce rural-urban income differentials and reduce urban overcrowding.

Output level is determined to maximize profits Π^{NA}

$$\Pi_F^{NA} = P_{NA} \cdot Y_{NAF} - W_{UF} \cdot L_{FNA} - P_{AG} \cdot IN_{AG \cdot F}$$

$$\Pi_{IFU}^{NA} = P_{NA} \cdot Y_{NAIF}^{U} - W_{IF}^{U}\, L_{IFNA}^{U} - P_{AG} \cdot IN_{AGIF}^{U}$$

$$\Pi_{IFRNA}^{NA} = P_{NA} \cdot Y_{NAIF}^{R} - W_{IF}^{R} \cdot L_{IFNA}^{R} - PAG \cdot IN_{AGIF}^{R}$$

where

Π_F^{NA} = profit in formal nonagriculture
Π_{IF}^{NA} = profit in informal non-agriculture
Y_{NAF} = output in formal non-agriculture
Y_{NAIF} = output in informal non-agriculture
L_{FNA} = labour use formal non-agriculture
L_{IFNA} = labour use informal non-agriculture
PAG = price of agriculture inputs
PNA = price of nonagriculture output
IN_{AGF} = agricultural input use in formal NAG
IN_{AGIF} = agricultural input use in informal NAG
Subject to the following constraints:

$$Y_{NAF} = \left[\alpha_1 (K_{NAGF}^{\beta_1}) + \alpha_2 (e^{\mu_1 t} L_{NAF})^{\beta_1} \right]^{-1/\beta_1} \quad (a)$$

$$Y_{NAIF} = \left[\alpha_3 (K_{NAIF}^{\beta_2}) + \alpha_4 (e^{\mu_2 t} L_{NAIF})^{\beta_2} \right]^{-1/\beta_2} \quad (b)$$

$$IN_{AGIF}^{R} = f(Y_{NAIF}^{R}) \quad (c)$$

$$IN_{AGIF}^{U} = f(Y_{NAIF}^{U})$$

$$IN_{AGF} = f(Y_{NAF})$$

The model distinguishes between the formal and informal sector through both differences in production function as well as differences in relative factor prices. The rural and urban location of non-agricultural production is solely on the basis of differences in factor prices.

LARGE ESTATE AGRICULTURAL PRODUCTION MODULE—AGL

Large estate holders input allocation decisions are based on profit maximization.

Land availability by agro-climatic zones is specified exogenously in the model. Land is added on to the large estate sector through land purchase by urban high income groups. This increased land availability is specified exogenously.

Given expected harvest prices and/or prices paid by marketing boards, prices of inputs and subsidies on fertilizer and fuel, large estate holders allocate inputs to different crops.

As there are many non quantifiable constraints affecting acreage and input allocation decisions, the crop production will be determined through a Nerlovian type acreage allocation model* and a simultaneous input allocation yield model**

The maximization system will be as follows:

$$\text{maximize } \Pi_{AG}^{L} = \sum_{j} P_{AGj} YLD_{jll} - Z_{jll}^{k} P_{INP}^{k} (1-S^{k}) - W_{RL} LD_{L}^{R}$$

* N.S.S. Narayana and M.M. Shah, "Farm Supply Response in Kenya: Acreage Allocation Model" WP-82-103, IIASA, Laxenburg, Austria
** G.Fischer and M.M. Shah, "Farm Supply Response in Kenya: Yield Model", IIASA, Laxenburg, Austria (forthcoming)

where

j = number of commodities

k = number of specified inputs both agricultural and nonagricultural

Π^k_{AG} = profits of large estate agriculture

P_{AGj} = price of agricultural commodity j.

YLD_{jil} = yield of agricultural commodity j by technique i and agroecological zone l

Z^k_{jil} = input use per hectare of input k in commodity j by technique i and agro-ecological zone l

P^k_{INP} = price of input k

S^k = subsidy for input k, as a proportion of per unit cost.

A technology matrix, with fixed coefficients for each crop technology level and agroecological zone constrains the maximization procedure.

The technology matrix† differentiates 10 categories of inputs--fertilizers N, P, K, seed ordinary, seed high yielding, human labor, animal labor, tractor and other implements, pesticides, and coefficients of fuel use are also specified for tractor and other farm implements, Table 7.

The large estate livestock model distinguishes dairy cattle, beef cattle, sheep, pigs and poultry. As an example (similar relationships for other livestock products) the following relationships have been used to estimate beef supply for the large holder sector.

$$LHS^{t+1} = LHS^t + LAR^t - LSR^t - LFSR^t$$

$$LAR^t = LHS^t (1 + LARR^t)$$

$$LSR^t = LHS^t (1 + LSRR^t)$$

$$LFSR^t = f (AFOD^t, FEED^t)$$

$$LARR^{t+1} = f (LARR^t, EMZP^t, ELVP^t)$$

$$LSR^{t+1} = f (LSRR^t, ELVP^t)$$

$$BEEF^t = (LSR^t + LFSR^t) * MCON^t$$

where

LHS^t is livestock herd size at time t

$LARR^t$ is reproduction rate at time t

$LSRR^t$ is slaughter rate at time t

$LFSR^t$ is forced slaughter rate at time t

$AFOD^t$ is area under fodder crops at time t

$FEED^t$ is additional feed required at time t

$EMZP^t$ is expected maize price at time t

$ELVP^t$ is expected livestock price at time t

$BEEF^t$ is beef supply at time t

$MCON^t$ is beef conversion factor

† The technology matrix is derived primarily with the help of the AT 2000 Technology Matrix, Agriculture Towards 2000, C79/24, FAO, Rome, Italy, July 1979.

SMALLHOLDER AGRICULTURAL PRODUCTION—MODULE AGS

Small holder input allocation decisions are based on profit maximization subject to a minimum admissable loss constraint. Adoption of new technology by smallholders is constrained by possible variations in yield. Smallholders also face a capital constriant. Capital availability is based on net surplus from previous period, remittances from nonagricultural income and availability of credit.*

Land by agroclimate zone for smallholders sector is specified exogenously. The distribution of land among small holders is specified by a log normal distribution (see Module LD).

