AGRICULTURAL PRICING IN MALAWI: A REDUCED-FORM MODEL

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Agricultural Pricing in Malawi
A Reduced-Form Model

ABSTRACT

This is the third in a series of papers on agricultural pricing in East Africa. It describes a simple, multi-market model for the analysis of agricultural pricing in Malawi. Prices for the main crops—maize, tobacco, cotton, rice and groundnuts—and for fertiliser are set by the Agricultural Development and Marketing Corporation (ADMARC) each season prior to planting. The model was used to guide the Ministry of Agriculture's pricing recommendations for the 1984-85 season and is again being used for the 1985-86 season.

The model comprises six sets of supply and demand equations—one for each of the crops and one for fertiliser. Land is assumed to be in fixed supply and labour to be in perfectly elastic supply. The model reports the effect of price changes on these outputs and inputs. In addition, it shows the effect of price policy on several items of interest to government decision-makers. These include the real incomes of smallholders, the real incomes of urban consumers, ADMARC's surplus from its crop trading activities, and net foreign exchange earnings from agriculture.

The results suggest that a pricing package comprising no change in the price of maize, an increase in export crop prices and an increase in the price of fertiliser would have several advantages over existing policy. It would maintain maize self sufficiency without excessive accumulation of stocks. It would dramatically improve ADMARC's cash flow, foreign exchange earnings, and smallholder incomes. And it would have almost no effect on urban incomes.
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A REDUCED-FORM MODEL

by

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February 1985

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The opinions expressed in this paper are those of the authors. They
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I. INTRODUCTION

1. Agricultural pricing issues are critically important throughout Africa, and are becoming a central concern in donor project and program lending. Because agriculture is the largest sector of the African economies—perhaps larger than all other sectors combined—in these countries, agricultural policy decisions have important implications for economic productivity and growth. Since the vast majority of the households provide for their subsistence food needs and generate much of their cash income through agriculture, pricing policies have profound effects on the well-being of a large proportion of the population. Crop exports represent the primary source of foreign exchange earnings, and the substantial implicit taxes and subsidies on agricultural production make policy decisions important for government revenue as well.

2. Effective policy dialogue on agricultural pricing is often hampered by an inadequate analytical base. While much of the agricultural policy advice is basically sound, it often suffers from one or more of the following shortcomings:
3. One reason pricing proposals may go awry is that their quantitative effects are inadequately understood and measured. The challenge, then, is to develop analytical tools that can be used to describe the impact of complex policy recommendations on a variety of government objectives in explicit quantitative terms. Such tools can help to reduce policymakers' skepticism about the policy proposals being made to them.

4. This paper reports on an application of an integrated analytical framework to trace the impact of changes in agricultural prices, taxes, subsidies, and quotas on agricultural production, domestic procurement and consumption, parastatal revenues, smallholder and urban real incomes, and foreign exchange earnings. The purpose is to provide a link between a set of policy instruments and a set of policy goals, in order to illuminate the trade-offs among the different objectives as revealed by the simulation of alternative pricing policies.
Background of the Current Analysis

5. The theoretical foundation for this work was developed by Braverman, Ahn, and Hammer and the first empirical application was conducted using Korean data. 1/ Their approach was modified by the present authors to fit synthetic data for a "prototype" African economy which included a number of salient features common to many countries in the region. 2/ This framework was then applied to the analysis of agricultural pricing policy in Malawi. Malawi was chosen because certain aspects of its institutional and pricing setting (enumerated in the next section) are relevant to many East African economies. A series of policy simulations were prepared as an input to the agricultural pricing dialogue. 3/

6. During a mission to Malawi to discuss the model results, the need became apparent for an approach that would retain the conceptual richness of the original approach while reducing its technical complexity and computational difficulty. Specifically, an approach with the following attributes was needed:

o More transparent mathematical structure;
o simpler economic descriptions of producer and consumer behavior;
o reduced computational complexity to allow the use of a microcomputer;
o simpler, more straightforward data requirements appropriate to the aggregate data available in government economic reports;
o clearer, less complicated computer program to allow hands-on use by member government policy analysts or computer technicians.

7. During the mission, a reduced-form analysis meeting these criteria was developed. It was demonstrated to government planners, and Malawian technicians were trained in its use. The Agriculture Ministry's own personnel quickly made use of the model to evaluate policy recommendations for their annual pricing review. 4/

8. This paper documents the reduced-form model and describes the results of scenarios that have been prepared for Malawi's next planning cycle. The balance of the paper is organized in three main parts. The


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first section describes the agricultural sector in Malawi and introduces some of the current agricultural policy issues. The second section explains the model structure and compares it to the more complex model from which it was derived. The third section presents simulation results for policy scenarios which can be used to explore a variety of possible policy initiatives. The full detailed model results are included as an annex. A final section contains some brief concluding remarks.

II. AN OVERVIEW OF MALAWIAN AGRICULTURE

9. The purpose of this section is to present the salient features of Malawi's agricultural sector that are relevant to the present study. First, we examine the general characteristics of Malawi's agricultural situation that are common to many other East African nations as well. Next, data are presented to describe the relative magnitude of different components of the agricultural sector. Finally we briefly explain the Government's role in market intermediation. The treatment here is not meant to be exhaustive; it is meant instead to highlight the most significant of the available data.

10. Malawi shares with other African countries certain features in its institutional and pricing setting. These common aspects give a case study of agricultural policy in Malawi greater general relevance. The following institutional features are common to many countries in the region, in addition to Malawi:
Extensive government administration of prices takes place through parastatals or marketing boards. These agencies set official producer prices for most agricultural inputs and products, and often set consumer prices and the margin for private traders and processors as well. Sometimes price regulation is enforced through official control of marketing and distribution which grants legal monopolies and monopsonies to the state agencies.

Unofficial markets, whether legal or not, are possible where state control cannot be enforced (against, for example, private trading of food crops by millions of rural smallholders), or where official prices fail to reflect the true scarcity value of commodities.

Large disparities exist between two types of farms. The vast majority of rural households in the smallholder sector farm small plots mainly for subsistence. A small fraction of rural households makes up the estate sector, engaged in more capital- and skill-intensive farming of large areas mainly for urban and export markets.
Malawi also shares with many African countries the following concerns over agricultural policy issues:

- There is a need to keep consumer prices of staple food grain commodities low to protect the welfare of politically sensitive urban dwellers. At the same time, producer prices must provide adequate incentives to encourage production to meet food security concerns and provide adequate incomes to producers.

- Implicit or explicit taxation of export crops is traditionally a major source of government revenue, partly to subsidize domestic food crops. However, taxation discourages exports and thereby decreases foreign exchange earnings.

- Imported farm inputs such as fertilizer and fuel are often subsidized to keep them affordable for producers in the face of rising world prices. Input subsidies often lead to large budgetary deficits.

This report explores these common institutional features and policy concerns in the specific context of Malawi.
11. Malawian agriculture is divided into two distinct components, the estate sector and the smallholder sector. In Malawi, estates and smallholdings are distinguished solely by land tenure rather than by size or management system. Smallholder agriculture takes place on "customary land" that is administered by village chiefs, whereas any agricultural enterprise on freehold or leasehold land is, by definition, estate agriculture. In practice, the contrasts between smallholdings and estates in terms of size, management, and commercial orientation are similar to those in other countries in the region. Under Malawian law, estates and smallholders each may grow only certain crops for cash sale. The major estate crops are burley and flue-cured tobacco, tea and sugar. In March 1979, estate agriculture occupied 13 percent of cultivated land, and was growing at roughly 10-15 percent per year. Estates market their crops directly at auction or through private contracts, with little Government intervention. As a result, the estate sector is not a prominent part of the current agricultural policy planning in Malawi. For this reason, our reduced-form analysis will concentrate on smallholder agriculture, although the same approach could be applied to the estate sector as well.

