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ZAMBIA MAIZE POLICY SIMULATOR MODEL

(User's Manual)

ZATPID PROJECT

LUSAKA, ZAMBIA

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Introduction

The importance of maize to agriculture and the general economic health of Zambia is shown by a number of alternative statistics. In terms of area planted, maize is estimated to have occupied over 70% of the total land under cultivation. In terms of its importance to the overall nutritional level for the country, statistics are somewhat more difficult to obtain. According to the 1974/75 household consumption survey however, maize meal made up___% of total weight of food consumed. Calorie intake levels associated with maize are similarly quite high, especially in urban households.

With maize being so important to Zambia's economy, it is not surprising that considerable attention has been devoted to policies related to promoting its production and in some instances, subsidizing its consumption. Maize policy has formed the backbone of agricultural policy for over two decades in Zambia. Prices were fixed at predetermined levels to provide national self-sufficiency. Jansen (1986) provides a review of historical maize pricing policies.

As an indication of how maize pricing policies at the retail level are used to affect national economic policy, Kumar (1984) indicates that maize meal prices received a subsidy of nearly 30% from 1972-1982. This subsidy was provided to keep meal prices low and therefore to allow wages to also remain low. Further, the urban population does not have the opportunity to produce self-sufficiency crops such as casava. This places a great importance on meal prices to the urban consumer as few alternatives exist in the diet. Attempts to raise meal prices in the recent past have met with considerable urban resistance.

In examining the approach taken for past policy selection, it is apparent that the majority of decisions have been reached without substantial empirical analysis, particularly with respect to the longer term impacts of the policy levers selected. Atherton and Reintsma (1986, pg v) indicate that there are long and short term analyses incorporated in the policy formulation, but that the decision makers are only now "...coming to rely increasingly on an empirically-based process, and to generate some demand for data collection and analysis to underpin decisions".

With respect to the hierarchy of that policy formulation process, Atherton and Reintsma suggest that support be provided to key organizations. Number one on the list is the Planning Division of the Ministry of Agriculture and Water Development, (PD/MAWD).

This report details the development and implementation of a policy analysis tool to be utilized directly by personnel within PD/MAWD. The analysis tool is a set of software for projecting supply and utilization of maize within Zambia, indicating expected levels of production, retention, marketing, import needs, producer revenues and a variety of government cost factors. The modeling system, developed in conjunction with two key

individuals within PD/MAWD, is intended to be a simplified system model with a minimum degree of a "black box" approach to the analysis. The policy analyst within PD/MAWD has the opportunity to override the model solutions at several key decision points and to impose his/her insight with respect to current policy actions within Zambia. Further, the modeling system is not intended to provide the "right" answer. It is developed to indicate the consequences of a variety of policy decision. The political process within Zambia should be utilized to determine the appropriate action for Zambia. If the modeling system converts the arguments from the vocal forum into debate with respect to the economic consequences of the various actions, it will have been successful.

This document is intended as a working guide to the model system. It is organized as follows: First, a flow chart of the entire evaluation is presented to provide an overview of the system. Second, each of the nine principal parts of the model is explained in detail. Explanation includes a complete list of externally supplied values and the formulas for the internally generated values. Next, Table 10 outlines two alternate scenarios. Finally, two additional tables are provided to show how other features might be attached to the present system.

To reiterate, this system is designed to be utilized by the analyst. As such there are a limited number of "whistles and bells" attached. The spreadsheet does not make extensive use of macros or the windowing capability of the underlying software. This is done so that the user has complete access to the analysis system.

Data Constraints and Utilization

The difficulty of obtaining consistent cross-sectional and time series data sets for Zambia is well documented. FAO Report No. 4715-ZA, Annex 5, pg 4 states: "The paucity of recent data on nutrition status reflects wide acknowledgement that Zambian agricultural and economic conditions have worsened since 1971." Atherton and Reintsma's (1986 pg 34) report on the ZATPID project indicates "..the available data and analyses were relatively weak and not adequate to meet the greatly increased demand..." As an additional example of data concerns for Zambia, Memorandum #2 in this report series describes three separate supply and utilization tables for maize in Zambia. These three sources are: ERS, FAS, and a composite developed by Fosu (1987).

This combination of lack of data at worst and conflicting data series at best, forced a decision that econometric estimation of demand and supply was not possible. Further, as PD/MAWD is the destination agency, a methodology was needed to provide PD/MAWD with a system which could quickly accept information relative to the entire gamut of policy options as well as new data.

PD/MAWD has reported a consistent series of data reflecting area, yield, production

and sales for the major crops. These data are jointly compiled by PD/MAWD, CSO and the FAO-sponsored early warning service. The data reported by PD/MAWD are gaining acceptance as the definitive source of agricultural information. Thus, since their data bases are gaining acceptance and they are the destination agency, a decision was reached to utilize the maize data on area and production held by PD/MAWD exclusively.

Other items of data are also important in determining the final supply and utilization tables. These are stock holdings and imports. Official import data is relatively easily to obtain. NAMBOARD is the sole importer of maize for Zambia and has excellent historical records on maize imports. Some unofficial, quasi-illegal exporting of maize and maize meal likely occurs over the northern border. However, data on these small shipments are unavailable, due in part to the quasi-smuggling nature of these activities.

