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# THE COSTS OF FOOD SELF-SUFFICIENCY: MAIZE PRICING AND TRADE POLICY IN ZIMBABWE[1]

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## 1 Introduction

Food policy analysis in Zimbabwe must start from the country's unique conditions that separate it from most other parts of Africa. First, the major staple crop, white maize, is thinly traded on world markets. Zimbabwe's production instability combined with its landlocked location and poor regional infrastructure result in huge fluctuations between import and export parity prices. The Grain Marketing Board (GMB) captures almost all of the marketed maize surplus and has contributed to maize price stability, primarily in urban areas, through fixed prices, subsidies and stockholding policies. These policies and associated regulations explain the virtual absence of parallel grain markets, and the difficulty in reducing state intervention in food markets without a viable private sector to fill the void.

Despite its uniqueness, Zimbabwe is facing food policy dilemmas similar to other African countries undertaking structural adjustment. It is now clear that the level of maize producer prices over the past several years are insufficient to maintain Zimbabwe's status as grain exporter. The need for higher real producer prices coincides with the country's mandate under structural adjustment to reduce the massive indirect and direct government subsidies on maize and maize meal. A critical policy issue is how to procure national maize supplies while reducing these subsidies without causing intolerable increases in consumer prices that would exacerbate food insecurity.

Maize self-sufficiency has historically been an explicit policy goal in Zimbabwe. This has been justified on the grounds that the world market for white maize is thin, and that the producer price needed for self-sufficiency is normally substantially below import parity levels. This article reassesses the implications of these arguments for maize pricing and trade policy. A framework is developed to measure the trade-offs

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associated with the pursuit of maize self-sufficiency compared to alternative maize price levels/import volumes. The effects of these alternative pricing levels on average maize procurement costs are derived under a range of weather/yield outcomes. Results of an econometrically-based simulation model indicate that a pricing policy geared toward maize self-sufficiency would benefit a small number of relatively wealthy farmers and require either greater government subsidies or higher prices to consumers (many of whom are among the poorest segment of the population). After considering likely substitution effects in production and consumption, self-sufficiency strategy also appears to provide a lower level of national income than a self-reliance strategy involving lower producer prices and imports. A major implication of this analysis for other countries in the region is that -- even if the expected producer price needed for self-sufficiency is below the c.i.f. import price -- the pursuit of food self-sufficiency may inflate average food costs, reduce national income and exacerbate food insecurity compared to a self-reliance policy involving imports.

The following section identifies factors contributing to changes in maize production and marketing costs in Zimbabwe, and the subsequent production decline. In light of these trends, Section 3 examines the evolving nature of the country's food price dilemma. Section 4 presents a framework for analyzing the costs and benefits of continuing the historical commitment to maize self-sufficiency. Section 5 presents the simulation model used to evaluate the effects of self-sufficiency compared to a self-reliance strategy based on various mixes of producer price/import levels. Results are discussed in Section 6. The final section examines the broader implications of these findings for food policy in Eastern and Southern Africa.

## 2 Key Trends in the Maize Sector[2]

Zimbabwe has been a net exporter of maize for 10 of the 12 years since independence in 1980 and has received wide acclaim for its smallholder maize revolution (BLACKIE, 1986; STACK, 1989). Between 1980 and 1985, smallholder maize production doubled and maize sales to the Grain Marketing Board (GMB) tripled, overtaking commercial farmers as the major source of national maize supply. The elements of this production success have been well documented, and provide important food policy lessons for other countries in the region. Even though Zimbabwe is in the throes of its worst drought in over 25 years, and will import maize during 1992. It is widely perceived that Zimbabwe's position as food importer is a transitory one that will subside with the return to normal weather.

A closer look, however, reveals a relatively neglected second chapter of Zimbabwe's maize revolution, which holds equally important policy lessons for countries experiencing declining budgets for investment in agriculture. Per capita food production has declined 25% below the average during 1980-85. This has been caused by an erosion of public investments in agriculture that, until the mid-1980s, had reduced food production and marketing costs and offset the effect of falling real

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2 Zimbabwe's agricultural structure is bi-modal, characterized by a large-scale, capital-intensive commercial sector and a small-scale, low-input smallholder farming sector. The commercial sector is composed of about 4,000 farmers of mainly European-descent controlling 35% of the country's arable land, while the smallholder sector is composed of about 900,000 African households controlling the other 65%. Maize plays the dominant role in the food economy, accounting for over 85% of national coarse grain production and roughly half of the calories consumerd by the average Zimbabwean.

producer prices. The decline in public investment, which has not been matched by an expansion of private trading networks, has exacerbated Zimbabwe's drift toward becoming a high-cost food producer. This has in turn put upward pressure on real maize prices, thus increasing the severity of the trade-off between food self-sufficiency and household food security. In spite of these trends, the continued pursuit of maize self-sufficiency has gone largely unquestioned in Zimbabwe, as in much of Southern Africa.

*The 1980-85 maize revolution*

Smallholder maize sales to the GMB rose progressively from 87,000 tons to 830,000 tons between 1980 and 1985. Smallholder maize production doubled over this period (AGRITEX). There were six primary causes of the smallholder maize success story of the early 1980s (Rohrbach, 1989): First, the ending of the independence war facilitated an 85% increase in smallholder maize area between 1979 and 1981. Second, the Grain Marketing Board (GMB) rapidly increased the number of depots in smallholder regions, from 3 in 1980 to 18 in 1985. Over 100 state grain collection points were established by 1985.[3] These investments reduced smallholders' marketing costs and risks associated with surplus maize production. Third, agricultural credit disbursed to smallholders increased dramatically through the early 1980s, which led to a rise in fertilizer use and maize yields. Fourth, private sector input suppliers rapidly expanded in smallholder farming areas, especially those benefiting from new GMB infrastructure and credit. Fifth, sustained public and private seed research over the previous decades generated higher-yielding maize hybrids applicable to most smallholder conditions. Between 1979 and 1985, hybrid seed sales increased fivefold, and over 90% of smallholders growing maize now use hybrids. Sixth, official producer prices were normally kept above export parity levels. However, real producer prices declined by 20% between 1981 and 1985, reflecting the importance of public investments in new technology and market infrastructure in facilitating a doubling of production despite falling prices.

However, perceptions have lagged behind reality since the mid-1980s. The maintenance of large grain stockpiles carried forward from the mid-1980s has focused attention on methods to dispose of maize surpluses such as the manufacture of ethanol for fuel. This view of the maize sector is based on the assumption of continued chronic surplus production, a premise that remains largely taken for granted by policy makers. This view has obscured Zimbabwe's trend since 1985 toward national maize deficits.

*The 1985-1992 decline*

Figure 1 presents trends in area planted to maize over the past decade. The area planted to maize by commercial farmers has declined at a rate of 18,000 hectares per year since 1981. Smallholder maize area peaked in 1985, but then declined at an average rate of 55,000 hectares per year from 1985 to 1991. Most of the decline in smallholder maize area appears to be in the lower-rainfall areas that are already subject to chronic food deficits. Maize area in the Mashonaland provinces, the maize belt of Zimbabwe, has been roughly unchanged over the past five years.

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3 Depots are permanent crop buying stations located in town centers while collection points are temporary buying points located in the more remote rural smallholder areas.

Commercial farm maize yields have been stagnant over the past 12 years (Figure 2). Smallholder yields in the Mashonaland provinces have been trending upward over the decade, but on average, smallholder yields has shown little improvement since 1985.

Both smallholder and commercial maize production fluctuate considerably with the weather. However, production from neither sector has ever exceeded its 1984/85 level. Since 1985, the growth rate of maize production has been outstripped by population growth (Figure 3). Per capita maize production was about 25% lower in 1991 than at independence. Most of the stagnation in maize production is due to declining area.

The maize production stagnation since 1985 is due to several factors. The most conspicuous is drought, which has affected the country three times since 1985. Yet there are also underlying structural causes of the maize decline. First, the improved hybrid seed varieties that stimulated smallholder productivity during 1980-85 are now almost universally adopted. A new set of technological improvements or management practices is necessary to stimulate additional gains in productivity. The national agronomic and crop breeding research institute (DR&SS) receives only 75% of the budget it had in 1980/81 in real terms. The number of on-farm trials and sites by DR&SS has shrunk from 63 in 1987/88 to 31 in 1990/91 (SHUMBA, 1991).