Again as there are many constraints which are not easily quantified, the crop production will be determined through a Nerlovian type acreage allocation model and a simultaneous input allocation yield model as in the case of large estate agriculture.

The smallholder livestock model is similar to the large estate livestock model. The distribution of livestock income among the three smallholder income groups is on the basis of the 1974/75 Integrated Rural Survey of Small Farms. The pastoralists are treated as a separate group. Time series data on the livestock numbers as well as production of livestock products in the smallholder and the pastoralists sector are not available; data from the FAO Supply Utilization Accounts and Annual Agricultural Census of large farms have been utilized to derive the smallholder and pastoralists time series data.

The maximization system will be as follows:

$$\Pi^{S}_{AG} = \sum_{j} \sum_{i} P_j \, YLD_{jil} - Z^{k}_{jil} \, P^{k}_{INP} \, (1-s^{k}) - W^{R}_{INF} \, (LD_{SAG} - LS_{s})$$

where

Π^{S}_{AG} = profits of smallholder agriculture

W^{R}_{INF} = wage rate in rural informal sector

LS_s = labor supply in smallholder agriculture

LD_{SAG} = labour demand in smallholder agriculture

subject to

(1) Capital constraint. See Module K, under smallholder agriculture

(2) Technology constraint

(3) Risk aversion constraint.*

A finite set of probalistic outcomes is attached to each yield level, at each technology, for each agro-climatic zone. The model must allocate inputs so as to provide a minimum survival income.

$$\sum_{pn} YLD_{jiln} - cost \leq \Theta$$

* Small Farmer Credit in Kenya, AID Spring Review of Small Farmer Credit, No. SR 107, Washington, Feb. 1973.

* J.M. Wolgin, "Resource Allocation and Risk: A Case Study of Smallholder Agriculture in Kenya" American Journal of Agricultral Economics, 57(4), Nov. 1975.

where

n = the states of nature

pn = the attached probabilities

Θ = the minimum survival income.

Alternatively self-sufficiency constraints are specified exogenously.

INCOME MODULE Y

Eight household groups comprising of five rural and three urban are considered as follows,

Rural

1. Smallholder low income (including landless)
2. Smallholder medium income
3. Smallholder high income
4. Pastoralists
5. Rural informal non-agriculture and wage workers in rural formal non-agriculture

Urban

1. Low Income: urban informal non-agriculture and unemployed
2. Medium Income: urban wage workers in formal non-agriculture
3. High Income: large estate owners and owners of capital in formal non-agriculture

For each of the above income groups, except smallholders, the model endogenously generates the annual income. In the case of three smallholder income groups, the aggregate smallholder agriculture income is distributed among the three groups according to the distribution of land (Module--LD and Module INCH) as well as information on cropping intensity, input usage, asset distribution, net labour supply, etc. Data on these aspects for the three income groups has been obtained from the 1974/75 Integrated Rural Survey of small farms in Kenya.

MARKET EQUILIBRIUM MODULE--MKT

The model achieves sectoral market equilibrium through a combination of changes in domestic prices, and/or by international trade.

Equilibrium is achieved when the following material balance holds.

$$Y_i = \sum \alpha_{ij} \cdot Y_j + PC_i + GC_i + INV_i + EX_i - IM_i + \Delta S_i$$

where

Y_i = output by commodity i.e. 17 agricultural products and non-agriculture

PC_i = private consumption by commodity

GC_i = domestic goverment consumption by commodity

ΔS_i = stock changes by commodity

EX_i = exports by commodity

IM_i = imports by commodity

α = domestic input-output matrix

INV_i = investment by commodity

All commodities are treated as tradeable, but not all commodities are traded freely. Excess supply is exported at international prices. Food prices are prefixed by government policies. Food imports, are used to attain these prefixed food prices in the market. For all other excess demand sectors i.e., basically nonagriculture imports are controlled through a licencing system (quotas). Imports are made a function of final demand through fixed coefficients:

$$IMP_i = \Psi_{1i}\, PC_i + \Psi_{2i}\, GC_i$$

Under the trade liberalization policy these import coefficients are altered. The imported commodities are rationed through price changes.

Price Adjustment

The price adjustment is done through a subsidiary iteration mechanism between Module MKT and Nodule D (the demand system).

The iteration system is thus composed of:

$$Y_i = \sum \alpha_{ij}\, Y_i + PC_i + GC_i + EX_i - IM_i + INV_i + \Delta S_i$$

$$PC_i = \overline{PC}_i + b_i \frac{(INC - \sum PC_j \cdot P_j)}{P_i}$$

$$\frac{P_i - \bar{P}_{i-1}}{\bar{P}_{i-1}} = \Phi \cdot \frac{X_i - y_i}{X_i}$$

$$IM_i = \Psi_{1i}\, PC_i + \Psi_{2i} \cdot GC_i$$

where

X_i = production of commodity i

INC = income

P_i = price of commodity i

PRIVATE CONSUMPTION MODULE—PC

Private consumption is estimated* through the linear expenditure system estimated separately for the urban and rural population for Kenya. The parameters of the rural LES are used for the following groups of households:

(a) smallholder agriculture: low income (including landless)

(b) smallholder agriculture: medium income

(c) smallholder agriculture: high income

(d) pastoralists

(e) rural informal non-agriculture and wage workers in rural formal non-agriculture

* C. Williamson and M.M. Shah, "Models of Expenditure Systems for Kenya" WP-81-71, IIASA, Austria, June 1981.
M. M. Shah. 1979. Food Demand Projections Incorporating Urbanization and Income Distribution. FAO/UNDP/Kenya Food Marketing Project. Ministry of Agriculture, Nairobi, Kenya.

The parameters of the urban LES are used for the following household groups.