Smallholder Agriculture

12. Smallholders make up the vast majority of Malawi's farmers, and are the source of almost all of Malawi's food crop production. The
major smallholder crops are, in order of volume, maize, groundnuts, rice, cotton, and dark-fired and sun-cured tobaccos. Smallholders also grow beans, wheat, sunflower seeds, cassava, coffee, tea, millet, sorghum, and other minor crops. There are roughly 1.1 million smallholder households in Malawi, with an average household size of 4.8 and an average farm size of 1.1 hectares (2.7 acres). The following table presents aggregate data on the major smallholder crops:

### Table 2.1.

**MALAWI: SMALLHOLDER PRODUCTION, AREA, AND INPUTS 1981**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Production (MT/yr)</th>
<th>Area (ha)</th>
<th>Yield (MT/ha)</th>
<th>Labor Use (Mandays/ha)</th>
<th>Fertilizer Use (Kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unfertilized local</td>
<td>735,000</td>
<td>686,000</td>
<td>1,070</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Fertilized local</td>
<td>275,000</td>
<td>198,000</td>
<td>1,390</td>
<td>110</td>
<td>150</td>
</tr>
<tr>
<td>Fertilized improved</td>
<td>226,000</td>
<td>87,000</td>
<td>2,590</td>
<td>120</td>
<td>350</td>
</tr>
<tr>
<td>All Maize</td>
<td>1,236,000</td>
<td>971,000</td>
<td>1,270</td>
<td>95</td>
<td>60</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>62,400</td>
<td>165,900</td>
<td>380</td>
<td>170</td>
<td>25</td>
</tr>
<tr>
<td>Rice</td>
<td>48,100</td>
<td>25,000</td>
<td>1,900</td>
<td>270</td>
<td>100</td>
</tr>
<tr>
<td>Cotton</td>
<td>21,700</td>
<td>38,700</td>
<td>560</td>
<td>250</td>
<td>25</td>
</tr>
<tr>
<td>Tobacco</td>
<td>12,800</td>
<td>39,200</td>
<td>330</td>
<td>400</td>
<td>250</td>
</tr>
</tbody>
</table>

13. A glance at Table 2.1 shows that maize is clearly the dominant smallholder crop. Malawi's smallholders produce nearly six times as much maize as all other crops combined. Local maize accounts for 80 percent of all maize production, despite the much higher yields available from improved (hybrid or composite) varieties. There are at least three reasons for smallholders' preferences for local maize. First, it performs better than improved varieties for those farmers who cannot afford the high levels of fertilizer inputs they require. Second, it apparently is less vulnerable to pests in storage. Third, it is better suited to the traditional pounding process. As a result, a larger share of improved maize is marketed, and local maize is generally kept for farm household use. Over 80 percent of maize production is consumed on the farm. Average per capita consumption is approximately 200 kg/yr.

14. Groundnuts and rice are important components of the Malawian smallholder diet. Groundnuts represent an important source of protein, whereas rice is the staple food grain in limited areas of the country. Roughly two-thirds of the production of each of these crops is consumed on the farm. Confectionary varieties of groundnuts are a major source of cash income for smallholders, and cotton and tobacco are also grown as cash crops.

15. In general, smallholder agriculture in Malawi can be characterized as low-input, low-yield, extremely labor-intensive rainfed farming. There is substantial room for improvement in farming practices and farm management.
ADMARC and Smallholder Marketing

16. The Agricultural Development and Marketing Corporation, or ADMARC, is the primary vehicle for all smallholder market intermediation in Malawi. ADMARC has a legal monopoly on the marketing of all smallholder export crops. Virtually all the cotton and tobacco produced by smallholders are marketed through ADMARC. Smallholders must also sell their produce to ADMARC to pay off the credit they have received during the growing season, usually in the form of agricultural inputs, such as fertilizers, that ADMARC is legally charged with providing. ADMARC is also a residual buyer of almost all other smallholder crops, including maize, groundnuts, and rice.

17. ADMARC domestic buying and selling prices are uniform throughout the country and are set in consultation with the Government. Producer prices are announced each year before the start of the planting season, so that farmers know before they plant what they can expect to receive for their crops. According to ADMARC, producer prices are set with the dual goals of providing a reasonable return to the farmer and enabling ADMARC to earn profits to provide government revenue. Over the past few years, ADMARC producer prices have been changed dramatically by successive adjustments to agricultural price policies. These policy adjustments are illustrated in the following table.
Table 2.2
ADMARC Producer Prices and Procurements, 1978–1983
(Average prices in Kwacha per Metric Tonne, Procurements in Metric Tons)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>price</td>
<td>52</td>
<td>52</td>
<td>66</td>
<td>66</td>
<td>111</td>
<td>122</td>
<td>122</td>
</tr>
<tr>
<td>procurements</td>
<td>120,617</td>
<td>82,171</td>
<td>91,888</td>
<td>136,647</td>
<td>246,062</td>
<td>244,899</td>
<td>249,000</td>
</tr>
<tr>
<td>Groundnuts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>price</td>
<td>200</td>
<td>302</td>
<td>308</td>
<td>307</td>
<td>327</td>
<td>497</td>
<td>523</td>
</tr>
<tr>
<td>procurements</td>
<td>11,130</td>
<td>24,296</td>
<td>31,418</td>
<td>19,694</td>
<td>10,432</td>
<td>10,218</td>
<td>13,400</td>
</tr>
<tr>
<td>Rice</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>price</td>
<td>98</td>
<td>99</td>
<td>101</td>
<td>100</td>
<td>109</td>
<td>125</td>
<td>155</td>
</tr>
<tr>
<td>procurements</td>
<td>30,816</td>
<td>20,487</td>
<td>17,498</td>
<td>14,682</td>
<td>12,543</td>
<td>7,933</td>
<td>10,800</td>
</tr>
<tr>
<td>Cotton</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>price</td>
<td>213</td>
<td>218</td>
<td>218</td>
<td>214</td>
<td>269</td>
<td>363</td>
<td>400</td>
</tr>
<tr>
<td>procurements</td>
<td>24,218</td>
<td>22,411</td>
<td>23,114</td>
<td>21,739</td>
<td>14,800</td>
<td>13,368</td>
<td>32,450</td>
</tr>
<tr>
<td>Tobacco</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>price</td>
<td>475</td>
<td>412</td>
<td>423</td>
<td>481</td>
<td>446</td>
<td>741</td>
<td>810</td>
</tr>
<tr>
<td>procurements</td>
<td>23,742</td>
<td>19,541</td>
<td>11,341</td>
<td>12,755</td>
<td>8,794</td>
<td>9,279</td>
<td>13,000</td>
</tr>
</tbody>
</table>

18. Table 2.2 shows ADMARC's recent procurement experience. Perhaps the most dramatic single price policy shift in recent years occurred in 1981-82, when ADMARC's producer price for maize nearly doubled. This price increase brought a surge in procurement of maize, and a shift away from production of other crops. Groundnut procurements fell by nearly 50 percent, and cotton and tobacco volumes dropped by 30 percent as well. Since 1982, maize prices have increased only slightly, and the Government has sought to bring the prices of other commodities into line through a series of gradual increases.

19. ADMARC's recent history demonstrates general smallholder responsiveness to producer prices. Of course, the correlation between relative prices and ADMARC procurements is far from perfect. One must allow for a significant lag in production response, fluctuations in weather, insect pests, and crop diseases, as well as the effects of the conversion of smallholdings to burley tobacco estates. Such factors must also be taken into account in interpreting the simulation results presented in Section IV.

20. A more detailed understanding of ADMARC's functions can be gained by looking at its marketing activities, crop by crop, for a single year. The data shown below are compiled from ADMARC and Ministry of Agriculture estimates for 1984, the calibration year for the
reduced-form model. It should be emphasized that these figures have been derived from rough preliminary data only. While they do not represent a final accounting for the year, they nevertheless illuminate the workings of agricultural pricing and market intermediation in Malawi.