Stocks until recent periods have also been held exclusively by NAMBOARD, with a few days' supply held by millers. However, cooperatives have recently been allowed to hold stocks, implying that stock holding information must now be gathered from two sources. Some stocks are undoubtedly held at the farm level. However, data on these activities are not available. Further, as fixed prices are in place for maize on an annual basis, there is little incentive for the producer to retain quantities in excess of subsistence levels much beyond harvest periods.

Thus, nearly all categories making up the supply and utilization tables are in hand with some degree of consistency and reliability. These data include area, yield and production from PD/MAWD, NAMBOARD and cooperative stock levels and crop receipts, imports by NAMBOARD and sales of maize to mills by cooperatives and NAMBOARD. As is the case for stocks, both the cooperatives and NAMBOARD are allowed to make sales to mills. Thus data must be collected on both categories from both organizations. These data sources are combined into a consistent supply and utilization table with data extending back to the 84/85 drop year. As previously mentioned, this time period of observations is too short for reliable econometric estimation of supply and demand responses.

All of the variables described above are either collected by, or are readily available to PD/MAWD. Analysts within PD/MAWD are familiar with the individuals within NAMBOARD who have data concerning mill sales and stocks. Further, there are contacts within the cooperatives for obtaining data on coop purchases and stock holdings. This allows for the analysts to update the supply and utilization tables as new information becomes available.

It is important to note the data series which are considered "hard" as these will be important when the variables to be projected are concerned. Those considered to have the most reliability are area, yields, imports, stocks and sales to mills.

Maize Model Structure

The maize model developed for Zambia incorporates economic factors on both the supply and demand sides. However, the final model development is much more pragmatic than originally designed. As an example of the simplification generated at a request of the PD/MAWD analysts, the demand side now contains one, as opposed to two demand components. The previous model incorporated economic factors affecting meat consumption and feed use per animal. Further, human consumption was projected based on income and price factors. However, as indicated in memorandum #2 concerning data, the information on consumption alone is subject to considerable question. Splitting the consumption series into two components implies substantially more information than is available.

For the data reasons and usage factors, the model now contains three primary economic relationships, area planted, per capita sales to mills and retentions. The functional relationships have not changed markedly from earlier models. Area remains a function of the producer price of maize and the price of fertilizer. Consumption, proxied by per capita mill sales, is a function of real income and real prices. Each of these and the third relationship will be discussed in turn.

Area Planted

The area planted to maize is considered to respond to two economic terms and a trend growth factor. The economic factors are the producer price of maize and the price of fertilizer. The elasticity of area response to maize price is taken as 0.3 and that for fertilizer price at -0.2. Trend growth raises plantings by 20,000 ha/year. These elasticities and trend term were chosen in such a way as to minimize the sum of errors over the period of time when data is considered reliable.

Per Capita Mill Sales

Per capita mill sales are used as a proxy for demand as opposed to total consumption. A review of historical data on per capita consumption when total supplies are considered indicates substantial variability. Further, it is difficult to identify any economically driven fluctuations as consumption appears to be driven primarily by supply shifts.

For this reason, per capita mill sales are estimated as responding to the real consumer price of maize, real income, and production levels. Price responsiveness is assumed to be very low at -0.1 due to the subsistence nature of maize in Zambia. For this same reason, the income elasticity is placed at 1.0. Finally, sales are estimated to respond to production levels as well. As prices are fixed during the year, the demand curve could

be assumed to be perfectly elastic. Thus consumption levels would be more driven by supply. Empirically, the addition of supply greatly aided in reducing errors as well.

Farm Retentions

One concern of agencies within Zambia is that the price differential between the farm and consumer level had widened to such an extent in 1986 that there would be little reason for producers to keep any maize on the farm. This would then require moving large amounts of milled corn back out to the rural communities causing further transportation problems. Further, as the flow of information section will indicate, imports are determined by the difference between mill sales and NAMBOARD/Coop purchases coupled with stock changes. Thus, the proportion of maize which is produced and actually sold off the farm is doubly important. This is estimated as a constant percentage, adjusted by the differential between producer and consumer prices of maize. As the differential increases, i.e. producer prices rise without adjustment in consumer prices, then the producer will market a larger portion of his crop.

With subsidized consumer prices, it is to a producer's advantage to market his crop if the differential is high and buy the processed product. If that gap is small, the producer is better off to by-pass the difficulties of transportation, and selling his maize by keeping it for personal consumption.

Model Closure

These three factors are taken together with stock identities to close the supply and utilization projection system. Area is determined as mentioned. Yield is taken as exogenous to price and is projected to show trend growth of 0.2 bags/ha/year. These two factors generate production and when beginning stocks are added, total domestic supply is determined. Marketed production is estimated as previously described so that stocks plus marketed production give the level of grain available for sales to mills.

Demand for mill sales is estimated based on the factors already described. Stocks are determined based on the objectives provided in the marketing order for the 1986 crop. The change in stock levels and mill sales are compared to the level of grain available for mill sales. If the demand levels are greater than available supplies then maize is imported to close the system. Should supplies be greater than demand, a portion is added to stocks and a portion is exported.