(a) urban: low income: urban informal non-agriculture and unemployed

(b) urban: medium income: urban wage workers in formal non-agriculture

(c) urban: high income: large estate owners and owners of capital in formal non-agriculture

The classification of commodity groups is different between the estimated rural and urban LES for Kenya. The consumption classification is also very different from the input-output commodity classification. These are matched together by using the translation code 2A and 2B given in Appendix 2.

SAVING MODULE–S

Savings functions, using survey data, are estimated separately +for the rural and urban household groups.

$$\frac{S}{Y} = s_0 + s_1 Y$$

Average income levels for each household group is used to derive average savings rates. Private total consumption expenditure is simply incomes minus savings so derived.

$$S_j = (s_0 + s_1 Y_j) Y_j$$

where j = 1 to 8 household groups.

$$TPC_j = Y_j - S_j$$

where TPC_j is total private consumption by household group j.

$$P_i \cdot PC_{ij} = P_i \overline{PC}_{ij} + b_{ij} [TPC_j - \sum P_k \overline{PC}_{kj}]$$

$$PC_i = \sum_j PC_{ij}$$

WHOLESALE AND RETAIL MARGINS–WRM

The price structure in Kenya is strongly influenced by government intervention*. The institutional machinery set up for this purpose is composed of the Annual Agricultural Price Review, the Industrial Protection Committee, the Price Controller's Office, and the Inspectorate of Statutory Boards.

Our model follows a 3-tier price structure with the following hierarchy:

producer price < wholesale price < retail price

* J.T. Mukai (ed.), Price and Marketing Controls in Kenya, Institute for Development Studies, Occasional Paper No. 32, Nairobi 1979.

All production decisions in the model are based on producer prices. The input-output system (Module **IO**) clears at wholesale prices and the private consumption module (Module **PC**) clears at retail prices. While there may exist considerable scope for reducing these margins,** especially those between the producer price and the wholesale price fixed proportonal differences calculated from base year data are used in our model. While much has been written about the socially nonprofitable speculative activities of private trade, most evidence indicated that public trading boards are usually operating at higher trading margins. In one normative scenario, trade margins are reduced, so as to examine the potential benefits of this policy.

DATA REQUIREMENTS AND CONCLUDING REMARKS

The data requirements of the model described are considerable. Since data on the Food and Agriculture sector in Kenya is not available from one compiled sourced, our first major task was to compile all relevant data. Following this, various components of the model were estimated; these results have been documented in previous publications from the Food and Agriculture Program at IIASA.

The next stage of the work is concerned with the linking of all components within the overall framework and evaluation of alternative policies. This is in progress and the results will be reported in subsequent reports.

** See:

(1) Heyer, The Marketing System, in Heyer, Maitha and Senga (1976),

(2) Final Report of the Marketing Development Project--Phase 1 KEN/75/005, Government of Kenya/UNDP/FAO, Nairobi, Dec. 1978,

(3) J. Sharpley "Pricing Policies and Rural Incomes in Kenya" DERAP Working Paper, No. A74, Bergen, Norway, April 1980.

APPENDIX 1: SEQUENCE OF SOLUTION

GIVEN in year t:

1. tariff/quota policy
2. tax rates
3. new public borrowing and accumulated public debt
4. new foreign borrowing, accumulated foreign debt and foreign aid
5. subsidy payments

We get government investment in year t.

GIVEN

6. exogenously specified distribution of government investment
7. private capital flows in year t.

We get capital stocks availability in each of 4 sectors in year t.

GIVEN expected producer prices in year t, price support policies and fuel and fertilizer subsidies, we get

8. acreage allocation across 17 agricultural commodities
9. input allocation across 17 agricultural commodities for both small and large farms in year t.

GIVEN government wage policy, and rural-urban migration and population we get

10. production nonagricultural formal and informal sector in year t + 1
11. production by input-output commodity groups in year t + 1

GIVEN targeted food prices by food input-output sectors, we get

12. food imports in year t + 1
13. capital and other commodity imports in year t + 1
14. income levels by each household group in year t + 1
15. equilibrating prices for nonfood

I-O sectors for year t + 1 through iterative mechanism.

16. distribution of smallholder income given log-normal land distribution.
17. rural-urban split of non-agriculture formal and informal nonagriculture.
18. rural-urban migration in year t + 1 for rural-urban population distribution in year t + 2
19. regional breakdown of incomes in t + 1
20. government investment again for t + 1,

and so on.

APPENDIX 2. Translation Codes

Translation Code 1. Production Commodity Groups to Input-Output Sectors

FAP/IIASA Classification I-O Sector	Kenya Production Groups
1. Wheat & Wheat Products	Wheat
2. Rice	Rice
3. Other Grains	Maize
	Sorghum & Millet
	Barley & Oats
4. Animal Fats & Oils	Groundnuts
	Sesame
	Sunflower
	Other Oilseeds
	Cattle
	Sheep & Goats
	Pigs
5. Protein Feeds	Maize
	Sorghum & Millet
	Barley & Oats
6. Sugar & related products	Sugarcane
7. Bovine & Ovine products	Cattle
	Sheep & Goats
8. Pork	Pigs
9. Poultry & Eggs	Poultry & Eggs
10. Dairy Products	Cattle
	Sheep & Goats
11. Vegetables, legumes	Vegetables
and starchy roots	Roots
	Pulses
12. Fruits & nuts	Fruits other
	Fruit citrus
13. Fish and Fishery Products	Fish (freshwater)
	Fish (saltwater)
14. Coffee	Coffee

Translation Code 1 cont.

FAP/IIASA Classification I-O Sector	Kenya Production Groups
15. Cocoa & Tea	Tea
16. Alcoholic Beverages	Alcoholic Beverages
17. Clothing Fibres	Cotton
18. Industrial Crops	Jute
	Pyrethrum
	Sisal
	Tobacco
19. Non-Agricultural Production	Non-Agricultural Formal
	Non-Agricultural Informal

Translation Code 2A.