A second cause of the structural decline since 1985 is the failure to evolve low-cost input distribution systems for smallholders. Disbursement of government credit to smallholders has been declining since 1987 while input costs have been rising. The amount of fertilizer that can be purchased with government credit disbursed to smallholders is 44,000 metric tons in 1992 compared with 148,000 tons in 1986. Moreover, smallholders' ability to procure fertilizer is hampered by poor roads and lack of transport. Declining fertilizer input use, along with relatively poor rainfall, may explain why smallholder maize yields, even in the relatively productive Mashonaland provinces, have exceeded their 1985 level only once.

Third, GMB buying stations in smallholder areas have been reduced. Even though 17 additional grain buying depots have been established since 1985, the number of rural collection points has declined from 135 in 1985 to 42 in 1989 to 9 in 1991. Smallholder maize sales are likely to be slowed further if GMB closes depots in remote smallholder areas as currently planned. Retrenchment by the public sector has not been offset by expansion of private sector services, largely due to regulatory and infrastructural constraints on private trade (CHISVO et al., 1991). The major reason for the withdrawal of GMB rural infrastructure has been pressure to reduce costs.

Ironically, the rapid expansion of GMB infrastructure into remote smallholder areas in the early 1980s provided the impetus for its own subsequent contraction. The 1980-85 expansion contributed to higher GMB marketing costs and put pressure on the GMB to increase the margin between its pan-territorial buying and selling prices to cover these costs. The widening of this uniform margin, irrespective of location, has intensified the lobbying by commercial maize farmers -- who are generally closer to urban areas and face lower unit marketing costs -- to relax the regulations prohibiting trade with private buyers. Uniform pricing tends to reduce prices received by producers and inflate prices paid by consumers within the low-cost trading routes. However, it is these regulations that have enabled the GMB to generate profits on the low-cost trading routes to cross-subsidize its high-cost routes in the more distant, semi-arid smallholder areas. The potential loss of market share in the low-cost trading areas has given GMB a strong financial incentive to maintain and enforce existing regulations prohibiting the private movement of maize into urban areas. If these

controls on private maize movement are abolished, GMB would incur substantially greater trading deficits unless there were a change to spatially-differentiated pricing to give the GMB latitude to set depot-specific prices in line with prevailing market conditions, or unless the government directly subsidized GMB's losses in commercially-unviable areas. However, within the existing system of pan-territorial pricing, government pressure to reduce parastatal deficits under structural adjustment has resulted in efforts by GMB to shed operations in unprofitable remote areas. Unfortunately, this contraction has not been associated with regulatory changes and support for private investment to develop viable private marketing networks in these regions.

A fourth cause of the post-1985 maize decline has been the consistent decline in real maize producer prices throughout the 1980s (Figure 4). Producer prices in 1991 were 25% lower than in 1985. However, unlike in the early 1980s, there has been little improvement in maize yields to offset the effect of declining prices for farmers. Thus, the area under maize has gradually contracted since 1985. Ironically, lower maize producer prices have not resulted in lower consumer prices for maize meal. An increasing proportion of the value of industrially-processed maize meal is taken up in marketing costs. Higher marketing costs over the past decade, while commonly attributed to GMB, are also due to substantial increases in margins to high-cost industrial millers and the regulations that entrench their position in the market by restricting access to maize by lower-cost small-scale millers (JAYNE *et al.* 1991).

Against this background of stagnating production incentives is a 5.5% annual increase in GMB maize sales to buyers (mainly industrial millers). Domestic sales in 1991 were 80% higher than in 1985. About half of this increase is due to urban population growth, and the other half is due to increased rural dependence on industrial maize meal during poor harvests. The demand for GMB maize has outstripped intake for the past three years (Figure 5). Until recently, this trend has been masked by the carryover of large maize stockpiles accumulated during the 1980s. Much of the current situation has been attributed to the 1992 drought, the worst in decades. Yet the data suggest that Zimbabwe's present maize deficit is not simply a transitory phenomenon due to drought. The gradual erosion of input delivery systems and product markets, the decline in investments in new technology, and very little progress toward the development of private trading networks have contributed to higher production and marketing costs for maize.

## 3 Balancing Agricultural Growth and Food Security: The Evolving Food Price Dilemma

The effects of the post-1985 maize decline are manifesting as an increasingly severe food price dilemma (TIMMER, FALCON and PEARSON, 1983). With escalating production and marketing costs, farmers require higher prices to maintain current food production levels. Yet higher food prices will exacerbate poverty and food insecurity among low-income consumers, many of whom live in rural areas.

The argument for substantially higher government-guaranteed maize prices for farmers has been forcefully articulated by Zimbabwe's most powerful farm lobby -- the Commercial Farmers Union (CFU) -- which has heightened influence over crop price setting in times of shortages. The CFU has successfully advocated switching from an export parity-oriented pricing structure to prices just under import parity levels. The gap between these price levels in landlocked countries of Eastern and Southern Africa

is extremely large. The resulting 140% increase in the real producer prices over the past year to promote maize self-sufficiency has pushed up real prices of maize meal by 90% at a time when government is streamlining employment, granting pay increases that have not kept pace with inflation and reducing subsidies to education, transport, health and other sectors. Such changes underscore the evolving severity of the food price dilemma in Zimbabwe: How should the food system be managed to achieve the needed 3% to 5% growth in national food availability without exacerbating household food insecurity by pricing low-income consumers out of the market?

In the longer run, adequate price incentives to farmers are only part of a comprehensive strategy to restore national and household food security. The long-run solution to the food price dilemma ultimately involves raising poor consumers' incomes and reducing food costs. Rehabilitation of agricultural support institutions would help revive production incentives to producers by reducing the costs of production and marketing. Cost reduction would in turn relieve the need for large increases in prices to maintain production incentives. These public investments, in combination with changes in market regulations, would also encourage private investment in input supply, product distribution and processing. Unfortunately, many of these cost-reducing investments have payoffs mainly in the long run. In the current environment of rising production and marketing costs and a reluctance on the part of the government to remove major regulatory barriers to private trade, greater increases in food prices will probably be necessary to achieve a given increase in supply in the short run. This will raise the costs of Zimbabwe's historic orientation toward maize self-sufficiency.

## 4 Food Self-Sufficiency vs. Self-Reliance: Conceptual Issues

Food self-sufficiency involves meeting domestic demand through production and stockholding. Food self-reliance involves meeting a country's requirements through a combination of production, stocks and trade, with the mix depending on the relative costs of procurement from each source.

A fundamental issue guiding the management of a national food economy is identifying the least costly way to secure national food requirements (RUKUNI and EICHER, 1987). The conventional wisdom in Zimbabwe is that national food needs can normally be met at lower cost through self-sufficiency than through a strategy that involves imports. Available supply response models indicate that, under most weather outcomes, the average producer price required to achieve self-sufficiency is below the range of import parity prices over the past decade (BUCCOLA and SUKUME, 1988; GMB, 1992). Powerful interest groups, in particular the farm lobbies, argue that a departure from the objectives of food self-sufficiency would thus represent an agricultural policy failure, since the cost of maize imports are higher than the price necessary to achieve self-sufficiency.[4]

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4 Import parity prices are unusually high in landlocked countries of Southern Africa because of high regional and international transport costs from international suppliers of white maize such as Argentina and the United States. Moreover, white maize, the preferred type of maize for human consumption, normally sells at a 10% to 30% premium over yellow maize in world markets. Import prices may be much lower when the Republic of South Africa has a white maize surplus. However, weather patterns and maize yields in South Africa are somewhat correlated with those of Zimbabwe (Kingsbury, 1989), which may cause mutual shortfalls at the same time, as in 1992.