POLICY EVALUATION PROCESS

SEQUENCE

- TABLE 1: Cost of production estimates for commercial and small farms to determine recommended price supports
- TABLE 2: Predetermined information -- inputs, population, exchange rate, etc.
- TABLE 3: Estimated planted area
- TABLE 4: Total domestic maize supply
- TABLE 5: Zambia internal market prices and handling costs
- TABLE 6: Maize mill delivery equation (consumer demand)
- TABLE 7: Supply and demand utilization estimates for maize
- TABLE 8: Total domestic consumption
- TABLE 9: Government costs

FLOW CHART

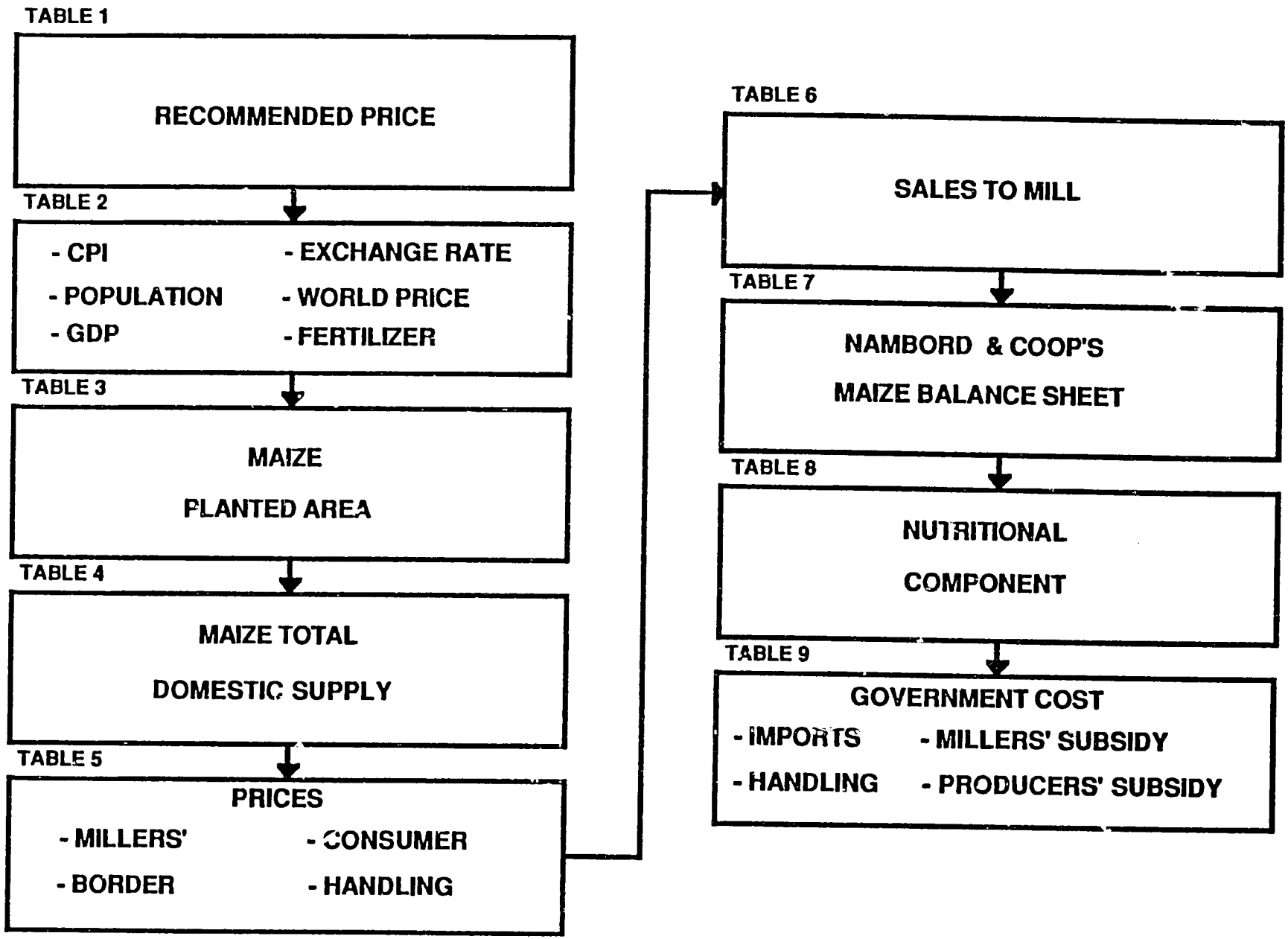

FIGURE 1

Table 1: Cost Of Commercial Maize Production

Table 1 computes the total cost per bag at the commercial farm level for three yield levels. Using an average cost, a recommended price per bag is determined.

Externally Supplied Values

- Three Yield Values
- 1986/87 Value of Capital Used
  - Cost/Unit
  - Units/Hectare
- 1986/87 Variable Costs
  - Cost/Unit
  - Units/Hectare
- Seasonal Interest
  - Interest Rate
  - Number of Months
- Allowed Depreciation

Internally Generated Values

- The Cost/Unit of each subsequent year is inflated by 20%
  $$\text{Cost/Unit}_T = (\text{Cost/Unit}_{T-1})(1.2)$$
- Units/Hectare are assumed constant throughout the period
- Interest Rates, Number of Months and Allowed Depreciation are assumed constant through the period
- Recommended Price/Bag
  $$= [(\text{Total Price/Bag})_1 + (\text{Total Price/Bag})_2 + (\text{Total Price/Bag})_3]/3$$