Consumption Commodity Groups Urban	I-O Sector
Wheat bread	1
Wheat flour	1
Maize	3
Rice	2
Other coarse grains	3
Fats & oils	4
Sugar	6
Vegetables	11
Legumes	11
Fruits & nuts	12
Coffee	14
Tea	15
Alcoholic beverages	16
Tobacco	19
Bovine & ovine meat	7
Poultry & eggs	9
Dairy products	10
Fish	13
Non-agriculture	17,18,19

For consumption groups whose consumption is derived from different I-O sectors, the distribution of total consumption expenditures is done through Engel functions.

Translation Code 2B

Consumption Commodity Groups Rural	I-O Sector
Grain & roots	1,2,3
Meat & Fish	7,8,13
Fat & Oils	4
Dairy products	10
Sugar & sweets	6
Fruit & vegetables & beans	11,12
Beverages	16
Other foods	16,19
Clothing	17
Non-agriculture	19

FIGURE 1. Value of Imports–Kenya (1961–76)

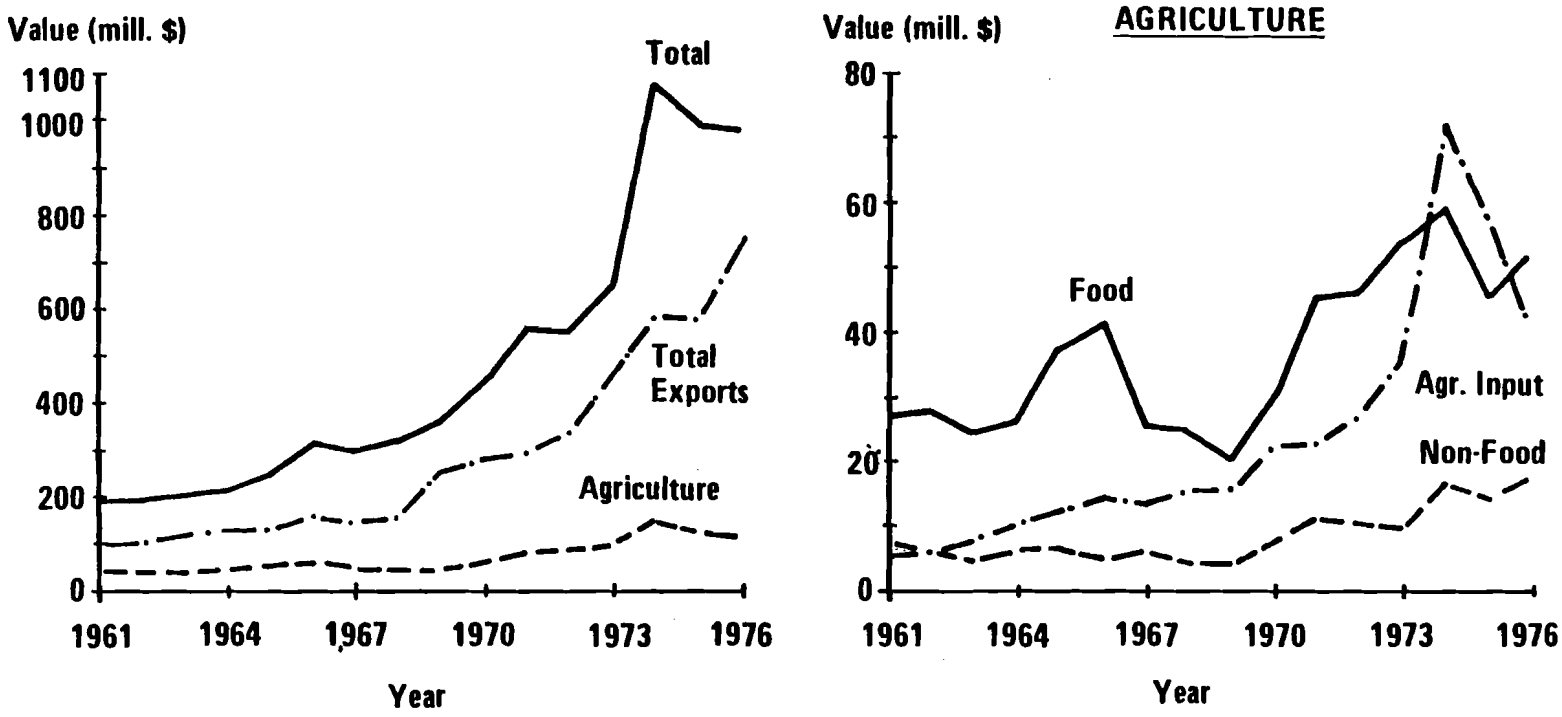


FIGURE 2. Value of Exports—Kenya (1961—76)