However, this situation would not necessarily justify an explicit policy of maize self-sufficiency. When the government can effectively control prices and trade, the average cost of securing national maize requirements may be lower using a combination of domestic production and imports (food self-reliance) than sole reliance on domestic production. This is clarified in Figure 6. Assume that $Q_{ss}$ is total maize requirements given a specified consumer price, and that a producer price of $P_{ss}$ is necessary to generate this amount through domestic production. A lower producer price, $P_i$, would generate domestic production, $Q_i$, that is below self-sufficiency. However, the country could pay $P_i$ for this level of domestic production and pay the import parity price, $PW$, for residual import requirements ($Q_{ss} - Q_i$), resulting in an average procurement price, $P^*$, that is potentially less than the self-sufficiency price. This would be the case if $(P_iQ_i)+PW(Q_{ss} - Q_i)$ were less than $P_{ss}Q_{ss}$, or equivalently, if shaded area *B* were less than area *A*. The cost implications of this analysis are sensitive to the price elasticity of supply. The lower the price elasticity of supply, the higher the costs of self-sufficiency compared to a self-reliance strategy.[5]

It is also questionable that a departure from the objective of maize self-sufficiency would adversely affect most of the rural population. The distribution of land and assets is extremely skewed in rural Zimbabwe, causing very concentrated benefits from maize producer price incentives (Table 1). At least 50% of smallholder farmers sell no grain during a normal rainfall year. About 40% of rural households are normally grain buyers. From 1988/89 to 1991/92, 1% of the smallholder households (located mainly in the high-productivity areas) received 45% of the income from smallholder maize sales to GMB. The top 10% of smallholder households received over 90% of this income. When combining commercial sector farmers to this well-equipped group of smallholders, about 1% of all farm households account for over 70% of GMB's expenditure on domestic maize procurement.

Three major conclusions may be drawn from these findings. First, GMB maize pricing policy has extremely concentrated distributional effects on the supply side. Most rural smallholders derive little or no direct benefit from higher maize prices.[6] Second, many farm households are directly hurt by higher maize prices. It is likely that a decline in maize and maize meal prices would either increase or not appreciably alter the disposable incomes of the majority of rural farm households. Third, food self-sufficiency is not necessarily the least costly way to secure national food requirements

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5 To demonstrate this, let $Q = a_0 + a_1P$ be the supply function, where $Q$ is marketed supply, $P$ is producer price, $a_0$ is the sum of a constant and a vector of exogenous variables evaluated at their mean levels and multiplied by their respective coefficients, and $a_1$ measures the change in supply for a given increase in price. Substituting this supply function for $Q_i$ and $Q_{ss}$ in the above equation and rearranging terms, the conditions under which a self-reliance strategy will result in a lower average cost of procurement are if the elasticity of supply is greater than:

$$\frac{P_{ss}-P_i}{P_{ss} - PW + (P_{ss}PW-P_{ss}^2)/P_i}$$

6 This does not account for any indirect benefit to the poor that higher maize prices would have on demand for hired labor due to acreage expansion by the larger farmers. This issue is examined in more detail below.

even if the producer price necessary for self-sufficiency is below the world market price. This point should not be construed as an argument for artificially low maize prices relative to non-agriculture. Rather, in an environment in which staple food subsidies to consumers and marketing board losses must be eliminated, a cost-minimizing procurement strategy could help relieve the severity of the food price dilemma in the short run and buy time while longer term efforts are undertaken to reduce the cost of food production and marketing through rehabilitation of the agricultural support system.

The foregoing also implies something about methods to measure the effects of alternative maize price and trade policies. To a large extent, the skewed distribution of maize income and agricultural income in general are the impetus behind the Government of Zimbabwe's commitment to land redistribution. In such a situation, normative evaluations of alternative policies based on efficiency or welfare criteria such as the aggregation of producer and consumer surplus may not be useful for decision makers, since Government's objectives clearly reflect the interests of asset-poor consumers (many of which are rural farmers) moreso than the small group that derives the bulk of the producer surplus from maize sales. Moreover, as in all countries of the world, mechanisms of redistributing income in Zimbabwe are limited and costly. In such cases, production and distribution are not separable and the evaluation of alternative policies cannot be based on efficiency criteria under the assumption that redistribution can take place to account for other government objectives. In light of this, alternative levels of maize prices and net imports are evaluated according to their effects on specific groups and objectives, without attempting to aggregate them into a normative measure of social welfare.

## 5 Method: Measuring the Costs of Food Self-Sufficiency

This section presents a framework for assessing the costs and trade-offs associated with maize pricing geared toward self-sufficiency vs. a self-reliance strategy involving various price and import combinations.

Area equations for maize were specified separately for Zimbabwe's smallholder and commercial sectors. Area equations are generally preferred to production or sales equations because they better reflect producers' response to price incentives and are less affected by weather, pests and other random disturbances (ASKARI and CUMMINGS, 1977). The estimated equations were:

$$(1)\quad A^S_t = a_0 + a_1(PM^e_t) + a_2(PC_{t-1}) + a_3(LOANS_t) + a_4(A^S_{t-1}) + e_1$$

$$(2)\quad A^C_t = b_0 + b_1(PM^e_t) + b_2(PT_{t-1}) + b_3(PFERT_t) + b_4(A^C_{t-1}) + e_2$$

where $A^S$ and $A^C$ are area planted to maize by the smallholder and commercial farmers, $PM^e_t$ is the expected inflation-adjusted GMB producer price of maize to be announced at harvest,[7] $PC_{t-1}$ and $PT_{t-1}$ are the inflation-adjusted producer prices for cotton and tobacco (the most important substitute crops in the smallholder and commercial farming sectors, respectively), $LOANS_t$ are the real value of government

7 An F-test rejected the hypothesis of non-linearity in expected maize price within the range of historical data in both equations.

credit disbursed to smallholder farmers for crop inputs (predominantly used for maize),[8] $PFERT_t$ is the deflated price of fertilizer at planting time,[9] and $e_1$ and $e_2$ are error terms. The commercial sector equation was estimated over the 1975-91 period, while data for the smallholder equation was available only from 1979-91. Data sources and estimation results are presented in Appendix 1.

Since GMB maize prices have been announced after planting time for the past decade, the maize area equations must be formulated on the basis of price expectations, using information available to the farmer at planting time to predict the likely price announced after harvest. It is well known that the government-determined maize producer price is influenced by the level of GMB maize stocks from the previous harvest and by recent price trends (WRIGHT and TAKAVARASHA, 1988). This suggests a simple maize price expectations model of the form:

$$(3)\quad PM^e_t = d_0 + d_1(STOCKS_{t-1}) + d_2(PM_{t-1}) + d_3(PM_{t-2}) + d_4(PM_{t-3})$$

where $STOCKS_{t-1}$ is GMB maize stock levels at the end of the previous marketing year and $PM_{t-i}$ is the observed value of the deflated maize price in year $t-i$.

Equations (1), (2) and (3) were estimated separately using OLS. Simultaneous estimation of prices and supplies is not necessary because, in contrast to the case in other developing areas, the GMB captures almost all of the marketed maize surplus in the country. It may thus be safely assumed that producer behaviour responds to the official price rather than parallel market prices. Estimates of $PM_t$ from equation (3) were used as instruments in equations (1) and (2). Producer and consumer prices also bear no necessary relationship to one another, due to varying levels of government subsidies to producers and consumers.

The regression results were then used to estimate expected maize area at alternative producer price levels. Expected maize production was calculated for each price level under three weather scenarios: average yields and a drought and high rainfall scenario that correspond roughly to one standard deviation below (above) average yields. Estimates were made by setting the values of government loans and prices of cotton, tobacco and fertilizer at their 1991/92 levels.

Next, equations were specified to measure producers' sales response to ex post production outcomes:

$$(4)\quad SGMB^s_t = \gamma_0 + \gamma_1\ (Q^S_t) + \gamma_2\ (PR) + \gamma_3\ (D) + v^s_t$$

$$(5)\quad SGMB^c_t = \delta_0 + \delta_1\ (Q^c_t) + \delta_2\ (PR) + v^c_t$$

where $SGMB^S_t$ and $SGMB^C_t$ are GMB intake from the smallholder and commercial sectors, and $Q^S_t$ and $Q^C_t$ are smallholder and commercial production. $PR$ is the price ratio between the retail price of industrial roller meal and the GMB producer price; at times, roller meal was so heavily subsidized that it was profitable for smallholders and

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8 Theory would specify that the price rather than quantity of key inputs would enter into standard supply response models. In this case, however, smallholder credit is typically rationed at subsidized interest rates, hence the rationale for measuring this input variable in quantity terms.