Table 1: Costs of Commerical Maize Production
and Recommended Price per Bag

YIELD.90kg BAGS/HA	65.00	COST/UNIT	UNITS/HA	COST/HA	COST/UNIT	UNITS/HA	COST/HA	COST/UNIT	UNITS/HA	COST/HA
ITEM:	UNITS	1986/87			1987/88			1988/89		
VALUE OF CAPITAL USED										
(a)VEHICLES	EACH	1166.00	1	1166.00	1399.20	1	1399.20	1679.04	1	1679.04
(b)EQUIPMENT	EACH	214.00	1	214.00	256.80	1	256.80	308.16	1	308.16
(c)BUILDINGS,ETC.	EACH	621.00	1	621.00	745.20	1	745.20	894.24	1	894.24
(d)LAND CLEARING	EACH	1000.00	1	1000.00	1200.00	1	1200.00	1440.00	1	1440.00
TOTAL REPLACEMENT COST				3001.00			3601.20			4321.44
AVG.VALUE OF CAPITAL				1500.50			1800.60			2160.72
****VARIABLE COSTS****										
SEED	KG.	2.26	25	56.50	2.71	25	67.00	3.25	25	81.36
FERTILISER: D MIXTURE	KG.	0.68	300	204.00	0.82	300	244.80	0.98	300	293.76
• UREA	KG.	0.68	250	170.00	0.82	250	204.00	0.98	250	244.80
• LIME	KG.	0.30	250	75.00	0.36	250	90.00	0.43	250	108.00
CHEMICALS: PRIMAGRAM	LITRES	57.75	4	231.00	69.30	4	277.20	83.16	4	332.64
• THIODAN	LITRES	26.25	2	52.50	31.50	2	63.00	37.80	2	75.60
LABOUR	DAYSWK/DAY	4.21	45	189.45	5.05	45	227.34	6.06	45	272.81
FUEL,+ 20% OIL & LUB.	L. @ K/L	2.24	130	291.20	2.69	130	349.44	3.23	130	419.33
VEHICLE & TRACTOR R&M	EACH	222.09	1	222.09	266.51	1	266.51	319.81	1	319.81
EQUIPMENT REP.&MAINT	EACH	120.20	1	120.20	144.24	1	144.24	173.09	1	173.09
REPAIRS TO BLDGS,RDS	EACH	44.93	1	44.93	53.92	1	53.92	64.70	1	64.70
INSURANCE	EACH	101.43	1	101.43	121.72	1	121.72	146.06	1	146.06
CROP TRANSPORT	/BAG YIELD	1.58	65	102.70	1.90	65	123.24	2.28	65	147.89
PACKING MATL (BAGS)	/BAG YIELD	1.00	65	65.00	1.20	65	78.00	1.44	65	93.60
OTHER EXPENSES	EACH	28.22	1	28.22	33.86	1	33.86	40.64	1	40.64
SUB-TOTAL				1954.22			2345.06			2814.08
SEASONAL INTEREST	MONTHS @ %	25.0%	9	366.42	25.0%	9	439.70	25.0%	9	527.64
VARIABLE COSTS: Total				2320.64			2784.76			3341.72
****FIXED COSTS****		Base Cost	% Allowed	COST/HA	Base Cost	% Allowed	COST/HA	Base Cost	% Allowed	COST/HA
DEPRECIATION										
VEHICLES		1166.00	25.0%	291.50	1399.20	25.0%	349.80	1679.04	25.0%	419.76
EQUIPMENT		214.00	20.0%	42.80	256.80	20.0%	51.36	308.16	20.0%	61.63
BUILDINGS, ETC.		621.00	5.0%	31.05	745.20	5.0%	37.26	894.24	5.0%	44.71
LAND CLEARING		1000.00	2.5%	25.00	1200.00	2.5%	30.00	1440.00	2.5%	36.00
				390.35			468.42			562.10
RETURN ON AVG. CAPITAL		1500.50	25.0%	375.13	1800.60	25.0%	450.15	2160.72	25.0%	540.18
MANAGEMENT ALLOWANCE		3086.11	5.0%	154.31	3703.33	5.0%	185.17	4444.00	5.0%	222.20
TOTAL FIXED COSTS				919.78			1103.74			1324.48
TOTAL COST OF PRODUCTION				3240.42			3888.50			4666.20
COSTS/BAG, BY YIELDS		Var'ble/bag	Fixed/bag	Total/bag	Var'ble/bag	Fixed/bag	Total/bag	Var'ble/bag	Fixed/bag	Total/bag
Bags/ha =	55.00	41.72	16.72	58.45	50.26	16.72	66.99	60.89	16.72	77.62
Bags/ha =	60.00	38.46	15.33	53.79	45.83	15.33	61.16	55.46	15.33	70.79
Bags/ha =	65.00	35.70	14.15	49.85	42.12	14.15	56.27	50.91	14.15	65.06
RECOMMENDED PRICE/BAG (Kw/bag)				54.03			61.47			71.16
Percent increase (%)							13.78%			15.75%

Table 2: General Data

Table 2 brings together various data which will be widely used in subsequent tables.