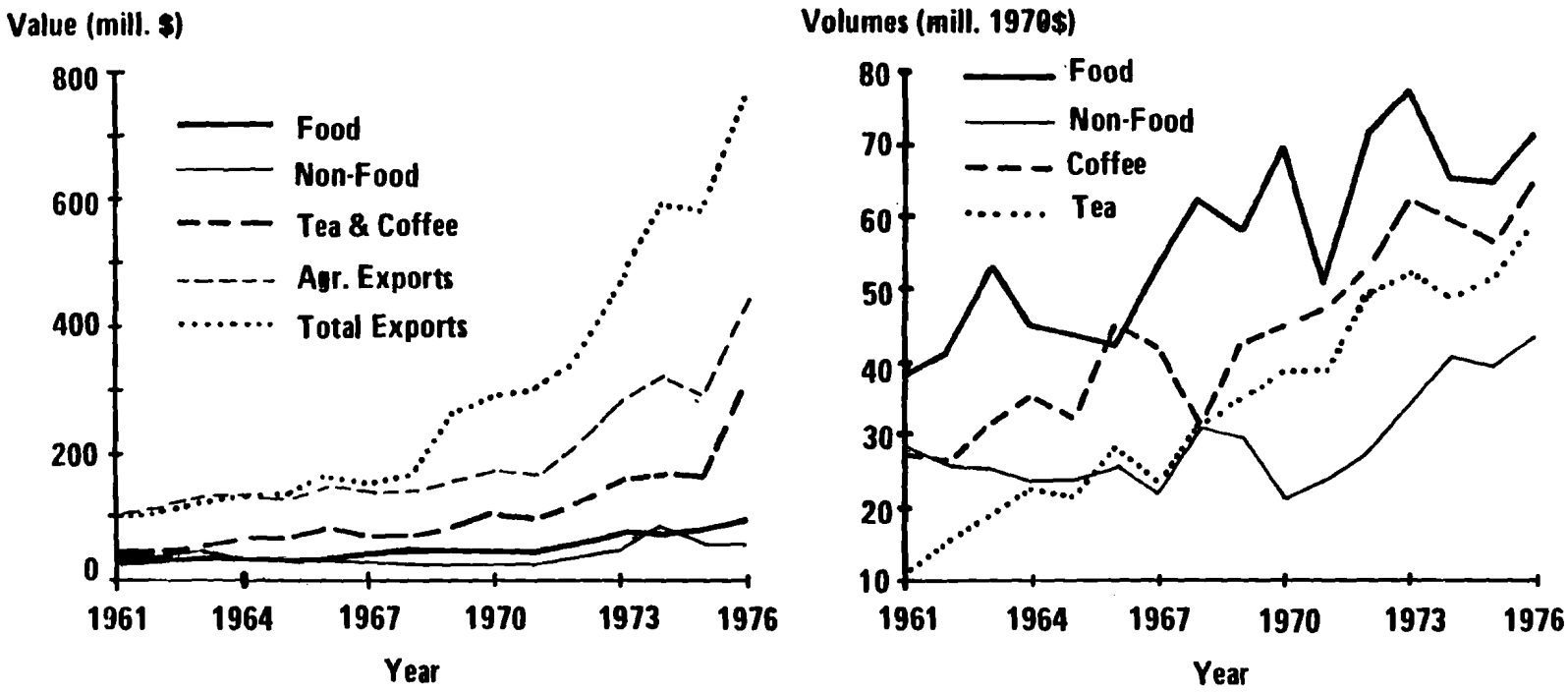


FIGURE 3. Exports and Terms of Trade: Kenya (1961–76)

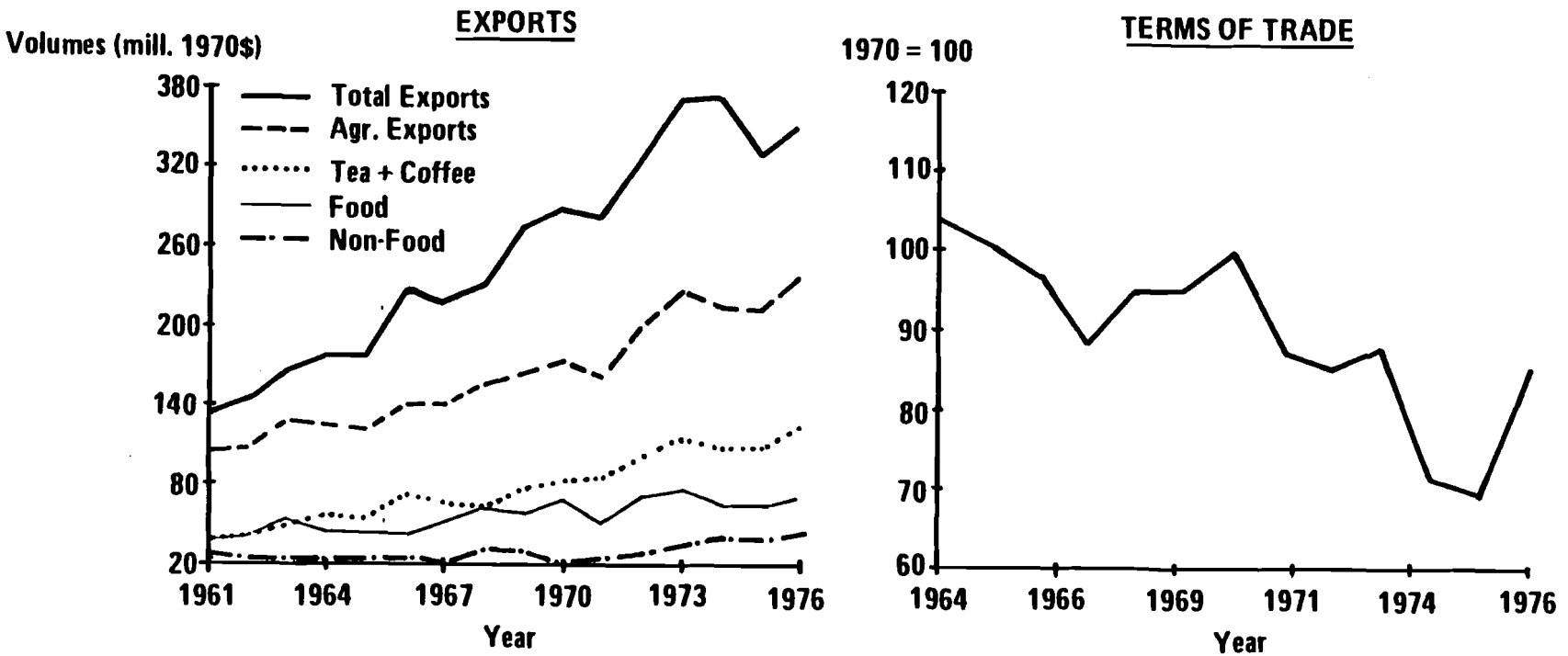
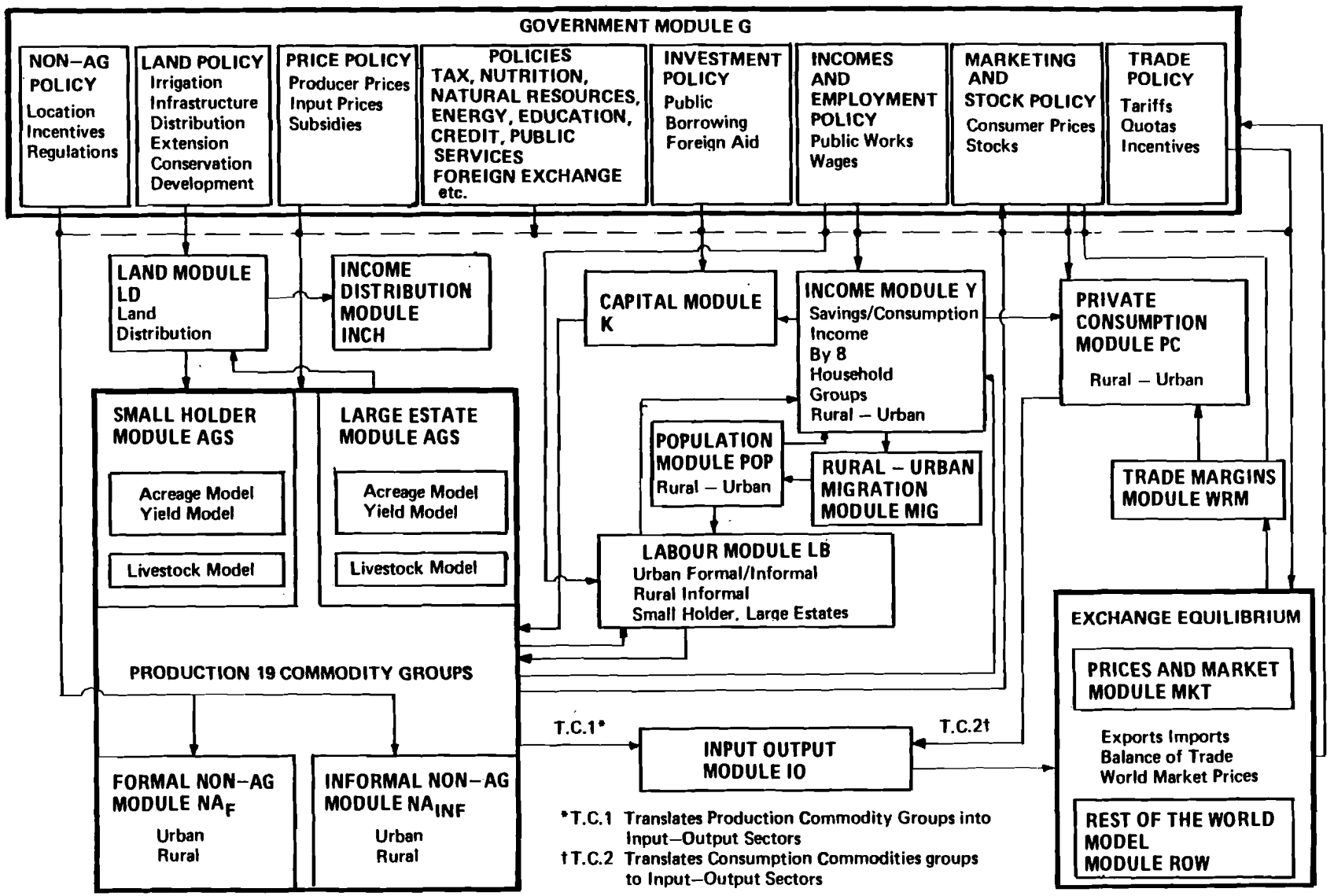