9 Very little fertilizer is used on maize cultivated by smallholders except in a small number of high-potential areas.

commercial livestock operators to sell their maize to GMB and buy back processed maize meal. *D* is a dummy variable for the post-independence years in which marketing infrastructure was weak in smallholder areas, reducing the influence of production on GMB maize intake from smallholder areas. Lastly, $v_{st}$ and $v^c_t$ are error terms. At the beginning of the marketing year, the harvest and price announcements have already occurred and are hence exogenous. The hypothesis of a linear relationship between sales and production was tested and not rejected by the results of an F-test at the 10% level in either equation.

The GMB has stated that national maize requirements in 1993 are about 1.1 million tons, including stock accumulation, under normal weather. Requirements are sensitive to weather. In years where production was about one standard deviation below average, the rural sector's demand for GMB-held maize increased by about 200,000 tons. When production was about one standard deviation above the mean, demand falls by about 140,000 tons. On this basis, expected net import requirements were calculated for each producer price level, given alternative weather scenarios.

The analysis does not attempt to determine the optimal size of maize stocks, which is a function of how government weighs certain objectives against one another, such as price stabilization, cost minimisation and import minimisation (PINCKNEY, 1988). The approach taken here is to consider the GMB's weather-adjusted estimates of official maize demand -- including stocks -- as given, and then to determine the costs and distributional effects of procuring this quantity from a blend of domestic production and trade. The average procurement cost is either the domestic producer price plus marketing costs (if total maize requirements were obtained from local production), the c.i.f. import price plus marketing costs (if total requirements were obtained from world markets), or some blend price between the two if requirements were met through a combination of domestic production and imports. This analysis allows one to calculate the net revenue saved by pursuing a self-reliance strategy (i.e., domestic production and imports) at various producer price levels compared to a self-sufficiency strategy. In Figure 6, this corresponds to the net revenue saved from choosing price $P_i$ and importing quantity $Q_{req} - Q_i$ at the import price *PW*, rather than procuring total requirements at the expected self-sufficiency price; equivalently, shaded area *A* minus *B*. In this calculation, the c.i.f. value of imported white maize in Harare was Z$1,230/mt.[10]

10 This figure was a high-end estimate of several c.i.f. figures used by the GMB in its own analyses (GMB, 1992). The figure assumes an international price of US$150/ton, 25% port and transport cost inflation over the next year, and a shadow exchange rate premium of 20%. The actual c.i.f. import price over the first half of 1992 has averaged only Z$950/ton.

## 6 Results

The results of the average rainfall scenario are presented in Table 2. The producer prices considered in this analysis range from the lowest real price offered since 1980 to slightly more than the 1992 price of Z$900,[11] which is the highest price in real terms offered since 1980. Based on the regression results for equations (1) - (5), the producer price expected to achieve maize self-sufficiency is Z$845/ton. This price would yield an average procurement cost of Z$1,020/ton including marketing costs.

By contrast, the domestic producer price that minimizes the cost of procuring national maize requirements is Z$630/mt (US$105/mt at the shadow exchange rate). This price would require an estimated 385,000 tons of maize imports and would reduce the expected cost of procuring national maize requirements by 9.6% compared to a self-sufficiency policy, under normal weather. The producer price-procurement cost curve is somewhat flat near the cost-minimizing price level, i.e., there is little difference in the average procurement cost for producer prices between the ranges of Z$550/ton and Z$700/ton. This is because the lower producer prices for domestic supplies are counterbalanced by larger import bills. Beyond a producer price of about Z$700/ton, the cost of procuring national maize requirements rises sharply. Under the drought and high-yield scenarios, the expected cost-minimizing producer price would reduce the average cost of procuring national maize requirements by 1.3% and 16.1%, respectively, relative to the expected self-sufficiency price. Under all yield scenarios within one standard deviation of the mean, the government is thus capable of acquiring its maize requirements at lower cost through a strategy involving domestic production and imports rather than a self-sufficiency strategy. These cost savings could in turn be passed onto consumers without requiring costly subsidies.[12]

The remainder of this section evaluates the effects of alternative maize price levels on food security, consumer maize meal prices, net farm income, farm wage income, and the risks of reliance on world markets for white maize.

### *Food Security and Consumer Maize Meal Prices*

The foregoing has estimated that a transition from food self-sufficiency pricing (Z$845/ton) to a pricing policy that minimizes the costs of procuring national maize requirements (Z$630/ton) would save the government about Z$125 million per year. Assuming that these savings were passed onto consumers in the form of lower maize meal prices, so that the government incurred neither a loss nor a surplus on its maize trading account, maize meal prices would decline by 7%. Household food security would be promoted to the extent that lower maize meal prices would stimulate consumption. The effect of alternative producer prices on average procurement prices is presented in Column (d) of Table 2.

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11 This is about US$150/ton, assuming an exchange rate overvaluation of 20%.

12 To gauge the robustness of these findings, we repeated this analysis using the GMB's own econometric model linking the level of producer price to expected maize production (GMB, 1992). The expected self-sufficiency price, according to this model, is Z$904. This is very close to the Z$900/mt price that the Government of Zimbabwe actually announced for maize in June 1992. Following the same procedure as before, the GMB's model suggests that the domestic producer price that minimizes total procurement costs is about Z$610/mt. This price would reduce total procurement costs by an estimated 10.1% under normal weather, 2.8% under a drought, and 24.2% under the high-yield scenario, relative to the announced price of Z$900/mt.

The level of consumer maize meal prices may also affect food security through their effect on crop diversification. Available survey evidence indicates that groundnut and sunflower normally provide higher returns to land and labour than maize in most semi-arid areas of Zimbabwe (MLARR, 1990). Since the majority of smallholders in these areas are net grain purchasers, the true opportunity cost of cash crop production is not the net returns to growing and selling maize, but rather the cost of acquiring the maize foregone by cultivating cash crops, which is related to the acquisition price of maize meal, not the farm-gate maize producer price (JAYNE, forthcoming). Thus, the ability to minimize consumer maize prices may simultaneously contribute to governments' food security and agricultural growth objectives by both reducing the cost of food purchased and by raising the value of farm output sold.

*Effects on the Wheat Market*

The main substitute commodity for maize in consumption is wheat. Wheat is an import commodity in Zimbabwe and is more expensive on world markets than maize. One might expect a decline in the price of maize to reduce wheat consumption and hence the food import bill. In actuality, wheat is rationed at artificially low controlled prices, and shortages are common. Thus, increased maize consumption would probably not appreciably affect the effective demand for wheat and would thus have little welfare impact associated with substitution in consumption.

*Commercial and Smallholder Maize Sellers*

The total impact of alternative maize producer prices on the net income of maize sellers is the sum of the change in net income from maize sales plus the change in net income due to substitution in production. Note that this differs greatly from the change in net income of farm households, because a large portion of rural farm households are net purchasers of maize.

The direct effect of alternative maize producer prices on net income of maize sellers are calculated from the results of the econometric equations (1) - (5). These equations form market supply functions that link particular prices to corresponding levels of maize sales and net farm income (gross revenue minus imputed production and marketing costs). The effects of substitution in production are inherently more difficult to measure; information is needed on the aggregate price elasticity of crop supply, and information on gross margins across a variety of crops that are likely substitutes for maize. Gross margins may vary widely from year to year due to changes in real producer prices and weather-induced yields. Therefore, sensitivity analysis was used to examine the robustness of results to several assumptions about substitution in production. Assuming an aggregate price elasticity of supply of 0.2,[13] and assuming that the gross margins of substitute crops are 75% and, alternatively, 50% of those for maize production, the difference in maize sellers' net farm income at alternative producer prices is presented in Column (f) of Table 2.

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13 Most literature surveys indicate that aggregate agricultural supply elasticities vary from about zero to at most 0.3 (Krisha 1982, Cleaver 1985, Bingswanger 1990). Assuming 0.2 for exposition, a 20% decline in the producer price of maize (which currently comprises about 50% of total crop land in Zimbabwe) would result in an estimated 0.2*0.2*0.5 = 2% reduction in total crop area. Even if the aggregate supply response were tripled, a 20% decline in maize prices would still keep 94% of the original area under cultivation.