Externally Supplied Values

- Consumer Price Index, 1982-85
- Producer Price, 1982-85
- Fertilizer Price, 1982-88
- Urban and Rural Population, 1982-90
- Gross Domestic Product, 1982-87
- U.S. Corn Price, 1982-90
- Exchange Rate, 1982-90

Internally Generated Values

- Consumer Price Index (1986-90): $CPI_T = CPI_{T-1} \times 1.25$
- Producer Price (1986-90): Table 1
- Gross Domestic Product (1988-90): $GDP_T = GDP_{T-1} \times 1.2$
- Per Capita Gross Domestic Product = GDP x 1,000,000 / Total Population
- Real Per Capita GDP = Per Capita GDP/ CPI

TABLE 2: GENERAL DATA	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91
CPI - All Items	258.5	308.6	363.8	479.2	599.0	748.8	935.9	1169.9	1462.4
Producer Price (Kw/bg)	16.00	18.30	24.50	28.32	54.03	61.47	71.16	83.03	97.63
Fert.Price(Kw/bg Urea)	10.95	14.95	24.10	26.75	26.75	48.00	58.00	63.80	70.18
Total Population	6,060,822	6,262,756	6,472,763	6,691,209	6,918,473	7,154,954	7,154,954	7,154,954	7,154,954
Urban	2,690,562	2,825,090	2,966,345	3,114,662	3,270,395	3,433,915	3,433,915	3,433,915	3,433,915
Rural	3,370,260	3,437,666	3,506,419	3,576,547	3,648,078	3,721,040	3,721,040	3,721,040	3,721,040
Gross Domestic Product	3,595	4,181	4,733	5,908	7,377	9,212	11,054	13,265	15,918
PerCap GDP	593.2	667.6	731.3	883.0	1066.2	1287.5	1545.0	1854.0	2224.7
Real Per Cap GDP	2.29	2.16	2.01	1.84	1.78	1.72	1.65	1.58	1.52
U.S. Corn Price					$2.05	$1.85	$1.95	$2.05	$2.20
Exchange Rate (K/$)	0.928	1.251	1.794	3.894	7.150	7.250	7.250	7.250	7.250

Table 3: Estimate Of Area Planted To Maize

Table 3 uses Producer Price, Fertilizer Price, and the Consumer Price Index to estimate the area planted to maize.

Externally Supplied Values

- Price and Fertilizer Price Elasticities
- Trend
- Calibration
- 1982 Estimated Area
- 1981 CPI (C99)

Internally Generated Values

- Real Price Change Effect

$$= \text{Area}_{T-1} \times \text{Price Elasticity} \times \frac{\text{Producer Price}_{T-1}/\text{CPI}_{T-1}}{\text{Producer Price}_{T-2}/\text{CPI}_{T-2}} - 1 + \frac{\text{Producer Price}_{T}/\text{CPI}_{T}}{\text{Producer Price}_{T-1}/\text{CPI}_{T-1}} - 1$$

- Fertilizer Price Change Effect

$$= \text{Area}_{T-1} \times \text{Fertilizer Price Elasticity} \times \frac{\text{Fertilizer Price}_{T}/\text{CPI}_{T}}{\text{Fertilizer Price}_{T-1}/\text{CPI}_{T-1}} - 1$$

- Estimated Area_T

$$= \text{Area}_{T-1} + \text{Price Change Effect}_T + \text{Fertilizer Price Change Effect}_T + \text{Trend} + \text{Calibration}$$

Table 3: Estimate of Area Planted to Maize

Price Elasticity:	0.3
Fert. Price Elasticity	-0.2

	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91
Real Price Change Effect ('000 Ha)		1.26	7.61	0.99	34.88	37.43	-14.23	-12.41	-11.53
Fert Price Change Effect ('000 Ha)		-13.1	-39.8	15.8	23.0	-49.8	3.9	14.1	14.7
Trend ('000 Ha)		20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Calibration ('000 Ha)		78.5	-28.0	38.0	-82.0	0.0	0.0	0.0	0.0
Estimated Area ('000 Ha)	454.5	541.2	501.0	575.8	571.7	579.4	589.0	610.7	633.8

Table 4: Total Domestic Supply

Table 4 uses Estimated Area, the Consumer Price Index and Producer Price to estimate Production, Marketed Production, and Beginning and Ending Stocks.

Externally Supplied Values

- Beginning Stocks, 1982-85
- Production, 1982-85
- Marketed Production, 1982-85

Internally Generated Values

- Area: Table 3
- Yield
  1982-85: Yield = Production / Area
  1986-90: $Yield_T = Yield_{T-1} + 0.2$
- Beginning Stocks
  1987-90: $Beginning\ Stocks_T = Ending\ Stocks_{T-1}$
- Percent Marketed
  1982-85: Percent Marketed = Marketed Production / Production
  1986-90: Percent Marketed = (Producer Price / CPI - 0.07) x 3 + 0.63
- Marketed Production (1986-90) = Production x Percent Marketed
- Retention = Production - Marketed Production
- Total Domestic Supply = Beginning Stocks + Production
- Ending Stocks
  1982-85: $Ending\ Stocks_T = Beginning\ Stocks_{T+1}$
  1986-90: Ending Stocks = Max [(Marketed Production x 0.35),2750]

TABLE 4: TOTAL DOMESTIC SUPPLY

	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91
Area ('000 Ha)	454.5	541.2	501.0	575.8	571.7	579.4	589.0	610.7	633.8
Yield (bags)	18.3	19.2	19.3	21.7	21.0	21.2	21.4	21.6	21.8
Beginning Stocks ('000 bags)	1,321	1,652	1,635	1,953	1,454	2,902	2,864	2,859	2,922
Production ('000 bags)	8,336	10,392	9,686	12,471	12,006	12,282	12,604	13,191	13,818
% Marketed	68%	57%	65%	57%	69%	67%	65%	63%	62%
Marketed Production	5,706	5,902	6,268	7,070	8,291	8,184	8,168	8,349	8,571
Retention	2,630	4,490	3,418	5,401	3,715	4,098	4,436	4,842	5,247
Total Domestic Supply ('000 bags)	9,657	12,044	11,321	14,424	13,460	15,184	15,468	16,050	16,740
Ending Stocks ('000 bags)	1,652	1,635	1,953	1,454	2,902	2,864	2,859	2,922	3,000

Table 5: Price Data

Table 5 uses Producer Price, Marketed Production, U.S. Corn Price, and the Exchange Rate to compute the Millers Price and Import Price.