FIGURE 4 SCHEMATIC OUTLINE OF KENYA POLICY MODEL



*T.C.1 Translates Production Commodity Groups into Input–Output Sectors

†T.C.2 Translates Consumption Commodities groups to Input–Output Sectors

TABLE 1 Development Plans and Economic Growth

Plan Period	Plan Focus	Growth %			
		Non-Agr.	Agriculture		
			Monetary	Non Montary	Total
1966–70	Rapid Economic Growth	6.3	4.2	4.7	4.5
1970–74	+ Stress on Rural Development	6.6	5.2	2.4	3.7
1974–78	+ Focus on Employment and Income Distribution	6.5	4.8	2.6	3.7
1979–83	Alleviation of Poverty + Rural Population + Agricultural Development	(6.4)*	6.3*	3.0*	4.7*

*Government Target

TABLE 2a Export Cropping of Coffee, Tea, Pyrethrum and Sisal in Kenya, 1961 and 1975 (the percentage share from small farms is given in parentheses).

	1961	1975
Area (1000 ha)	196 (10)	267 (50)
Labour (1000 people)	195 (10)	261 (56)
Fertilizer (1000 m.t)	22 (1)	32 (9)
Export (K£M)	20 (17)	70 (41)
Maize Imports equiv. (1000 m.t)	925	1228
Potential (1000 m.t)	311 (10)	791 (43)
Potential (K£M)	6	17
Export Crops/ Food Imports	5.34	5.11

NOTES:

- From 1961 to 1975 the export earnings from these crops increased from 20 to 70 million Kenyan pounds. During this period the share of small-farm production increased from 17% to 41%.
- If these foreign exchange earnings were used to import maize, at cost, insurance and freight via the Kenyan port of Mombasa, then in 1961 0.925 million tonnes of maize could have been imported (Table 1). In 1975 the corresponding figure is 1.228 million tonnes. However, if the land, labour and fertilizer resources in cash crop production had been used for maize production then in 1961 and 1975 these would have amounted to 0.311 and 0.791 million tonnes respectively.

TABLE 2b. The Benefits of Export Cropping (Coffee,Tea,Pyrethra and Sisal) for Kenya Small Farms, 1961 and 1975

SMALL FARMERS NET REVENUE KShs./ha	1961	1975
Food Crops	428	1002
Export Crops	3424	4302
Food/Export Crops Strategy	451	1136
Food Strategy*	–	1027

Rural Food Price Index (1961–75) = 1.647

INCREMENTAL ANNUAL GAIN IN SMALL FARMER REVENUE

Food/Export Crop Strategy (Actual 1961–75)	3.08%
Food Strategy* (Alternative 1961–75)	2.34%

*Assumes that all resources allocated to producing the four cash crops are used instead for additional food production

TABLE 3 Availability Land Resources in Kenya and Potential for Rainfed Production/Soil Erosion Productivity Losses for Maize, Wheat, Sorghum and Millet – Year 2000.