Information presented earlier in Table 1 indicates that changes in net income would be distributed over a very narrow range of well-equipped farmers. Most smallholder farmers, particularly those in the drier portions of the country, would experience little or no loss in income from a maize price decline; in fact, many would directly benefit from the lower acquisition prices. The effects on net income of maize sellers and rural farm households should be carefully differentiated.[14]

*Total Effects on National Income*

Figure 7 presents the total change in maize sellers' net income and consumer expenditures at alternative producer prices relative to the expected self-sufficiency price of Z$845/ton. Changes in consumer expenditure were based on BUCCOLA and SUKUME'S (1988) econometric estimate of maize price elasticity of demand in Zimbabwe of -0.65. Note that consumer expenditure is relatively insensitive to price levels between Z$550 and Z$700 per ton, because the model indicates that relatively low producer prices are offset by the need for greater quantities of relatively expensive maize imports. The relationship between producer price levels and consumer expenditures is not linear, as shown in column (d) of Table 2.

The results indicate that sum of net farm income from maize sales minus consumer expenditures is maximized at a producer price of about Z$740/ton, given the existing structure of the agricultural system and prevailing world maize prices. This price is about 13% below the expected self-sufficiency price, and would be expected to reduce consumer maize meal prices by about 6%. At this price, the government might expect to import about 180,000 tonnes of maize in 1993, but the GMB's total expenditures on

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14 A reduction in maize prices may also affect the demand for hired labor in agriculture, but this effect is likely to be small, and perhaps even positive, in Zimbabwe. This is because cultivation would shift from maize to crops with a substantially greater hired-labor component (e.g., cotton, tobacco, groundnuts), which might outweigh the small decline in total cropped area commensurate with aggregate agricultural supply response. Based on the econometric results, which indicate that a transition from self-sufficiency pricing to cost-minimization procurement pricing would result in a reduction in maize area of 285,000 hectares and 51,000 hectares from the smallholder and commercial sectors, respectively. Survey data from MLARR (1991) indicate that, even in the most productive maize-surplus smallholder areas surveyed, hired labor for maize cultivation averaged Z$4.68 per hectare during the 1988/89 cropping year. Under the extreme assumption that all of this land would be left idle, hired labor income would fall by an estimated Z$4.68/ha times 285,000 ha = Z$1.3 million. Commercial sector data presented in CFU (1985) reports that commercial maize production requires approximately 12 hours of hired labor per hectare. If valued at the prevailing wage rate of approximately Z$0.60/hr, this would cause an estimated Z$0.6/hr times 12 hrs/ha times 51,000 ha = Z$0.4 million loss in hired labor revenue from commercial maize production. Tobacco has an average labor input of over 90 hours per hectare. If 14% of the idled maize area were reallocated to tobacco, this would bring the net loss in labor income for commercial farm workers to zero. By contrast, a price increase of this magnitude is estimated to raise average maize prices by Z$97/ton. If this increase were passed on to rural consumers, who, on average, purchase about 400,000 tons of maize and maize meal annually and are among the poorest strata of the population, their expenditures on maize would rise by Z$38 million. This rough *ad hoc* calculation must be replaced by more rigorous analysis, but even without it, it is fairly clear that the effect of maize pricing changes on farm labor income -- normally accruing to relatively poor and/or landless workers -- would be overwhelmed by the direct effects on food expenditures.

procuring the needed 1.3 mmt would be 6.5% less than the expected expenditures under the self-sufficiency price.

*Uncertainty of White Maize Procurement from World Markets*

There are several other important issues associated with reliance on maize imports. First, white maize is the preferred type of maize for human consumption throughout Southern Africa, yet world trade in white maize is very thin. There is thus the risk that in times of shortage, the world market cannot produce the volume of white maize required for by Southern African states. Second, transport infrastructure linking landlocked countries in Southern Africa with the ports in neighbouring countries are capable of transporting relatively small volumes per unit of time.

While these problems are serious, the costs of addressing them directly may be far lower than the loss of income associated with the continued pursuit of maize self-sufficiency. For example, Zimbabwe may reduce the uncertainty of acquiring white maize from the world market by forward contracting with white maize exporters for a given volume each year. If these supplies are not needed in any particular year, the GMB can simply sell the contract to other world buyers before taking possession of the maize.

It is very likely that the second problem -- weak transport links to coastal ports -- can be addressed more cost effectively by investing in transport infrastructure and more timely import trigger mechanisms than by altering production patterns to adapt to existing capacity constraints in the transport system. This, however, is an empirical issue that is the subject for more detailed research. Grain stockholding is also a means of coping with the uncertainty of acquiring grain in a timely way from world markets. Whatever the desired stockholding level, it may be procured from either domestic production or through imports. This analysis identifies the producer prices that minimize the cost of procuring these requirements, and maximizes the sum of producer, consumer and farm labour income.

The main policy implication of this section is that an import-receptive pricing and trade policy may achieve higher levels of food security and national income growth compared to a self-sufficiency policy, even if import prices exceed the expected self-sufficiency price. An emphasis on self-reliance may relieve the severity of the food price dilemma in the short run, and help buy time while longer-run measures to develop cost-reducing agricultural support institutions are undertaken. It must be stressed that this finding pertains to the existing structure of the marketing system and world prices. Market reform, land redistribution and technical innovation could appreciably reduce the cost of domestic production and marketing as well as the supply of and demand for maize through the official marketing channel. Such developments could appreciably alter the costs of food self-sufficiency relative to food self-reliance.

## 6 Policy Lessons for Eastern and Southern Africa

The experience of Zimbabwe underscores a broader policy message that, even if the expected producer price needed for self-sufficiency is below the c.i.f. cost of imports, there may be an important trade-off between food self-sufficiency and food security. Without broader-based gains in productivity or a reduction in marketing costs, the stimulation of food production growth in high-potential areas through price incentives will erode purchasing power and food security in grain-deficit rural areas as well as urban areas. This situation has manifested itself in Zimbabwe in the recent past in the form of high rural malnutrition amidst national food surpluses.

Cabinet and the general public appear to harbour several important misconceptions about the maize sector, many of which have been promoted by lobby groups. To promote broad based income growth and reduce government budget deficits, The Ministry of Lands, Agriculture and Water Development has an important educational role in making the following cases to Cabinet:

1. *Artificially high maize prices do not contribute to broad-based rural income growth.* The GMB's own data on maize intake shows that most smallholders do not sell grain to GMB. The vast bulk of GMB expenditures on maize procurement is captured by commercial farmers and a small number of well-equipped smallholders in high-potential areas. Overwhelming survey evidence indicates that most smallholders in the drier parts of the country are purchasers of maize and maize meal. Higher maize prices, to the extent that they put upward pressure on maize meal prices, work against the welfare of these households. High food prices also work against crop diversification in the semi-arid areas.

   It is important that these points not be construed as arguments for artificially low maize prices. Maize prices should be set with the goal of promoting broad-based rural and urban welfare and food security at minimum cost to the government budget.

2. *The importation of maize does not necessarily constitute an agricultural policy failure.* Recent statements by the press and by lobby groups have suggested that maize imports are a national disgrace. While it is correct that low maize prices during the 1985-91 period have contributed to the current production shortfall and the expenditures on maize imports, it is not necessarily true that future maize policy should unquestioningly commit itself to maize self-sufficiency without a thorough analysis of the relative costs of acquiring grain from a combination of sources. The analysis above indicates that, even though maize import prices exceed the producer price needed for expected self-sufficiency, a mix of domestic production and imports may reduce GMB expenditures on maize requirements, and allow government to pass on these cost savings to consumers without subsidy. The importance of maintaining tolerable prices for maize meal in the current environment of ESAP cannot be underestimated.

3. *A cost-minimizing maize procurement policy should also include strategies to reduce the risks of white maize procurement from the world market.* This would include forward contracting (with the anticipation of simply reselling unneeded quantities to best advantage on the world market), and further investments in port and transport infrastructure between Zimbabwe and Southern Africa ports. While there are costs associated with these, they may pale in comparison to

the costs associated with higher food prices and cropping patterns that are potentially inconsistent with comparative advantage and foreign exchange generation.