Externally Supplied Values

- Millers' Price, 1982-85
- Millers' Subsidy, 1986-90
- Border Price, 1982-85
- Consumer Price, 1982-86
- NAMBOARD Charge, 1982-90
- Union Charge, 1982-90

Internally Generated Values

- Producer Price: Table 2
- Producer Payments = Producer Price x Marketed Production
- Millers' Price (1986-90) = Producer Price - Millers' Subsidy
- Total Millers' Subsidy = Millers' Subsidy x Marketed Production
- Border Price = (U.S. Corn Price x Exchange Rate x 4.5891) + 1.4211
- Consumer Price = (Miller Price x 50 / 90 / 0.96) + 3.5
- Total Handling = NAMBOARD Total + Union Total
- NAMBOARD Total = NAMBOARD Charge x Marketed Production / 2
- Union Total = Union Charge x Marketed Production / 2

TABLE 5: PRICE DATA	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91
Producer Price (Kw/bag)	16.00	18.30	24.50	28.32	54.03	61.47	71.16	83.03	97.63
Producer Payments ('000 Kw)	91289.25	108003.38	153557.11	200212.12	447990.62	503086.58	581228.19	693235.20	836746.74
Millers Price (Kw/bg)	17.00	22.48	26.00	28.32	34.03	51.47	66.16	83.03	97.63
Millers Subsidy (Kw/bg)	0.00	0.00	0.00	0.00	20.00	10.00	5.00	0.00	0.00
Total Millers Subsidy ('000 Kw)	0	0	0	0	165,828	81,837	40,842	0	0
Border Price Alternate Formula	16.73	17.09	23.24	35.34	44.74	41.06	43.20	45.34	48.56
Border Price (Kw/bg)	16.73	17.09	23.24	35.34	68.82	63.09	66.43	69.76	74.76
Consumer Price (50kg Roll)	13.00	16.90	18.77	20.64	20.64	33.29	41.78	51.55	60.00
Handling ('000 Kw)	19,285	21,955	25,635	45,953	99,497	98,205	98,021	100,187	102,849
KAMBOARD Charge (Kw/bag)	3.38	3.72	4.09	4.50	16.00	16.00	16.00	16.00	16.00
Total (Kw)	19,285	21,955	25,635	31,813	66,331	65,470	65,348	66,792	68,566
Union Charge (Kw/bag)	---	---	---	4.00	8.00	8.00	8.00	8.00	8.00
Total (Kw)	---	---	---	14,139	33,166	32,735	32,674	33,396	34,283

Table 6: Estimated Sales To Mills

Table 6 uses Consumer Price, CPI, and Real Per Capita Gross Domestic Product to estimate sales of maize to mills.

Externally Supplied Values

- Price Elasticity
- Income Elasticity
- Supply Adjustment Factor
- Baseline Per Capita Sales, 1982-90
- Calibration, 1982-90
- 1981 Consumer Price and CPI (B160)
- 1981 Real Per Capita GDP (B161)

Internally Generated Values

- Price Adjustment
  = Baseline Sales x (Consumer $Price_T/CPI_T$/Consumer $Price_{T-1}/CPI_{T-1}$) x Price Elasticity
- Income Adjustment
  = Baseline Sales x (Real Per Capita GDP_T/Real Per Capita GDP_{T-1}-1) x Income Elasticity
- Supply Adjustment
  = Supply Adjustment Factor x (Per Capita Production - Baseline Sales)
- Per Capita Sales Estimate
  = Baseline Sales + Adjustment Factors + Calibration
- Total Mill Sales
  = Per Capita Mill Sales x Population / 90,000

Table 6: ESTIMATED SALES TO MILLS

Price Elasticity:	-0.10
Income Elasticity:	1.00
Supply Adjustment Factor:	0.15

	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91
Baseline PerCap Sales to Mills (Kg)	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0
Price Adjustment (kg)	-3.3	-2.8	0.6	1.7	2.1	-3.0	0.0	0.1	0.7
Income Adjustment (kg)	-6.4	-6.0	-7.4	-8.7	-3.6	-3.6	-4.2	-4.2	-4.2
Supply Adjustment (kg)	2.8	6.7	4.5	9.4	7.7	7.4	8.0	9.1	10.3
Calibration (kg)	0.0	0.0	0.0	0.0	-1.0	0.0	0.0	0.0	0.0
Percap Sales Estimate (kg)	98.1	102.8	102.6	107.4	110.2	105.8	108.8	110.1	111.8
Total Mill Sales Estimate ('000 90 kg bags)	6,604	7,156	7,380	7,985	8,472	8,412	8,649	8,751	8,892

Table 7: NAMBOARD And COOP's Maize Balance Sheet

Table 7 uses Marketed Production and Sales to Mills to compute import levels.