	Low Technology*	Intermediate Technology*	High Technology*
Rainfed Arable Land† ('000 ha)	8313	6923	5771
% VH + H	27.2	31.4	27.7
% M	44.1	42.0	53.7
% L	28.7	26.6	18.6
Potential for Rainfed Production† ('000m.t) With Soil Conservation			
Maize	1280	4732	9964
Wheat	836	2315	3511
Sorghum	938	3716	7403
Millet	662	2719	6062
Without Soil Conservation (% Loss in Production Potential)			
Maize	50.7	37.9	29.0
Wheat	41.7	31.4	24.3
Sorghum	48.5	38.9	29.5
Millet	43.7	37.4	29.3

SOURCE
M.M. Shah and G. Fischer "Assessment of food production potential and prospects for self-sufficiency in Kenya, year 2000" IIASA, Austria (forthcoming).

* Low Technology assumes no chemical inputs and hand labour only.
Intermediate Technology is a mix of Low and High Technologies.
High Technology assumes all required chemical inputs and complete mechanization.
† Results for year 2000, appropriate allowance for nonagricultural land requirement according to regional population distribution has been made.

TABLE 4 Kenya, 1975 – Distribution of Calorie Consumption.

Income Class	Percentage of Total Population	Daily Calorie Consumption per Person	Daily Calorie Deficit per Person*
Rural			
1	39	1578	642
2	32	2077	143
3	19	2545	–
4	5	2867	–
5	2	2788	–
6	4	3036	–
Total	100	2069	151
Urban			
1	42	1787	343
2	25	2117	13
3	33	2453	–
Total	100	2086	44

* Monderately active rural requirement 2200 calories per day.
Urban light activity requirement 2130 calories per day.
SOURCE: M.M. Shah, Calorie Demand Projections Incorporating Urbanization and Income Distribution. FAP, IIASA, 1978.

TABLE 5a Resource Inputs and Outputs of Agriculture, Smallholder and Large Estates in Kenya.

		Small Farms	Large Farms
Cultivated Crop Land	1961 (mill ha)	2.9	0.5
	1975	3.5	0.5
Labour	1961 (1000 people)	2.17	0.26
	1975	3.06	0.19
Fertilizers	1961 (1000 m.t)	2.3	41.8
	1975	52.1	106.8
Tractors	1961 (1000)	0.250	6.40
	1975	10.90	5.98
Capital Stock*	1961 (K£mill)	37.1	44.6
	1975	69.6	72.5
Investment*	1961 (K£mill)	3.7	4.1
	1975	4.7	4.3
Output*	1961 (K£mill)	98.1	41.4
	1975	163.6	71.8

* 1964 Constant Prices

TABLE 5b Resources and Production (1976); Smallholder and Large Estate Agriculture in Kenya.

	Small Farms	Large Farms
LAND USE (mill ha)		
Total land	3.5	2.7
Cultivated Land	2.5	0.5
Food Crops	2.0	0.3
Non-Food Crops	0.5	0.2
VALUE OF PRODUCTION (K£mill)		
Food	145.6	12.7
Non-Food	33.0	51.4
Livestock	62.3	4.0
Total	240.9	68.1
Marketed	90.1	68.1

TABLE 6 Income Distribution* is Kenya, 1974

	% Population	% Income
Urban		
Low	0.42	0.19
Middle	2.57	3.22
High	6.81	39.40
Large Farms		
Low	–	–
Middle	–	–
High	0.14	1.07
Small Holders		
Low	20.92	4.04
Middle	37.43	19.87
High	13.97	15.10
Gap* Farms		
Low	–	–
Middle	–	–
High	1.89	5.03
Other Farmers and Squatters		
Low	2.17	0.40
Middle	3.43	2.24
High	–	–
Landless		
Low	1.47	0.57
Middle	1.47	1.13
High	1.71	6.48
Pastoralists		
Low	4.48	0.75
Middle	1.12	0.51
High	–	–

SOURCE: Derived from "Poverty and Growth in Kenya", P. Collier and D. Lal, World Bank Staff W/P 389, pp 5, World Bank, Washington, May 1980

* Farms size between small and large farms

Table 7. Kenya: development objectives and policy framework.

Overall Objective	Sector/Objective	Policy Instruments/Framework
A. Growth	Agriculture Growth -- self-sufficiency in basic food products -- agricultural production for import substitution -- agricultural production for exports	Prices and Availability of Inputs -- subsidies: fertilizer, fuel, seeds, etc. Prices of Outputs -- producer and retail prices of scheduled commodities -- seasonal price policy, e.g. milk -- export crops: prices to producers Investment and Incentives Credit Schemes Extension and Research Irrigation, Land, and Infrastructure Development
	Non-agriculture Growth -- rural formal -- urban formal -- urban informal	Incentives for Non-agriculture rural Investments Incentives for domestic and foreign investments Legal Regulations and Incentives
B. Equity and Poverty Alleviation	Income and Employment: -Agricultural Employment -- raise income levels -- increase labor absorption -- increase labor productivity -Pastorlists -- raise income levels -- increase livestock quality/numbers	Agricultural Intensification Rural Development Policy Land Policy: redistribution, registration, and adjudication Tax Policy Price and Marketing Policy Incomes and Wages Policy Development of Arid and Semi-arid Areas

Table 7 continued.