4. *The maize shortages experienced in the first half of 1992 were not due to the drought or dependence on world markets.* The crisis underscores a poor interface between technical analysis and senior policymaking. In August 1991, the GMB and National Early Warning Unit both forecasted the impending depletion of maize stocks and predicted that imports would be required to cover the period January to May 1992. These forecasts were reported a full four months before the Government actually purchased maize from world markets. By this time, in January 1992, maize stocks were virtually depleted. Zimbabwe's experience in 1992 highlights the need for timely identification and dissemination of emerging agricultural trends, and a mechanism to translate this information into timely action.

5. *One of the major factors preventing producers from receiving higher prices and consumers from paying lower prices is the high cost of maize marketing in the official marketing system.* This high-cost system is not due to the GMB (which, by most accounts, performs its storage and distribution functions efficiently) but rather to a set of market regulations that entrench consumers' dependence on a high-cost, high-value-added maize milling system. By restricting small millers' and consumers' access to GMB maize, the quantity produced of less expensive whole meal is sub-optimal relative to demand, based on several urban consumer preference surveys (see RUBEY, 1992). In addition to forcing consumers with a preference for whole meal to pay higher prices for more refined meals, the higher level of marketing costs also puts downward pressure on maize prices received by producers.

In the long run, the trade-offs between domestic production incentives and household food security may be relieved by measures to reduce the cost of food production and marketing. This requires sustained support for input and credit delivery systems, agricultural research and extension, efficient product distribution and processing systems, and promotion of income generating activities. In the current environment of dwindling public resources under structural adjustment, the choice of where government invests its scarce resources -- and where it allows the private sector to do so -- will critically determine the future costs of pursuing maize self-sufficiency and the longer-run implications for food security and income growth.

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## Appendix 1
## Regression Results for Equations (1), (2) and (3)

**Equation**

(1): $A^s_t = -350.50 + 2.22(PM^s_t) + 0.16(PC_{t-1}) + 4.35(LOANS_t) + 0.05(A^s_{t-1})$ — Adj R2 = .78, DW = 1.94, F = 12.68

(-1.21) (4.23)*** (1.15) (3.06)** (0.19)

(2) $A^c_t = -47.01 + 0.39(PM^c_t) - 0.01(PT_{t-1}) - 0.05(PFERT_t) + 0.71(A^c_{t-1})$ — Adj R2 = .81, DW = 1.90, F = 19.23

(-0.38) (3.79)*** (-1.40) (-1.33) (6.79)***

(3) $PM^s_t = 251.59 - 0.08(STOCKS_{t-1}) + 0.86(PM_{t-1}) - 0.47(PM_{t-2}) + 0.14(PM_{t-3})$ — Adj R2 = .81, DW = 2.34, F = 20.62

(4.07)*** (-4.29)*** (5.44)*** (-2.83)** (0.28)

(4) $SGMB^s_t = -176.65 + 0.48(Q^s_t) - 28.44(PR) - 156.09(D)$ — Adj R2 = .92, DW = 1.86, F = 52.02

(-0.38) (9.26)*** (-1.28) (-1.70)

(5) $SGMB^c_t = 383.18 + 1.10(Q^c_t) - 75.82(PR)$ — Adj R2 = .98, DW = 1.61, F = 357.16

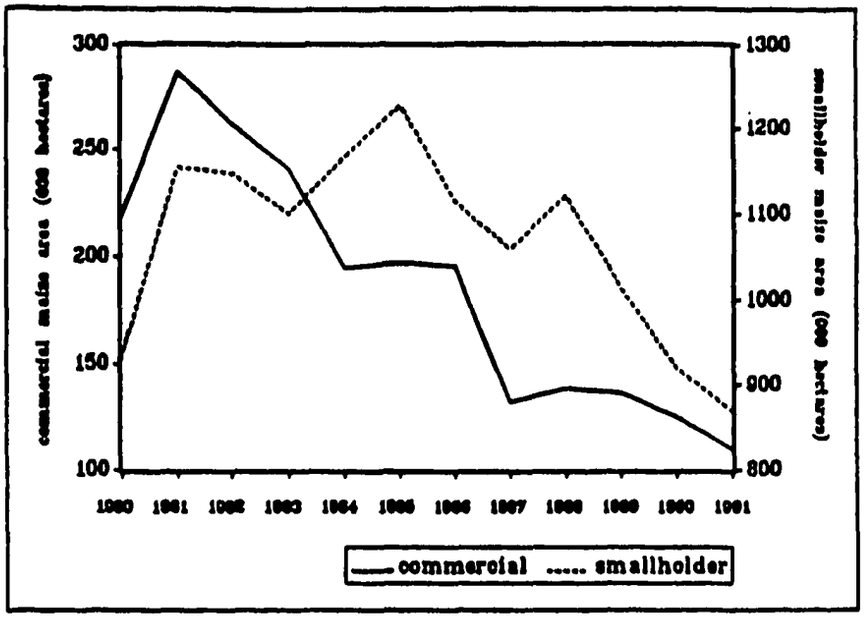
(-1.29) (31.80)*** (-2.94)**

* significant at the 10% level.
** significant at the 5% level.
*** significant at the 1% level.

Estimated price elasticity of maize area
(smallholder sector): +0.80
(commercial sector): +0.71

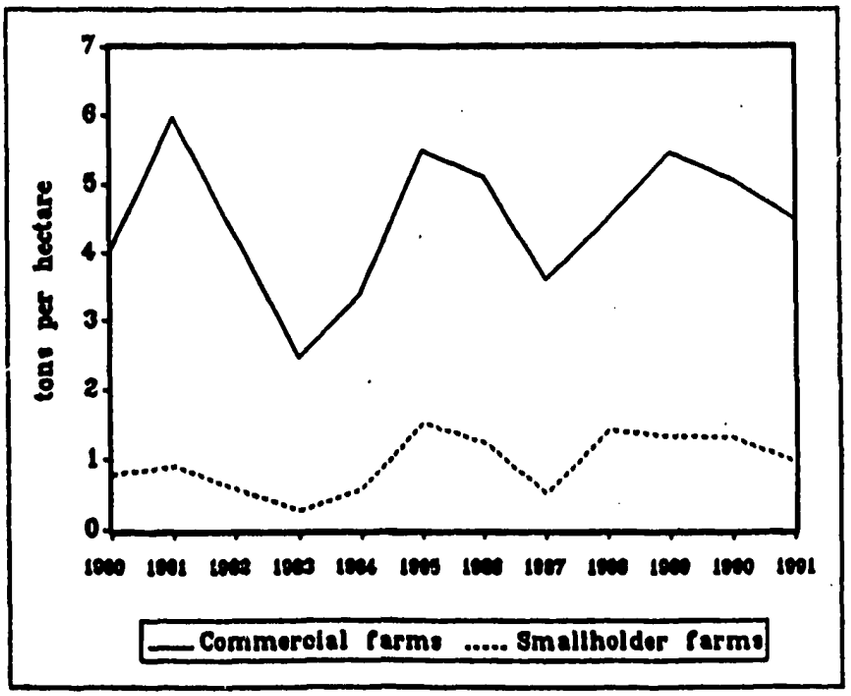
Estimated price elasticity of maize supply (derived from Equations (1), (2) (4) and (5), based on average yields)
smallholder sector: +0.93
commercial sector: +1.03

*Data Sources*: Data on area, commodity prices, sales to GMB and stock levels were obtained from the Agricultural Marketing Authority (1992a, 1992b). Loan data were obtained from the Agricultural Finance Corporation (various years). Fertilizer prices and the consumer price index were obtained from Masters (1991). Production data were obtained from AGRITEX (various years).