<table>
<thead>
<tr>
<th>Table 2.3 MALAWI: Maize Marketing, 1984</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Smallholder production</strong> (MT/yr)</td>
</tr>
<tr>
<td><strong>Smallholder consumption</strong> (MT/yr)</td>
</tr>
<tr>
<td><strong>ADMACR procurements</strong> (MT/yr)</td>
</tr>
<tr>
<td><strong>Urban consumption</strong> (MT/yr)</td>
</tr>
<tr>
<td><strong>Exports</strong> (MT/yr)</td>
</tr>
<tr>
<td><strong>Change in stored maize stocks</strong> (MT/yr)</td>
</tr>
<tr>
<td><strong>Producer price</strong> (K/MT)</td>
</tr>
<tr>
<td><strong>Export price</strong> (K/MT)</td>
</tr>
<tr>
<td><strong>ADMACR unit marketing costs</strong> (K/MT)</td>
</tr>
<tr>
<td><strong>ADMACR Maize account cashflow</strong> (K/yr)</td>
</tr>
<tr>
<td><strong>Balance of Payments Earnings for Maize</strong> (K/yr)</td>
</tr>
</tbody>
</table>

The figures reported here are adopted from Planning Division, Ministry of Agriculture, GOM, Use of the IBRD-Developed Agricultural Pricing Model for the Decision Making Process of the Agricultural Price Policy 1984/85 of Malawi, May 1984. This source uses ADMARC unit marketing cost data from 1982/83 for calibration and cost forecasts for 1984/85 for simulation. We use the 1984/85 cost forecasts for both calibration and simulation.
21. As Table 2.3 illustrates, the vast majority of maize production is consumed on the farm, with only 18 percent of production being marketed through ADMARC. For each of the three main food crops for which ADMARC is a residual buyer—maize, groundnuts, and rice—the fraction of production being marketed is relatively small. This means that ADMARC procurement levels are volatile, because a small percentage change in either production or consumption will mean a large percentage change in the residual reaching ADMARC depots. As a result, predicting ADMARC procurement on a year-by-year basis is extremely difficult.

22. Roughly half of ADMARC maize procurements are resold for urban consumption in this year. ADMARC domestic consumer prices for maize do not completely cover its unit costs of purchasing and processing; the resulting subsidy of roughly 0.27 Kwacha per metric tonne costs the maize cash flow account about K3.6 million in 1984. Far more important to the government cash flow situation, however, is what happens to the half of ADMARC maize procurements that are not sold domestically. If this maize could not be sold, it would represent a sizeable cash flow drain. However, the widespread drought in the region this year resulted in a good local export market for Malawi's surplus maize. The export price is sufficient to just cover ADMARC costs, so the direct contribution of exports to cash flow is small. However, the cash flow losses that are thus avoided prove to be substantial. If no maize could be exported, ADMARC's current account would show a loss of K24.5 million. But rather than unsalable maize being added to storage, maize
stocks are actually drawn down by 36,000 metric tons, representing a contribution to cash flow of K 6.7 million. This cash flow gain, of course, results from costs incurred in earlier years when maize was added to the grain reserve. Whether or not exports are a direct benefit to government revenue, however, they do make a substantial contribution of K 27.9 million to foreign exchange earnings.

Table 2.4
MALAWI: Groundnuts Marketing, 1984

<table>
<thead>
<tr>
<th></th>
<th>(MT/yr)</th>
<th>（MT/yr）</th>
<th>(K/MT)</th>
<th>(K/MT)</th>
<th>(K/yr)</th>
<th>(K/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smallholder production</td>
<td>54,900</td>
<td>41,500</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smallholder consumption</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADMARC procurement</td>
<td>13,400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban consumption</td>
<td>5,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exports</td>
<td>8,400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Producer price</td>
<td>523</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Export price</td>
<td>834</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADMARC unit marketing costs</td>
<td>194</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADMARC groundnut account cashflow</td>
<td>612,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance of payments earnings from groundnuts</td>
<td>7,000,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

23. As in the case of maize, over three-fourths of groundnut production is consumed on the farm. Of the amount sold to ADMARC, roughly 40 percent is sold domestically and the balance is exported. Unlike maize, there is a substantial export market for Malawian confectionary nuts, so any surplus can be readily exported. Because
prices vary greatly between grades of groundnuts and volume information by grade is not available to the authors, it is difficult to compute the exact subsidy on sales for domestic consumption.

Table 2.5
MALAWI: Rice Marketing, 1984

<table>
<thead>
<tr>
<th></th>
<th>(MT/yr)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Smallholder production</td>
<td>34,200</td>
<td>Smallholder consumption</td>
<td>23,400</td>
</tr>
<tr>
<td>ADMARC procurement</td>
<td>10,800</td>
<td>Urban consumption</td>
<td>5,300</td>
</tr>
<tr>
<td>Exports</td>
<td>5,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Producer price</td>
<td>155</td>
<td>Export price</td>
<td>445</td>
</tr>
<tr>
<td>ADMARC unit marketing costs</td>
<td>240</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADMARC rice account cashflow</td>
<td>1,040,000</td>
<td>Balance of payments earnings from rice</td>
<td>2,460,000</td>
</tr>
</tbody>
</table>

24. Approximately 30 percent of the rice grown by smallholders is sold to ADMARC rather than being consumed for subsistence. ADMARC procurements are rather neatly divided, half for domestic sales and half for export. ADMARC's margin on rice sales to consumers is actually greater than its margin on rice exports. Profits per unit are substantial, although volumes are low.
Table 2.6
MALAWI: Smallholder Cotton and Tobacco Marketing, 1984

<table>
<thead>
<tr>
<th></th>
<th>Cotton</th>
<th>Tobacco</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADMARC procurement (MT/yr)</td>
<td>32,500</td>
<td>13,000</td>
</tr>
<tr>
<td>Domestic sales (MT/yr)</td>
<td>32,500</td>
<td>0</td>
</tr>
<tr>
<td>Exports (MT/yr)</td>
<td>0</td>
<td>13,000</td>
</tr>
<tr>
<td>Producer price (K/MT)</td>
<td>400</td>
<td>810</td>
</tr>
<tr>
<td>Contract/Auction sales price (K/MT)</td>
<td>657</td>
<td>2,730</td>
</tr>
<tr>
<td>ADMARC unit marketing costs (K/MT)</td>
<td>242</td>
<td>427</td>
</tr>
<tr>
<td>ADMARC Cashflow (K/yr)</td>
<td>490,000</td>
<td>19,400,000</td>
</tr>
<tr>
<td>Balance of payments earnings (K/yr)</td>
<td>0</td>
<td>35,460,000</td>
</tr>
</tbody>
</table>

25. Cotton and tobacco are Malawi's major non-subsistence smallholder crops. The figures given here are based on the assumption that all the cotton grown in Malawi is marketed to mills within the country, and that all smallholder tobacco is exported. This assumption is discussed further in Section III. As Table 2.6 illustrates, cotton marketing appears to generate little ADMARC revenue or foreign exchange earnings. ADMARC's margin for cotton appears to do little more than cover its costs. In evaluating the balance of payments implications of cotton production, however, we should keep in mind the foreign exchange savings realized by avoiding the need to import roughly 30,000 metric tons of cotton at a CIF price of over 1,200 Kwacha per metric tonne.
26. Smallholder tobacco is the major source of both government revenue and foreign exchange from the smallholder sector. Tobacco accounts for very roughly half of Malawi's export earnings, and smallholder tobacco makes up approximately one-quarter to one-fifth of tobacco exports. ADMARC realizes substantial profits on tobacco trading, because the price it receives at auction is roughly twice as great as its costs.

Table 2.7
MALAWI: Smallholder Fertilizer Marketing, 1984

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADMARC fertilizer sales</td>
<td>MT/yr</td>
<td>63,500</td>
</tr>
<tr>
<td>Leakage to estate sector</td>
<td>MT/yr</td>
<td>9,000</td>
</tr>
<tr>
<td>Average smallholder fertilizer price</td>
<td>K/MT</td>
<td>274</td>
</tr>
<tr>
<td>Average fertilizer import price</td>
<td>K/MT</td>
<td>361</td>
</tr>
<tr>
<td>ADMARC unit marketing costs</td>
<td>K/MT</td>
<td>43 6/</td>
</tr>
<tr>
<td>ADMARC fertilizer account cashflow</td>
<td>K/yr</td>
<td>-8,260,000</td>
</tr>
<tr>
<td>Balance of payments earnings for fertilizer</td>
<td>K/yr</td>
<td>-22,930,000</td>
</tr>
</tbody>
</table>

27. Table 2.7 clearly illustrates that fertilizer is a substantial drain on both foreign exchange earnings and ADMARC revenue. The effective subsidy on fertilizer amounts to roughly 130 Kwacha per metric ton, which is nearly one-third of ADMARC's total unit costs or one-half

6/ Not including a five percent Government levy on fertilizer, paid by ADMARC.