Overall Objective	Sector/Objective	Policy Instruments/Framework
	-Non-agriculture Rural -- unemployed and underemployed -- increase productivity -- increase labor absorption	Rural Industrial Policy Production of Basic Need Goods Seasonal Public Works Agricultural Processing Rural Investment Incentives
	-Non-agriculture Urban -- alter relative lost of labor -- increase productivity -- increase labor absorption	Kenyanization Policy Wages and Incomes Policy Trade Policy Input Substitution Policy -- tariffs -- quantity restrictions Export Incentives -- credit, compensation, and guarantee schemes
	-Non-agriculture Urban Informal -- increase employment -- training and productivity	Legal regulations and Incentives Basic Services and Training Facilities
	Food and Nutrition:	
	-Broad Self-sufficiency in Nation's Food Requirements -Security of Food Supply -Nutritional Adequacy	Price Policy Agricultural Input Policy --prices and supply of fertilizers, seeds, etc. Research and Extension Policy --new varieties, services for land preparation, etc. Food Security Policy Processing and Marketing Policy Agricultural Trade Policy Nutritional Policy Resource Development Policy Employment Policy
	Disparties	
	-Rural - Urban -Rural - Rural (Province) -Agriculture - Non-agriculture -Small Farm - Large Farm -Urban Formal - Urban Informal	Wages and Income Policy Educational Policy Dispersal of Industrial Activity Terms of Trade Policy Allocation of Intermediates Institutional Credits and Public Services

Table 7 continued.

Overall Objective	Sector/Objective	Policy Instruments/Framework
C. Self-reliance and Stability	Balance of Payments -- agricultural exports -- non-agricultural exports -- import restrictions	Import and Trade Policy -- advance import deposit schemes -- letter of no objection practice -- foreign exchange controls -- quantity restrictions -- tariffs -- export incentives
	Food Security -- regional food stocks	Marketing Board Stock Operations Regional Movement of Food Commodities Food Import Policy
	Domestic Reliance	Fiscal and Monetary Policy -- public expenditure and investments -- taxes Monetary Policy -- selective credit schemes -- money supply flexibility -- interest rates and structure
D. Ecological Sustainability	Agriculture -- soil erosion -- semi-arid and arid areas -- nutrient leaching Water Resources Forest Resources Wildlife Resources Fishery Resources	Conservative and Productivity Policies

Source: Compiled from

(1) Development Plans, 1964-70, 1970-74, 1974-78, 1979-83 Republic of Kenya, Nairobi

(2) Economic Prospects and Policies, Sessional Paper No. 4 of 1974, Republic of Kenya, Nairobi

(3) Economic Prospects and Policies, Sessional Paper No. 4 of 1980, Republic of Kenya, Nairobi

(4) National Food Policy, Sessional Paper No. 4 of 1981, Republic of Kenya, Nairobi

(5) National Food Policy for Kenya, Report of a symposium on National Food Policy, Republic of Kenya, Nairobi, July 1981.

TABLE 8 Technology Matrix for MAIZE Production in Kenya.

		Igra				Ilra				Infl			
		ulow	low	high	uhigh	ulow	low	high	uhigh	ulow	low	high	uhigh
Seed Traditional	kg/ha	22.00	22.06	2.20	0.0	15.00	15.23	1.50	0.0	22.00	18.40	1.87	0.0
Seed Improved	kg/ha	0.0	1.25	22.27	25.00	0.0	1.00	17.91	20.00	0.0	1.04	18.97	15.00
Power	Man Day Equivalent	55.10	85.56	96.94	122.53	49.24	72.02	73.49	80.42	49.24	67.97	82.58	69.63
Fertilizer Nitrogenous	kg/ha	0.0	2.09	44.24	183.30	0.0	0.31	6.92	31.80	0.0	1.74	37.69	109.98
Fertilizer Phosphatic	kg/ha	0.0	1.36	28.89	119.71	0.0	0.21	4.61	21.20	0.0	1.13	24.61	71.83
Fertilizer Potassium	kg/ha	0.0	0.15	3.23	13.38	0.0	0.0	0.0	0.0	0.0	0.12	2.75	8.02
Pesticides	$ 1975	0.0	3.17	6.25	17.02	0.0	1.21	1.54	2.69	0.0	2.64	5.32	10.21
Yield	MT/ha	0.40	1.70	2.30	4.50	0.30	0.70	1.00	1.50	0.40	1.50	2.30	3.00
		Irrf				Irrp				prob			
		ulow	low	high	uhigh	ulow	low	high	uhigh	ulow	low	high	uhigh
Seed Traditional	kg/ha	25.00	23.94	2.50	0.0	15.00	14.29	1.50	0.0	27.50	27.39	2.75	0.0
Seed Improved	kg/ha	0.0	1.50	27.15	30.00	0.0	1.50	27.21	30.00	0.0	1.02	18.12	20.41
Power	Man Day Equivalent	83.63	102.80	128.16	164.44	82.12	99.44	126.04	161.80	60.23	91.65	106.22	138.95
Fertilizer Nitrogenous	kg/ha	0.0	2.73	56.34	194.00	0.0	3.49	70.83	219.82	0.0	1.99	42.26	179.98
Fertilizer Phosphatic	kg/ha	0.0	2.18	45.07	155.20	0.0	2.29	46.49	144.26	0.0	1.30	27.75	118.20
Fertilizer Potassium	kg/ha	0.0	1.64	33.81	116.40	0.0	0.22	4.43	13.74	0.0	0.15	3.15	13.43
Pesticide	$ 1975	0.0	1.43	5.55	16.03	2.08	3.20	5.39	10.55	0.0	0.29	6.22	28.58
Yield	MT/ha	1.50	2.60	4.40	7.55	1.20	2.00	3.50	6.00	0.30	1.10	1.50	3.70

SOURCE Derived* (for Kenya conditions) from Global Technology Matrix for Maize, Agriculture Towards Year 2000, C 79/24, FAO, Rome, Italy, 1979.

NOTES

Igra: 120–270 days length of growing period** zone and very suitable/suitable soil

Ilra: 75–120 days, length of growing period and marginally suitable soil

Infl: + 270 days, length of growing period zone plus marginally suitable soil from 120–270 days zone

Irrf: Fully irrigated zone

Irrp: Partially irrigated zone (drainage/low water supply reliability)

prob: 75–120 days, length of growing period zone

ulow: Ultralow Technology

low: Low Technology

high: High Technology

uhigh: Ultrahigh Technology

* G. Marzalles and M.M. Shah, IIASA, Austria, June 1980

** Agro-ecological zone project, Land and Water Division, FAO, Rome, Italy

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