Externally Supplied Values

- Imports, 1982-86

Internally Generated Values

- Opening Stocks: Table 4
- Purchases: Marketed Production (Table 4)
- Imports (1987-90)
  = Deliveries to Mills + Ending Stocks - Purchases - Opening Stocks
- Total Availability
  = Imports + Purchases + Opening Stocks
- Deliveries To Mills
  1982-86: Deliveries To Mills = Total Availability - Ending Stocks
  1987-90: Estimated Mill Sales (Table 6)
- Ending Stocks: Table 4

Table 7: NAMBOARD and COOP's Maize Balance Sheet

	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91
NAMBOARD & COOP Opening Stocks ('000 bags)	1,321	1,652	1,635	1,953	1,454	2,902	2,864	2,859	2,922
NAMBOARD & COOP Purchases ('000 bags)	5,706	5,902	6,268	7,070	8,291	8,184	8,168	8,349	8,571
Imports ('000 bags)	1,240	1,110	1,060	1,080	1,628	190	475	465	399
Total Availability ('000 bags)	8,267	8,664	8,963	10,103	11,374	11,276	11,508	11,673	11,891
Deliveries to Mills/Losses ('000 bags)	6,615	7,029	7,010	8,649	8,472	8,412	8,649	8,751	8,892
Ending Stocks ('000 bags)	1,652	1,635	1,953	1,454	2,902	2,864	2,859	2,922	3,000

Table 8: Nutritional Component

Table 8 uses price and domestic supply data to calculate total and per capita consumption and index of real per capita expenditure on meal.

Externally Supplied Values

- None

Internally Generated Values

- Consumption = Retained Stocks + Deliveries To Mills
- Per Capita Consumption = Consumption x 90,000 / Total Population
- Per Capita Mill Sales = Deliveries To Mills x 90,000 / Total Population
- Index Of Real Per Capita Expenditure On Meal
  = Consumer Price x Per Capita Mill Sales / CPI / 4.396

Table 8: Nutritional Component

	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91
Consumption ('000 bags)	9,245	11,519	10,428	14,050	12,186	12,510	13,084	13,593	14,138
Per Capita Consumption (kg)	137.3	165.5	145.0	189.0	158.5	157.4	164.6	171.0	177.8
Per Capita Mill Sales (kg)	98.22	101.01	97.47	116.33	110.21	105.81	108.79	110.08	111.84
Index of Real Per Capita Expenditure on Meal	1.00	1.12	1.02	1.01	0.77	0.95	0.98	0.98	0.93

Table 9: Government Costs

Table 9 examines the costs incurred by the government in Consumer Subsidies and Handling Charges.

Externally Supplied Values

- None

Internally Generated Values

- Consumer Subsidy = Import Subsidy + Domestic Subsidy
- Import Subsidy = (Border Price - Miller Price) x Imports
- Domestic Subsidy
  = (Producer Price - Millers Price) x (Deliveries To Mills - Imports)
- Handling Charges: Table 5
- Total Government Cost = Consumer Subsidy + Handling Charges

Table 9: Government Costs

	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91
Consumer Subsidy ('000 Kw)	-5709.38	-30723.05	-11850.25	7581.60	193516.67	84423.61	40997.82	-6174.22	-9112.90
Import Subsidy ('000 Kw)	-334.80	-5982.90	-2925.60	7581.60	56648.35	2209.46	128.86	-6174.22	-9112.90
Domestic Subsidy ('000 Kw)	-5374.58	-24740.15	-8924.65	0.00	136968.32	82214.15	40868.96	0.00	0.00
NAMBOARD & Union Handling Charges (Kw/bag)	19284.85	21954.79	25634.64	45952.64	99496.91	98204.71	98021.32	100187.30	102848.53
Total Government Cost	13575.48	-8768.26	13784.39	53534.24	293013.58	182628.33	139019.14	94013.09	93735.63

Table 10: 1989/90 Values for Varying Scenarios

The purpose of Table 10 is to show what would result by changing the original model parameters.

Scene 1: The Millers' Subsidy is maintained at 20 kw/bag from 1986/87 to 1990/91.

Scene 2: The Millers' Subsidy is maintained at 20 kw/bag and the Recommended Price is dropped by 20 kw/bag from 1986/87 to 1990/91.

TABLE 10: 1989/90 VALUES UNDER VARYING SCENARIOS

	Original Scenario	Scenario 2	Scenario 3
Production ('000 bags)	13,191	13,191	10,975
Ending Stocks ('000 bags)	2,922	2,922	2,750
Sales to Mills ('000 bags)	8,751	8,768	8,475
Imports ('000 bags)	465	483	1,931
Consumption ('000 bags)	13,593	13,611	13,382
Total Government Costs ('000 bags)	94,013	271,658	262,474

Table 1A: Cost of Non-Commercial (Oxen Farm) Maize Production

Table 1A computes the Cost of Production for maize at the oxen farm or non-commercial level.

Externally Supplied Values

- Yield
- 1986-87: Value Of Capital Used
  - Cost/Unit
  - Units/Hectare
- 1986/87 Variable Costs
  - Cost/Unit
  - Units/Hectare
- Seasonal Interest
  - Interest Rate
  - Number of Months
- 1986/87 Risk Allowance
- Allowed Depreciation

Internally Generated Values

- The Cost/Unit for subsequent years is inflated by 20%
  $Cost_T/Unit = Cost_{T-1}/Unit \times 1.2$
- Units/hectare are assumed constant throughout the period.
- Interest rates, number of months, and allowed depreciation are assumed constant throughout the period.