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of its selling price. The role of subsidized fertilizer in producing crops such as tobacco, which generate both export earnings and government revenue, must be taken into account in evaluating the true cost of Malawi's subsidy policy. This matter will be examined further in Section IV.

28. Another result of the fertilizer subsidy is leakage of fertilizer to the estate sector. It is widely believed that some smallholders choose to resell their fertilizer to estates rather than using it on their crops. The estates must otherwise buy their fertilizer from a private corporation, at market rates.
In this section, a reduced-form model for Malawian smallholder agriculture is described and discussed. As explained in the introduction, this model is derived from a more complex version, which is fully documented in Kirchner, Singh, and Squire, "Agricultural Pricing and Marketing Policies in Malawi: A Multi-Market Analysis," May 1984. We will not describe that "full model" in detail here, but we will explain its major features that differ from those of the reduced-form model.

The model encompasses six major commodities, namely the five most important smallholder crops (maize, groundnuts, rice, cotton, and tobacco) and the fertilizer used by smallholders. While Malawi, like any economy, has many crops, the intention is to focus on the major crops only. The five major crops included in the model make up 95 percent of the Malawian smallholders' production.

The structure of the model can be usefully divided into three major parts: the supply system, the demand system, and the marketing system. We will consider these three systems in turn.

The Supply System

The reduced-form model derives smallholder production from a set of market-level supply curves. Production is calculated for the
three major types of maize—unfertilized local maize, fertilized local maize, and fertilized improved (hybrid and composite) maize—and for the other four main smallholder crops. Production depends on own-price, the prices of competing crops, and the price of fertilizers. Smallholders are assumed to be price-takers in both output and input markets, with the relevant prices of crops and inputs set by ADMARC. The model also allows the influence of weather changes to be taken into account, through a yield multiplier that can be adjusted to simulate different assumptions of yield variation.

33. The supply curves are determined by the market-level price elasticities of supply, and are calibrated to the base-year production. Supply of a given crop, then, is the base-year supply figure, with any departures from base-year prices (weighted by the appropriate elasticities) factored in. The general equation used to calculate production is:

\[ S_i = a_i W_i P_i^{e_i} P_j^{e_j} P_k^{e_k} P_f^{e_f} \]  

(3.1)

In other words, the supply of crop \( i \) is the product of a calibration constant \( a \), a weather effects factor \( W \) (equal to one for normal weather), the own-price raised to its supply elasticity, the prices of competing crops \( j \) and \( k \) raised to their appropriate cross-price elasticities, and the price of fertilizer raised to its elasticity. The calibration constant \( a \) is derived by dividing the base-year supply by
the rest of the right-hand side of equation 3.1, with the appropriate base-year values for the variables.

34. The supply elasticities used in the reduced-form model are intended to approximate profit-maximizing behavior. They are derived from the behavior of the full model, which explicitly models profit-maximizing resource allocation of farms that are disaggregated by cropping pattern and region. Using these elasticities, the reduced-form model's behavior approximates the behavior of the large model, without the computational complexity of the full model.

Table 3.1
Malawi Agricultural Pricing Model Supply Elasticities

<table>
<thead>
<tr>
<th>Production Response</th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
<th>Fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfertilized local maize</td>
<td>0.30</td>
<td>-0.06</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>Fertilized local maize</td>
<td>0.58</td>
<td>-0.05</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.20</td>
</tr>
<tr>
<td>Improved maize</td>
<td>0.66</td>
<td>-0.04</td>
<td>0.00</td>
<td>-0.01</td>
<td>0.00</td>
<td>-0.35</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>-0.22</td>
<td>0.70</td>
<td>0.00</td>
<td>0.00</td>
<td>-0.01</td>
<td>-0.05</td>
</tr>
<tr>
<td>Rice</td>
<td>-0.14</td>
<td>0.00</td>
<td>0.66</td>
<td>0.00</td>
<td>0.00</td>
<td>-0.14</td>
</tr>
<tr>
<td>Cotton</td>
<td>-0.18</td>
<td>0.00</td>
<td>0.00</td>
<td>0.39</td>
<td>0.00</td>
<td>-0.06</td>
</tr>
<tr>
<td>Tobacco</td>
<td>-0.14</td>
<td>-0.03</td>
<td>0.00</td>
<td>0.00</td>
<td>0.76</td>
<td>-0.24</td>
</tr>
</tbody>
</table>

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Table 3.1 shows the supply elasticity coefficients derived from 20 percent price parametric tests on the "full model" version. In undertaking studies similar to this one, it would not be necessary to follow this same route to obtain supply elasticities. These elasticities can also be obtained from the literature of empirical studies and from experts' estimates. Alternatively, they can be derived by calculation from farm budget data.

Factor demand for farm inputs (labor and fertilizer) is derived through a calculation similar to that used to simulate production response. The equation used to calculate fertilizer demand is:

$$F = a_0 p_1^{e_1} p_2^{e_2} p_3^{e_3} p_4^{e_4} p_5^{e_5} p_F^{e_F}$$

(3.2)

Fertilizer use is a function of the prices of the crops and fertilizer itself, raised to the appropriate elasticities, with a calibration constant. Labor use is calculated with a similar formula.
Table 3.2
Malawi Agricultural Pricing Model
Factor Demand Elasticities

<table>
<thead>
<tr>
<th>Factor demand response:</th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
<th>Fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer</td>
<td>1.20</td>
<td>0.14</td>
<td>0.02</td>
<td>0.03</td>
<td>0.23</td>
<td>-1.04</td>
</tr>
<tr>
<td>Labor</td>
<td>0.16</td>
<td>0.09</td>
<td>0.02</td>
<td>0.01</td>
<td>0.02</td>
<td>-0.08</td>
</tr>
</tbody>
</table>

36. These elasticities, like the production elasticities, were obtained from the behavior of the full profit-maximizing model. They could also be estimated from farm budget data.

37. The supply system of the model is based on the assumption of smallholder profit-maximization. This should not be interpreted too strictly. The assumption is that farmers on average tend toward profit-maximizing behavior.

38. Profit maximizing production behavior is not generally characterized by supply curves that exhibit constant price elasticity throughout their range, as the supply curves in the reduced-form model do. If properly calibrated, the model will show profit-maximizing behavior for relatively small price changes around the calibration point. However, as larger and larger price changes are simulated, the model's results will begin to diverge from realistic profit-maximizing behavior. Departures from realistic behavior will become obvious as
smallholder incomes are observed to move in a direction that is inconsistent with the direction of the price change being simulated. A somewhat more sensitive test for the breakdown of the profit maximizing assumption is to compare the smallholder income that is derived from the model (which allows for price response in production behavior) with the income that would result from simply applying the price change to constant production behavior. If the latter income figure is greater than the former—that is, if the price responsive adjustments in quantities of crops produced and inputs consumed do not increase farm income—the range of profit-maximizing behavior in the supply system is being exceeded. Supply system profit-maximization may be violated for price changes on the order of 50 percent of the base year price value. Some vigilance in examining the model results is required to detect and account for these departures from profit-maximization.

39. Three constraints on smallholder profit-maximizing behavior are explicitly represented in the model. First, smallholder demand for fertilizer is constrained by ADMARC's level of fertilizer imports. Information from field visits indicates that farmers have often wanted to use more fertilizer than was available from ADMARC. Second, smallholders' production of cash crops is constrained by their subsistence requirements for local maize. In general, smallholders seek to ensure they can meet their subsistence needs for maize from their own land, even to the exclusion of more profitable crops. This risk-averse
strategy protects the farmer from food shortages in local markets. Third, smallholder tobacco production could be constrained by quotas that the Government attempts to enforce through a producer licensing system. The rationale behind this system is that if too much of certain types of tobacco is produced, the over-supply will spoil the auction price.