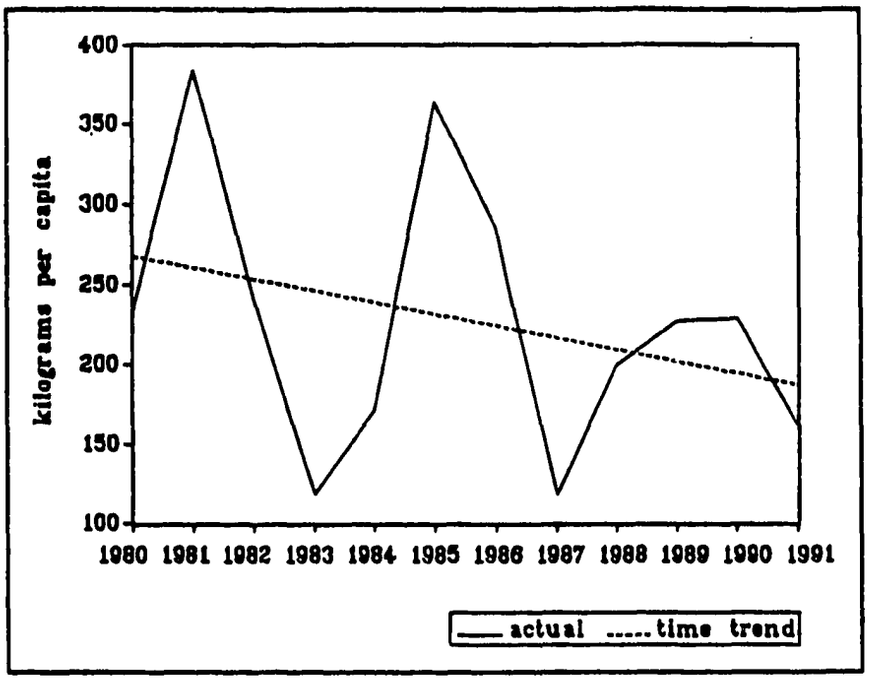

Note: specified years are harvest years; figures for 1991 are estimates
Source: Agritex (various years)

**Figure 1. Area planted to maize by commercial and smallholder farmers, 1980-1991.**



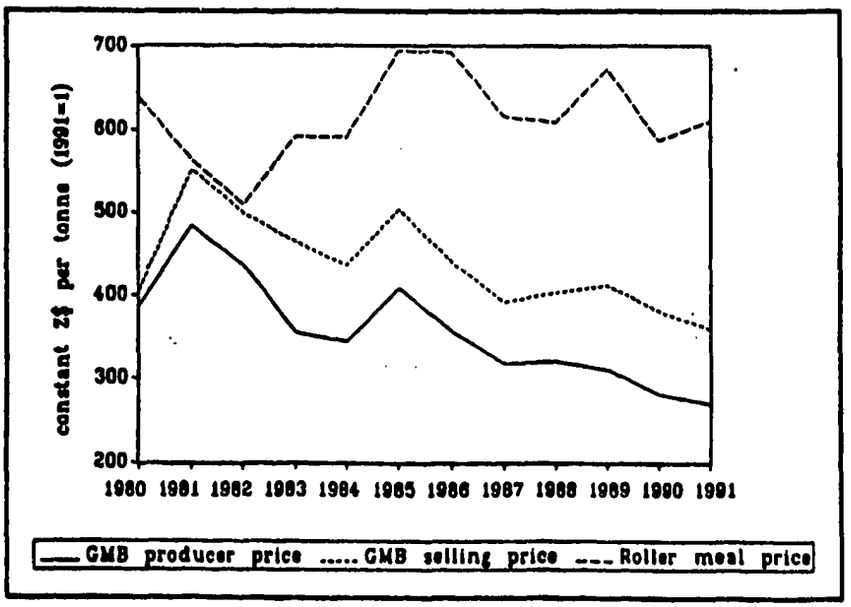

Note: specified years are harvest years; figures for 1991 are estimates
Source: Agritex crop forecasts (various years)

**Figure 2. Commercial and smallholder maize yields, 1980-1991.**



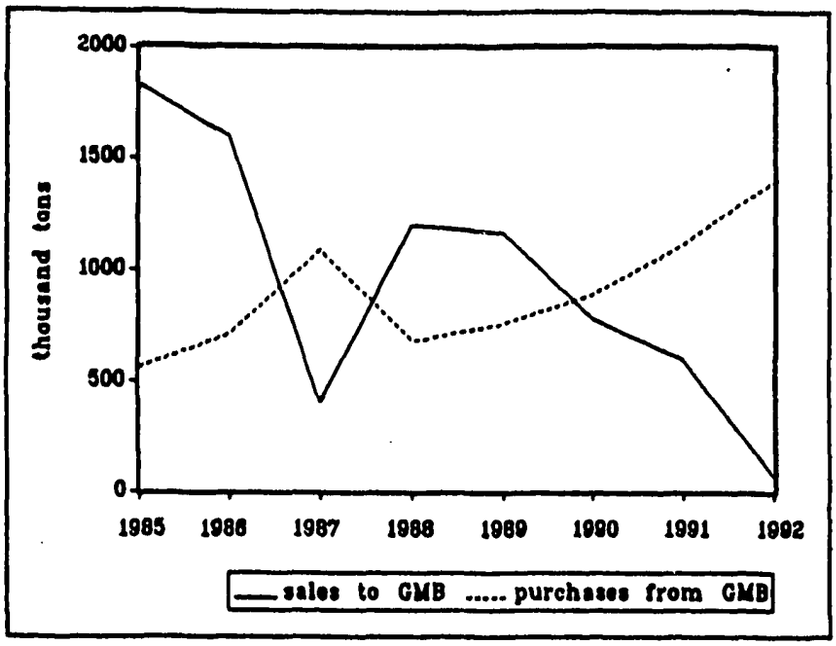

Note: specified years are harvest years. Figures for 1991 are estimates.
Source: Agritex Second Crop Estimates (various years); Central Statistics Office (various years); Central Statistics Office (ND).

**Figure 3. Maize production per capita in Zimbabwe, 1980-91.**




Note: Producer and selling prices apply to marketing years (e.g., 1980=April 1980 to March 1981).
Source: Agricultural Marketing Authority (various years); Ministry of Industry and Commerce files.

**Figure 4. Official maize and roller meal selling prices, 1980-91.**




Note: specified years are marketing years (e.g., 1980=April 1980 to March 1981). Figures for 1992 are estimates.
Source: Agricultural Marketing Authority (various years)