Table 1A: Costs of Non-Commerical (Oxen Farm) Maize Production

YIELD,90kg BAGS/HA	35.00	COST/UNIT	UNITS/HA	COST/HA	COST/UNIT	UNITS/HA	COST/HA	COST/UNIT	UNITS/HA	COST/HA
ITEM:	UNITS	1986/87	1986/87	1986/87	1987/88	1987/88	1987/88	1988/89	1988/89	1988/89
VALUE OF CAPITAL USED										
FIXED IMPROVEMENTS	/HA.	375.00	1	375.00	450.00	1	450.00	540.00	1	540.00
AVERAGE VALUE OF CAPITAL				187.50			225.00			270.00
*****VARIABLE COSTS*****										
SEED	KG(10/BAG)	2.94	25	73.50	3.53	25	88.20	4.23	25	105.84
FERTILISER: D MIXTURE	KG.	0.96	200	192.00	1.15	200	230.40	1.38	200	276.48
AMM/NITR	KG.	0.96	200	192.00	1.15	200	230.40	1.38	200	276.48
CHEMICALS: DDT	KG	17.01	2	34.02	20.41	2	40.82	24.49	2	48.99
LABOUR	DAYS@K/DAY	4.21	90	378.90	5.05	90	454.68	6.06	90	545.62
OXEN COSTS: PLOUGH	/HA	45.00	1	45.00	54.00	1	54.00	64.80	1	64.80
HARROW	/HA	29.00	1	29.00	34.80	1	34.80	41.76	1	41.76
RIDGE	/HA	29.25	1	29.25	35.10	1	35.10	42.12	1	42.12
CULTIVATE	/HA	50.40	1	50.40	60.48	1	60.48	72.58	1	72.58
CROP TRANSPORT	/BAG YIELD	1.80	35	63.00	2.16	35	75.60	2.59	35	90.72
PACKING MATERIAL (BAGS)	/BAG YIELD	2.50	35	87.50	3.00	35	105.00	3.60	35	126.00
SUB-TOTAL				1174.57			1409.48			1691.38
SEASONAL INTEREST	MONTHS @ %	25.0%	12	293.64	25.0%	12	352.37	25.0%	12	422.85
TOTAL VARIABLE COSTS				1468.21			1761.86			2114.23
*****FIXED COSTS*****		Base Cost	% Allowed	Total	Base Cost	% Allowed	Total	Base Cost	% Allowed	Total
DEP'N: FIXED IMPROVEMENTS		375.00	5.0%	18.75	450.00	5.0%	22.50	540.00	5.0%	27.00
RETURN ON CAPITAL (K)		187.50	25.0%	46.88	225.00	25.0%	56.25	270.00	25.0%	67.50
RISK ALLOWANCE		1204.00	5.0%	60.20	1444.80	5.0%	72.24	1733.76	5.0%	86.69
MANAGEMENT ALLOWANCE		1575.29	5.0%	78.76	1890.35	5.0%	94.52	2268.41	5.0%	113.42
TOTAL FIXED COSTS				204.59			245.51			294.61
TOTAL COST OF PRODUCTION				1672.80			2007.36			2408.83
COST/BAG				47.79			57.35			68.82
PERCENT INCREASE							9.6%			11.5%

Table 8A: Estimate Of Total Maize Consumption

Table 8A uses Consumer Price, CPI and Real Per Capita Gross Domestic Product to estimate total maize consumption.

Externally Supplied Values

- Price Elasticity
- Income Elasticity
- 1982/83 Baseline Consumption
- 1981/82 CPI and Consumer Price (M199)
- 1981/82 Real Per Capita Gross Domestic Product (M200)
- Calibration (1982-90)

Internally Generated Values

- Baseline Consumption is assumed constant through the period
- Price Adjustment_T
  $= \text{Price Elasticity} \times (\text{Consumer Price}_T/\text{CPI}_T/\text{Consumer Price}_{T-1}/\text{CPI}_{T-1}-1) \times \text{Baseline Consumption}$
- Income Adjustment_T
  $= \text{Income Elasticity}_T \times \dfrac{\text{Real Per Capita GDP}_T}{\text{Real Per Capita GDP}_{T-1}} - 1 \times \text{Baseline Consumption}$
- Supply Adjustment = Production x 90,000 / Total Population - Baseline Consumption
- Per Capita consumption = Baseline Consumption + Adjustments
- Total Consumption Estimate
  = Per Capita Consumption x Population / 90,000 + Calibration

Table 8A: Estimate of Total Maize Consumption

Price Elasticity	-0.3								
Income Elasticity	0.5								
	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91
Baseline Consumption (kg)	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0
Price Adjustment (kg)	-4.3	-3.6	2.3	6.7	8.1	-11.8	-0.2	0.5	2.8
Income Adjustment (kg)	-4.1	-3.9	-4.8	-5.6	-2.3	-2.3	-2.7	-2.7	-2.7
Supply Adjustment (kg)	-11.2	14.3	-0.3	32.7	21.2	19.5	23.5	30.9	38.8
Per Capita Consumption (kg)	115.3	141.9	132.2	168.8	162.0	140.4	155.7	163.8	173.9
Calibration ('000 bags)	1200	1200	500	1299	1299	1909	1909	1909	1909
Total Consumption Estimate ('000 bags)	8,968	11,072	10,010	13,849	13,751	13,074	14,285	14,927	15,734