40. These constraints are modeled through the use of shadow prices. The fertilizer constraint will be considered at some length as an example. If the demand for fertilizer at the official price (for fertilizer and smallholder crops) exceeds the available supply, the model calculates a shadow price as the price that would be required to push demand down to the constraint level. Then the model recalculates both fertilizer demand and smallholder production using the new shadow price for fertilizer rather than the official price. In this way, the model captures the effect of fertilizer supply constraints on both fertilizer demand and smallholder production decisions. Of course, in computing farm profits the official prices, rather than the shadow prices, are used.

The Demand System

41. The model calculates demand for the three major food crops, namely maize, groundnuts, and rice. Two consumer groups, smallholder households and urban households, are modeled. The demand system, like
the supply system, uses market-level demand curves characterized by constant elasticity about the calibration point. The form of the demand equation is the same for each crop and each consumer group.

\[ D_i = \alpha_i Y_{ik} p_i^e p_j^e p_k^e \]  

(3.3)

The demand equation is the product of income, own-price, and the prices of substitutes, weighted by income, own-price, and cross-price elasticities and normalized by a calibration constant. Demand, then, will be equal to the base year demand adjusted for price and income changes by the appropriate elasticity relationship.

42. Where the two consumer groups are treated differently is in the calculation of their household incomes. For urban dwellers, income is set outside of the model. The model does not try to capture the general equilibrium effects of agricultural prices on urban incomes. By contrast, farm incomes are calculated within the model to account for the effect of agricultural pricing on farm profits, and thereby on consumption. Farm income is calculated as the value of all crops produced, minus the cost of purchased inputs (labor and fertilizer from the factor demand equations), plus any non-farm income. This "full income," unlike cash income, captures the value of all production, whether consumed by the farm household or marketed for cash. Full income is calibrated to match the base year value by adjusting the farm household's contribution of labor to the farm, which in turn determines the amount of labor that must be purchased.
Table 3.3
Malawi Agricultural Pricing Model
Rural Consumption Elasticities

<table>
<thead>
<tr>
<th>Demand Response</th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>-0.21</td>
<td>0.00</td>
<td>0.00</td>
<td>0.53</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>0.10</td>
<td>-0.29</td>
<td>0.00</td>
<td>0.19</td>
</tr>
<tr>
<td>Rice</td>
<td>0.06</td>
<td>0.01</td>
<td>-0.44</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Table 3.4
Malawi Agricultural Pricing Model
Urban Consumption Elasticities

<table>
<thead>
<tr>
<th>Demand Response</th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>-0.22</td>
<td>0.01</td>
<td>0.02</td>
<td>-0.25</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>0.10</td>
<td>-0.30</td>
<td>0.00</td>
<td>0.23</td>
</tr>
<tr>
<td>Rice</td>
<td>0.05</td>
<td>0.00</td>
<td>-0.61</td>
<td>0.49</td>
</tr>
</tbody>
</table>

The demand elasticities used in the model are derived, in the same manner as the supply elasticities, from the behavior of the utility-maximizing demand sector of the full model. The price elasticities for the urban and rural groups are generally similar.
Note, however, that there are substantial differences between the two groups' income elasticities, particularly for maize. The negative urban income elasticity for maize reflects the fact that for urban dwellers, maize is an inferior good relative to other grains. By contrast, the importance of maize as a subsistence crop is reflected in its high rural income elasticity.

44. To evaluate the effects of pricing policies on smallholders' and urban households' well-being, the model includes a measure of real incomes. Real incomes are calculated by dividing nominal income by a price index, in which the prices of the three consumption goods are weighted by the share of expenditures they accounted for in the base year. Note that this measure approximates real income so long as the expenditure shares do not change greatly. For urban groups, the expenditure shares of food commodities are quite small and do not change much. For smallholders, however, food crops—particularly maize—represent a large share of expenditures. Consequently, crop prices will have a substantial effect on the price index. Caution must be used in interpreting the model results if the maize price is lowered and the share of maize in income drops below its base year share of expenditures. In that case, marginal fluctuations in the price of maize will cause the model to show smallholder nominal and real incomes moving in opposite directions. This result will prove very disconcerting if its origins are not kept in mind.
45. The model structure assumes that all marketing of the six major smallholder commodities takes place through ADMARC, at the parastatal's official prices. Some private trading does occur, particularly in maize, groundnuts, and rice, in which private trading is legal. However, the available information indicates that the volume of private trading is small in relation to ADMARC's marketing activities.

46. ADMARC crop procurements are the residual of smallholder production and consumption. For cotton and tobacco, smallholder consumption is assumed to be negligible and ADMARC procurement equals production. ADMARC domestic sales of food crops are determined by urban demand. The calibration procedure of the model is consistent with these assumptions. That is, base year urban consumption is derived from ADMARC sales data and smallholder consumption in the base year is taken to be the difference between smallholder production and ADMARC procurements. For cotton and tobacco, the model assumes no direct ADMARC sales to consumers; all tobacco is sold at export auction, and all cotton is assumed to be sold to domestic ginning mills under contract.

47. In general, market clearing takes place through exports and imports. That is, ADMARC crop surpluses are exported, and imports are made to meet shortfalls, at the prevailing world FOB and CIF prices. There are two important exceptions to this rule. First, as noted above,
in the model all cotton production is sold domestically by ADMARC at a contract price. Second, maize market clearing takes place through adjustments to ADMARC's strategic maize inventory. Exports or imports of maize are also possible. However, the inherent unpredictability of the regional market for maize means that exports and imports are treated in the model as explicit policy decisions. Transportation costs make Malawian maize essentially a non-tradeable on the world market; depending on the assumptions used, the border world export price is very small or possibly negative, and the border import price is several times the domestic price. As a result, Malawi can only export its surplus maize when its neighbors have shortages and a supply of currency for the purchase. Such exports are made at negotiated prices, as the result of an explicit policy decision by the Government.

48. Once ADMARC's commodity flows (procurements, domestic sales, exports, and imports) are known, it is a simple matter to calculate the profits and losses from its marketing activities. Similarly, by multiplying external trade volumes by the relevant border prices, the contribution of each commodity to the balance of payments situation can be readily computed. These two key aggregate results are reported for each crop individually and for all the crops jointly.
IV. ANALYSIS OF ALTERNATIVE PRICING STRATEGIES

49. This section summarizes and explains a series of policy scenario simulations using the reduced-form model. These simulations have been developed to test the effectiveness of alternative pricing strategies in accomplishing a number of government objectives. These five key issues are the following:

- food self-sufficiency
- government revenues
- foreign exchange earnings
- smallholder real incomes
- urban real incomes

The model is designed to provide indicators of these objectives. The model reports the annual surplus or deficit in maize, the main food crop, as a measure of food self-sufficiency. Government revenue effects are indicated by ADMARC's annual cash flows. The balance of payments effects resulting from exports and imports of the six major commodities represent the smallholder sector's contributions to foreign exchange earnings. The effects of pricing changes on urban and smallholder real incomes are reported directly.
Three basic smallholder pricing strategies are examined in this section, both singly and in combination. These three strategies are the following:

- Fertilizer parity—ADMARC's selling price for fertilizer is raised to a level which covers its import and marketing costs.
- Maize surplus and subsidy reduction—ADMARC's marketing margin for maize is adjusted to cover its marketing costs, and the producer price is adjusted so that annual additions to strategic maize inventories are small.
- Export "parity"—ADMARC's producer prices for groundnuts, rice, and cotton are raised to their export parity values, and domestic sales prices for these crops are adjusted to match their border (FOB) prices. ADMARC's producer price for tobacco is raised to the point that tobacco procurements match the quota for smallholder tobacco.

It is important to note that these are pricing strategies, not specific proposals for pricing policies. These strategies can be thought of as directions in which the Government of Malawi could move. The fact that
the simulations used here adopt these strategies fully, reflects only the fact that this makes their effects clearer, and should not be taken to imply that it is necessary or appropriate for the Government to follow one or another of these strategies to its ultimate conclusion. The strategies themselves are not expressed above in terms of precise price levels, but instead in terms of the benchmarks against which prices can be measured. The purpose of this analysis is not to recommend specific policies or price levels. Instead, we explore the implications of some idealized scenarios, in order to better inform the policy decisions that must be made.