**Figure 5. Maize sales to and maize purchases from the Grain Marketing Board, 1985-1992.**

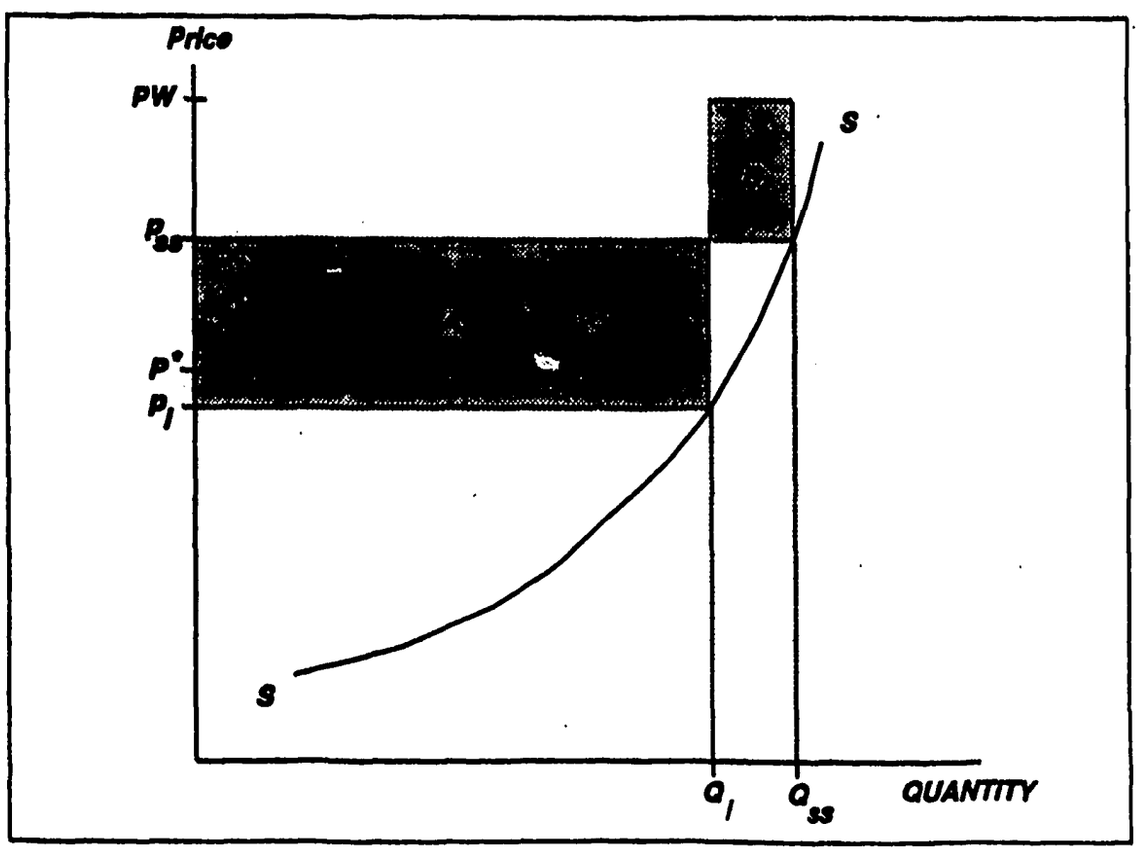



**Figure 6. The costs of procuring national maize requirements under monopsony procurement: an heuristic model**

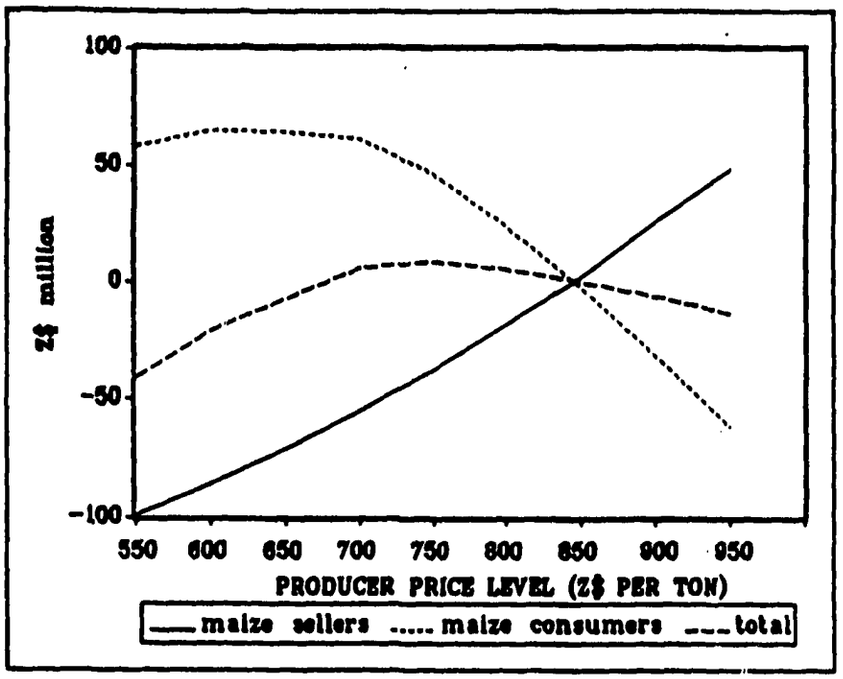



**Figure 7. Estimated effects of alternative GMB producer price levels on changes in net income of maize sellers and expenditures by maize consumers compared to the expected self-sufficiency price (Z$845/ton): normal weather scenario.**

Source: simulation model results

**Table 1. Concentration of Income from Maize Sales to GMB.**

| Average over the 1989/90 - 1991/92 marketing years | | | | | | |
|---|---|---|---|---|---|---|
| (a) | (b) | (c) | | (d) | | (e) |
| Approximate number of smallholder families in Zimbabwe | Approximate % of smallholder families that are net purchasers of maize | Number of smallholders selling maize to GMB | | % of smallholder income from maize sales to GMB accruing to the top | | % of total income from maize sales to GMB accruing to the top 8,000 farmers (including commercial farmers) |
| | | | | 8,000 smallholder families | 80,000 smallholder families | |
| (n) | (%) | (n) | (% of total) | | | (%) |
| 850,000 | 30% - 50% | 114,000 | 14% | 45% | 91% | 73% |

Sources: columns (a): Central Statistics Office (1985).
columns (b): based on survey of household surveys in Stack and Chopak (1990); Hedden-Dunkhorst (1990); and Jayne and Chisvo (1991).
columns (c)-(e): GMB data files.

**Table 2. A comparison of average maize procurement costs resulting from alternative producer price levels**

| (a) | (b) | (c) | (d) | | (e) | | (f) | |
|---|---|---|---|---|---|---|---|---|
| 1993 Producer price | Estimated maize supply to Grain Marketing Board | Estimated maize import requirement | GMB expenditures on maize procurement (domestic production + imports + marketing costs) | | Net reduction in GMB expenditure by offering the price in Column A instead of expected self-sufficiency price (i.e., Z$845/t) | | Difference in net farm income from maize sales to GMB (relative to self-sufficiency price) | |
| | | | | | | | commercial farmers | smallholder farmers |
| (Z$/mt) | ('000 mt) | ('000 mt) | (Z$ million)[b] | (Z$/ton) | (Z$ million)[c] | (% per ton) | (Z$ million) | |
| 550 | 771 | 529 | 1 203.4 | 926 | 122.6 | 9.2 | -61.6 (-104.0)[d] | -37.5 (-63.5) |
| 600 | 861 | 439 | 1 200.5 | 923 | 125.5 | 9.5 | -53.4 (-89.1) | -32.4 (-54.9) |
| 650 | 950 | 350 | 1 202.9 | 925 | 123.1 | 9.3 | -44.4 (-75.1) | - 26.8 (-45.3) |
| 700 | 1040 | 260 | 1 216.2 | 936 | 109.8 | 8.3 | -34.3 (-58.2) | -20.7 (-35.0) |
| 750 | 1129 | 171 | 1 245.9 | 958 | 80.1 | 6.0 | - 23.4 (-39.6) | -14.0 (-23.7) |
| 800 | 1218 | 82 | 1 290.0 | 992 | 36.0 | 2.7 | - 11.5 (-19.4) | -6.9 (-11.7) |
| 845 = $P_{ss}$[a] | 1300 | 0 | 1 326.0 | 1,020 | -- | -- | -- | -- |
| 850 | 1307 | -7 | 1 331.8 | 1,025 | -5.8 | -0.4 | 1.5 (1.9) | 0.9 (1.4) |
| 900 | 1397 | -70 | 1 392.2 | 1,071 | -66.2 | -5.0 | 14.9 (23.6) | 10.8 (16.4) |
| 950 | 1486 | -186 | 1 461.6 | 1,124 | -135.6 | -10.2 | 27.0 (40.9) | 21.3 (32.3) |

Results are based on the following assumptions:

National maize supply requirements: 1.3 million metric tons as derived from GMB (1992);
Maize yields (mt/ha): commercial sector -- 4.5 (normal rainfall); 3.5 (drought case); 5.5 (high-yield case);
smallholder sector -- 1.0 (normal rainfall), 0.55 (drought case), 1.3 (high-yield case).

[a] Producer price estimated to achieve self-sufficiency under normal weather.
[b] Formula for calculating GMB expenditures on national maize procurement: $(P_i + DMC)*Q_i + (cif + IMC - Ds)*NM$

where
- $P_i$ = producer price in Column A
- $DMC_i$ = marketing costs charged to domestic production at producer price $P_i$
- $Q_i$ = domestic production associated with $P_i$
- $cif$ = c.i.f. cost of imports (Harare from Argentina)
- $IMC$ = marketing costs charged to imports
- $NM$ = net import requirements (negative if domestic production exceeds 1.3mmt).
- $D$ = Dummy variable = 0 if NM>0; = 1 if NM<0.
- $s$ = annual maize storage costs per ton.

Maize surpluses, net of national requirements are valued at the c.i.f. price of maize minus annual storage costs, a proxy for the opportunity cost of surplus production. This may overstate the benefits of pursuing a self-sufficiency policy, since we have valued residual supply at the higher import price rather than the export price or some blend of the two.

[c] Equals GMB expenditures under self-sufficiency minus expenditures for alternative $P_i$ (Column d).
[d] First set of figures based on assumption that average gross margin for alternative crops equal to 75% of the average gross margin for maize; numbers in parentheses assume that average gross margin for alternative crops equal 50% of the gross margin for maize.