**Base Run 1985**

51. The base run serves as a point of reference for comparing the scenarios that follow, and indicates the smallholder sector's expected performance for the current cropping year. The base run is derived by calibrating the model to last year's performance, then simulating the effects of the price changes implied by this year's official price policies.

52. It is important to keep in mind that this model is designed for analyzing the effects of policy changes rather than for predicting actual agricultural or economic performance in any given year. In order to predict agricultural output, for example, one would need to also
predict such factors as weather conditions, insect pests, and plant diseases for the year in question. Unfortunately, precise prediction of such variables is currently impossible, so agricultural performance cannot be accurately predicted either. Similarly, changes in the world economy might alter the export-import conditions for the commodities in question, but they also cannot be accurately anticipated.

53. For this reason, the base run and policy scenarios will retain the effects of any unusual features of the calibration year, such as abnormally low groundnut production (due to Hilda's disease) or abnormally high cotton production (due to well-distributed rainfall). The analytic value of the model is not impaired by the unpredictability of these factors, because a comparison among policy scenarios assumes that all external factors are unchanged. Difficulties could arise, however, if unusual circumstances in the base year inherently favored one policy strategy over another. We address this problem later in this section by conducting a sensitivity analysis using different weather assumptions.

54. One important feature reflected in Table 4.1, the base run, is the assumption that no maize will be exported. For the current year this will almost certainly not be the case, in view of the drought conditions in much of Africa. Over the long run, however, it appears that Malawi cannot rely on a large export market for its maize. Malawi can compete with the world maize price only in the immediate region, and even there the export price may not cover purchase, processing, and transport costs. For an export market for Malawian maize to exist,
### Table 4.1

**Policy Simulation**  
**Base Run 1985**  
**Normal Weather**

<table>
<thead>
<tr>
<th></th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
<th>Fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Producer price (K/MT)</strong></td>
<td>122</td>
<td>624</td>
<td>169</td>
<td>438</td>
<td>1037</td>
<td>315</td>
</tr>
<tr>
<td><strong>Consumer price (K/MT)</strong></td>
<td>156</td>
<td>644</td>
<td>540</td>
<td>657</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>FOB price (K/MT)</strong></td>
<td>186</td>
<td>834</td>
<td>445</td>
<td>859</td>
<td>2730</td>
<td>305</td>
</tr>
<tr>
<td><strong>CIF price (K/MT)</strong></td>
<td>391</td>
<td>1093</td>
<td>658</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Smallholder production (MT)</strong></td>
<td>1348578</td>
<td>61856.04</td>
<td>36043.37</td>
<td>33558.22</td>
<td>15467.58</td>
<td></td>
</tr>
<tr>
<td><strong>Smallholder consumption (MT)</strong></td>
<td>1137320</td>
<td>39508.17</td>
<td>22667.44</td>
<td>0</td>
<td>0</td>
<td>30545.63</td>
</tr>
<tr>
<td><strong>ADMARC procurements (MT)</strong></td>
<td>211258.9</td>
<td>22267.92</td>
<td>13375.93</td>
<td>33558.22</td>
<td>15467.58</td>
<td></td>
</tr>
<tr>
<td><strong>Urban consumption (MT)</strong></td>
<td>135000</td>
<td>5042</td>
<td>5275</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Exports (MT)</strong></td>
<td>0</td>
<td>17224.41</td>
<td>8100.928</td>
<td>0</td>
<td>15467.58</td>
<td></td>
</tr>
<tr>
<td><strong>Imports (MT)</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>65054.63</td>
</tr>
<tr>
<td><strong>Balance of payments (K 1000)</strong></td>
<td>0</td>
<td>14365.58</td>
<td>3604.913</td>
<td>0</td>
<td>42226.5</td>
<td>-23094.39</td>
</tr>
<tr>
<td><strong>ADMARC cashflow (K 1000)</strong></td>
<td>-17600.38</td>
<td>-601.71</td>
<td>982.6585</td>
<td>-771.838</td>
<td>11581.96</td>
<td>-5399.534</td>
</tr>
</tbody>
</table>

**Surplus maize added to storage (MT)**  
76258.88

**Net ADMARC cashflow (K 1000)**  
-3808.842

**Net balance of payments (K 1000)**  
37102.6

| **Smallholder income (K/HH/yr)** | 261.6091 |
| **Smallholder real income**      | 258.1304 |
| **Urban income (K/HH/yr)**       | 1252     |
| **Urban real income**            | 1252     |
| **Fertilizer leakage (MT)**      | 7299.213 |
Malawi's neighbors must have both a need for its maize and the hard currency to pay for it. It is difficult to predict how often this situation will arise. We have assumed in these simulations that it is most realistic not to plan on a permanent export market for maize. The analytic procedure outlined here could be repeated for other export market assumptions.

55. The export market for maize is critical to the Government's cash flow situation. Whatever purchased maize cannot be sold domestically or exported must be stored. Accumulation of large maize stocks represents a huge drain on current accounts, because the stored maize has been paid for (and is incurring storage costs) but has not yet produced revenue. While stored maize undoubtedly has value in providing food security, its economic value depends on the future price and scarcity of maize, which are difficult to assess. The costs, on the other hand, are easier to evaluate. The 76,300 metric tons (MT) of surplus maize in the base run represent K 14 million in purchasing and handling costs alone. By contrast, the cost of the "consumer subsidy" on domestic maize is only K 3.6 million. If all the surplus maize could be exported at roughly K 185/MT, the K 14 million in costs could be recovered. This would turn the net ADMARC loss of (on all its smallholder marketing) K 3.8 million in the base run into a profit of K 10.2 million. If the surplus maize must all be stored, however, the interest on its value alone will probably amount to K 1.5-2.5 million.
56. None of the foregoing should be interpreted as an argument against the strategic maize reserve. These figures are intended simply to point out the costs of a pricing policy that generates persistent large surpluses of a nontradeable commodity.

57. In addition to the maize surplus, the major source of losses is the subsidy of K 5.4 million on fertilizer. The ADMARC selling price for fertilizer is a full K 40/MT below the CIF price and K 83/MT below ADMARC's total costs. A five percent government levy that ADMARC pays on its imports is not counted in these costs, because this levy is just one form of a transfer from the parastatal to the Government.

58. The primary source of cash flow revenues in the base run is tobacco trading. ADMARC's unit costs for tobacco purchase and marketing, amounting to K 1,464/MT, are little more than half the auction price of K 2,730/MT. As a result, tobacco marketing generates 19.6 million K in ADMARC cash flow revenues.

59. Smallholder tobacco exports are also a major source of foreign exchange in the base run, amounting to K 42 million. Groundnuts and rice exports contribute an additional K 14.4 and K 3.6 million, respectively. The primary drain on smallholder balance of payments is fertilizer imports, amounting to K 23 million.

Fertilizer Parity

60. The first pricing strategy we will examine is raising ADMARC's smallholder fertilizer price toward its import-parity level. Fertilizer
### Table 4.2

**Fertilizer Parity**
**Normal Weather**

<table>
<thead>
<tr>
<th></th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
<th>Fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Producer price (K/MT)</strong></td>
<td>122</td>
<td>624</td>
<td>169</td>
<td>438</td>
<td>1037</td>
<td>398</td>
</tr>
<tr>
<td><strong>Consumer price (K/MT)</strong></td>
<td>156</td>
<td>644</td>
<td>540</td>
<td>657</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>FOB price (K/MT)</strong></td>
<td>186</td>
<td>834</td>
<td>445</td>
<td>850</td>
<td>2730</td>
<td>355</td>
</tr>
<tr>
<td><strong>CIF price (K/MT)</strong></td>
<td>391</td>
<td>1093</td>
<td>655</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Smallholder production (MT)</strong></td>
<td>132073</td>
<td>61136.92</td>
<td>34882.31</td>
<td>33090.6</td>
<td>14623.29</td>
<td></td>
</tr>
<tr>
<td><strong>Smallholder consumption (MT)</strong></td>
<td>1131893</td>
<td>39521.3</td>
<td>22626.56</td>
<td>0</td>
<td>0</td>
<td>46702.67</td>
</tr>
<tr>
<td><strong>ADMARC procurements (MT)</strong></td>
<td>189080.4</td>
<td>21615.62</td>
<td>12255.75</td>
<td>33090.6</td>
<td>14623.29</td>
<td></td>
</tr>
<tr>
<td><strong>Urban consumption (MT)</strong></td>
<td>135000</td>
<td>5042</td>
<td>5275</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td><strong>Exports (MT)</strong></td>
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<td>16573.62</td>
<td>6980.746</td>
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<td>14623.29</td>
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<tr>
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<td>0</td>
<td>0</td>
<td>46702.67</td>
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<tr>
<td><strong>Balance of payments (K 1000)</strong></td>
<td>0</td>
<td>13822.4</td>
<td>3106.432</td>
<td>0</td>
<td>39921.59</td>
<td>-16579.45</td>
</tr>
<tr>
<td><strong>ADMARC cashflow (K 1000)</strong></td>
<td>-13541.71</td>
<td>-612.13</td>
<td>942.332</td>
<td>-761.084</td>
<td>18513.09</td>
<td>0</td>
</tr>
</tbody>
</table>

- **Surplus maize added to storage (MT)**: 54080.38
- **Net ADMARC cashflow (K 1000)**: 4540.496
- **Net balance of payments (K 1000)**: 40270.97
- **Smallholder income (K/HH/yr)**: 259,256
- **Smallholder real income**: 255,811
- **Urban income (K/HH/yr)**: 1252
- **Urban real income**: 1252
- **Fertilizer leakage (MT)**: 1417.323
subsidies of K 83/MT, or K 5.2 million per year, represent a major drain on revenues in the base run; reducing these subsidies would substantially improve government cash flows. To test the effects of reducing fertilizer subsidies, we simulate the extreme case, in which they are eliminated altogether by raising ADMARC's fertilizer selling price from K 315-398/MT.

61. Elimination of fertilizer subsidies directly improves ADMARC's cash flow situation by K 5.4 million. By comparing Tables 4.1 and 4.2, however, we notice that ADMARC's overall cash flow gain is much greater, totalling K 8.3 million. Most of the additional revenue gain occurs in the maize account. The increase in fertilizer prices decreases maize production very slightly, and the surplus that must be stored is reduced from 76,000 MT to 54,000 MT. This reduction in surplus of 22,000 MT saves ADMARC K 4.1 million in buying and processing expenses. Rising fertilizer prices also depress tobacco production by 1,100 MT, resulting in a loss to ADMARC's tobacco account of K 1.1 million.

62. The effects of the fertilizer pricing on ADMARC's maize and tobacco trading illustrate the importance of multi-market analysis in agricultural pricing discussions. If these interactions were not explicitly represented in the analysis, it would be difficult indeed to gauge their importance to the outcome. Ignoring the interactions entirely would result in a misleadingly low estimate of the total revenue effects of fertilizer price increases. This scenario also points out the importance of maize surpluses in determining ADMARC's
cash flow situation. In this case, the change in the maize surplus is nearly as beneficial to ADMARC's cash flow as the direct fertilizer effect. The simulations which follow will also demonstrate how important it is to keep this effect in mind.

63. What will be the effect of the fertilizer price increase on foreign exchange earnings? We would expect both fertilizer imports and crop exports to decline, but which change will be greater, and by how much? The model results provide an estimate. Smallholder fertilizer imports decline from 65,000 MT to 46,700 MT, saving K 6.5 million in foreign exchange. However, tobacco exports decline by about K 2.3 million, and groundnut and rice exports decrease by about half a million Kwacha each. The net effect is a balance of payments gain of K 3.2 million.

64. Note that not all of the drop in fertilizer purchases results from reductions in smallholder fertilizer use. Fertilizer leakage to estates decreases sharply, because ADMARC's parity price is close to the estate fertilizer price and the profitability of fertilizer leakage is almost completely eliminated. Of the 18,300 MT decrease in fertilizer purchases, 12,400 MT is due to reductions in use by smallholders and 5,900 MT is due to decreased leakage to estates.

65. The impact of fertilizer parity pricing on smallholder incomes is quite modest (about one percent), because smallholders use, on average, less than one bag of fertilizer per household per year. In practice, many households use no fertilizer and a relatively small fraction of households appears to account for the bulk of fertilizer
demand. The price increase required for fertilizer parity amounts to only K 4.15 per bag.

66. The fertilizer demand figures in this and the following runs seem surprisingly small, particularly in view of the planned imports of 87,000 MT per year. The model's fertilizer demand projections should not be taken too literally, because they depend a great deal on whether one assumes there is currently a substantial unmet fertilizer demand. These runs are based on the assumption that almost all current (1984) fertilizer demand, at the official price, is being met by ADMARC. This may not be the case. If there is currently substantial unmet demand, the fertilizer demand levels in these simulations may be an underestimate. However, we should also be cautious of forecasts of fertilizer demand that are derived from the yield response obtained in test plots. These forecasts tend to overestimate demand. In practice, the yield response obtained by smallholders is substantially smaller than experiments would indicate, and smallholders' demand is further limited by credit constraints and risk aversion.

Maize Surplus and Subsidy Reduction

67. Maize surpluses and subsidies are responsible for K 17.6 million in cash flow losses in the base run. The maize consumer subsidy of K 3.6 million on domestic maize sales could be eliminated by setting the margin between ADMARC's buying and selling prices wide enough to cover its costs. Maize surpluses account for the other K 14 million in
cash flow losses, representing a substantial investment (in purchases, processing, and transport) which produces no current revenue. To reduce maize surpluses, we adjust the producer price (moving the consumer price in step to keep the price margin the same) so that net procurements roughly equal domestic sales over the long run. Remember that what is being described here is a strategy rather than a particular price level. For example, if one believes that a given volume of maize exports are possible over the long term, one could adjust the producer price in the same manner to give an ADMARC maize surplus just large enough to support the desired level of exports.

68. The results of this simulation show that reducing the maize surplus and subsidy does improve ADMARC’s cash flow situation dramatically (Table 4.3). The net gain in ADMARC cash flow is nearly K 18.8 million. This cash flow gain is actually greater than that which would result from exporting the entire base year maize surplus at a border price of K 185/MT. The consumer subsidy is completely eliminated, and reducing the surplus from 76,300 to just 300 MT cuts maize account losses to only K 300,000.

69. The indirect effects of the decrease in maize producer prices further improve both the cash flow situation and foreign exchange earnings. A decrease in the maize price reduces smallholder fertilizer imports by 9,500 MT, and thereby cuts losses to both revenue and balance of payments. A decrease in the maize price also results in increased production of competing crops, thus boosting exports of groundnuts, rice
### TABLE 4.3

**MAIZE SURPLUS AND SUBSIDY REDUCTION**
**NORMAL WEATHER**

<table>
<thead>
<tr>
<th>Product</th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
<th>Fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Producer price (K/MT)</strong></td>
<td>105</td>
<td>624</td>
<td>169</td>
<td>438</td>
<td>1037</td>
<td>315</td>
</tr>
<tr>
<td><strong>Consumer price (K/MT)</strong></td>
<td>166</td>
<td>644</td>
<td>540</td>
<td>657</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>FOB price (K/MT)</strong></td>
<td>186</td>
<td>834</td>
<td>445</td>
<td>850</td>
<td>2730</td>
<td>355</td>
</tr>
<tr>
<td><strong>CIF price (K/MT)</strong></td>
<td>391</td>
<td>1093</td>
<td>625</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Smallholder production (MT)</strong></td>
<td>1266092</td>
<td>63932.2</td>
<td>36808.59</td>
<td>34322.16</td>
<td>15795.97</td>
<td></td>
</tr>
<tr>
<td><strong>Smallholder consumption (MT)</strong></td>
<td>1131032</td>
<td>38484.82</td>
<td>22152.32</td>
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<td>0</td>
<td>55537.07</td>
</tr>
<tr>
<td><strong>ADMARC procurements (MT)</strong></td>
<td>135060.6</td>
<td>25447.38</td>
<td>14656.27</td>
<td>34322.16</td>
<td>15795.97</td>
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<tr>
<td><strong>Urban consumption (MT)</strong></td>
<td>133167.3</td>
<td>5073.42</td>
<td>5291.412</td>
<td>0</td>
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<td>0</td>
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<td><strong>Exports (MT)</strong></td>
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<td>20373.95</td>
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<td>0</td>
<td>15795.97</td>
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<tr>
<td><strong>Imports (MT)</strong></td>
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<td>0</td>
<td>0</td>
<td>55537.07</td>
<td></td>
</tr>
<tr>
<td><strong>Balance of payments (K1000)</strong></td>
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<td>16991.88</td>
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<td><strong>ADMARC cashflow (K1000)</strong></td>
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<td>1030.31</td>
<td>-789.41</td>
<td>19997.7</td>
<td>-4609.577</td>
</tr>
</tbody>
</table>

- Surplus maize added to storage (MT) 1893.375
- Net ADMARC cashflow (K1000) 14757.93
- Net balance of payments (K1000) 44566.59
- Smallholder income (K/HH/yr) 243.9426
- Smallholder real income 255.0231
- Urban income (K/HH/yr) 1252
- Urban real income 1243.46
- Fertilizer leakage (MT) 7299.213
and tobacco. The net impact of these indirect effects alone is a gain of K 1.5 million in cash flow and a gain of K 7.5 million in foreign exchange earnings.

70. Smallholder and urban real incomes suffer under this pricing strategy, however. The simulation results show urban real incomes decreasing from K 1252 to K 1243 per household per year (less than one percent) as a result of the K 10/MT increase in the ADMARC selling price for maize. Such is the effect on the average household, but what about the poorest segments of the population, who are most affected by changes in prices of food staples? Even households in the lowest income group in the Urban Household Expenditure Survey 1979-80, those with monthly incomes of less than K 20, spend relatively little of their income on maize. Their maize expenditure share ranges from 8 percent in Lilongwe to a high of 19 percent in Mzuzu. For these households the decline in real income resulting from the maize price increase would amount to only 0.5 to 1.2 percent.

71. The decrease in the maize producer price from 122 to 105 K/MT reduces smallholder real income from K 258 to K 255, or roughly one percent. Because maize is a large fraction of rural consumption, however, the decrease in the maize price (and thus the change in the

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price index) masks a much larger change in nominal income. Nominal smallholder income decreases from K 262 to K 244, a change of seven percent. The effect on lower-income segments of the population may be larger because maize makes up a larger fraction of production for these households. It is also plausible that the income effect for low-income groups would be smaller because they market less of their maize and therefore would be affected less by market price changes.

72. This simulation is used to characterize the effects of a strategy which seeks to eliminate maize subsidies and unmarketable maize surpluses. It is important to point out, however, that these results are not meant to imply that the producer and consumer prices used in this simulation would in fact exactly eliminate maize surpluses. As was explained earlier in this section, the purpose of this model is analysis of pricing strategies rather than prediction of actual agricultural or economic performance. Accordingly, the model results do not allow us to predict the exact price levels that would be required to eliminate maize surpluses in any given year. The model results do, however, indicate the direction and approximate magnitude of the required price changes. If a policy decision were made to pursue one of these strategies, additional analytical work would be appropriate to more precisely ascertain the exact price levels needed.

73. We should also recognize that the price levels required to generate sufficient maize procurement (while avoiding excessive surpluses) will necessarily change over time. Malawi's population is growing rapidly;
at current rates, it will double in just 20 years. Relative producer prices will have to shift gradually toward maize to bring higher procurements to meet rising urban demand, particularly because growing rural populations will be pushing rural consumption upward as well. Over the long term, with Malawi's population forecast to reach 12 million by the end of the century and a staggering 35 million by the year 2050, self-sufficiency in maize will be determined more by population policy and agricultural technology than by pricing levels. While these issues are vital to the long term, however, they are beyond the scope of this report.

Export "Parity"

74. In the export "parity" strategy, prices for groundnuts, rice, and cotton are set at their parity values. That is, domestic consumer prices for these export crops are set at the FOB price, and producer prices are set at the FOB price minus ADMARC unit marketing costs. In this way, ADMARC trades these export commodities at cost. The export "parity" strategy also involves setting the producer price for tobacco at the value which yields the quota level of tobacco production, rather than at export parity (hence we put quotes around "parity"). There is

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little reason for ADMARC to encourage an explosion in tobacco production by raising the price to the parity level, and then enforce production restrictions to avoid spoiling the auction price through excess supply. Instead, it makes sense for ADMARC to control production levels through the pricing mechanism, and gain the revenue benefits of its large marketing margin.

75. Intuitively, raising producer prices for export crops would seem to improve the balance of payments (by stimulating exports) at the expense of government revenue (because ADMARC margins decline). However, the simulation results (Table 4.4) show that the export parity strategy results in both an increase in foreign exchange earnings of K 9.1 million and a gain of K 5.6 million in ADMARC cash flow. Looking at the results in some detail, we can see how this result occurs.

76. The first point to notice is that ADMARC's cash flow from tobacco does not decline as drastically as one might assume. Raising the tobacco producer price by K 230/MT cuts ADMARC tobacco revenues by roughly one million Kwacha, or only five percent. The growth in production almost offsets the reduction in ADMARC's unit profit from K 1,266 to K 1,036/MT.

77. Second, export parity pricing does not dramatically affect ADMARC's groundnut, rice, or cotton accounts. The price changes are small, as are the volumes involved. Furthermore, the base-year prices generally imply taxation of exports and subsidization of domestic consumption, with ADMARC cash flows for these crops swinging from positive to negative according to relatively minor fluctuations in the share of procurements going to each of these markets.
TABLE 4.4

POLICY SIMULATION

EXPORT *PARITY*
NORMAL WEATHER

<table>
<thead>
<tr>
<th></th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
<th>Fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producer price (K/MT)</td>
<td>122</td>
<td>640</td>
<td>205</td>
<td>608</td>
<td>1267</td>
<td>315</td>
</tr>
<tr>
<td>Consumer price (K/MT)</td>
<td>156</td>
<td>834</td>
<td>445</td>
<td>850</td>
<td>0</td>
<td>0</td>
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<tr>
<td>FOB price (K/MT)</td>
<td>186</td>
<td>834</td>
<td>445</td>
<td>850</td>
<td>2730</td>
<td>355</td>
</tr>
<tr>
<td>CIF price (K/MT)</td>
<td>391</td>
<td>1093</td>
<td>655</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Smallholder production (MT)</td>
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<td>62836.04</td>
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</tr>
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<td>Smallholder consumption (MT)</td>
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</tr>
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<td>ADMARC procurements (MT)</td>
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<td>17997.45</td>
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<td>Urban consumption (MT)</td>
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<td>Balance of payments (K 1000)</td>
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<td>0</td>
<td>18645.36</td>
<td>-5772.399</td>
</tr>
</tbody>
</table>

Surplus maize added to storage (MT) 40682.31
Net ADMARC cashflow (K 1000) 1787.775
Net balance of payments (K 1000) 46154.48
Smallholder income (K/HH/yr) 272.74
Smallholder real income 267.9256
Urban income (K/HH/yr) 1252
Urban real income 1249.097
Fertilizer leakage (MT) 7299.213
Third, the major cash flow savings in this run actually result from improvement in the maize account, caused by shrinking surpluses as production and smallholder consumption shift. Maize production decreases by 10,000 MT (because the relative prices have shifted in favor of other crops), and smallholder maize consumption increases by 25,000 MT (because higher export crop prices bring higher farm incomes, and also tend to shift consumption away from these export crops). As a result, the maize surplus decreases by 35,000 MT and ADMARC maize account losses are reduced by K 6.5 million.

The simulation results illustrate once again how important the interactions between markets and commodities can be in determining the effects of price policy. If the cross-price elasticities of production and consumption were ignored, we would indeed arrive at the intuitively obvious result described above—that foreign exchange earnings and parastatal revenues are necessarily conflicting objectives in export crop pricing. But the intuitively obvious results are not always correct. By including in our analysis the effects of other crop prices on the maize account—in which no prices change—we create a potentially important refinement to our intuition.

The export parity strategy results in significant income gains to smallholders. Both smallholder nominal and real incomes rise by roughly four percent as a result of the producer price increases. Note that export crops are a small part of the average household's production, so even dramatic producer price increases (of roughly 40 percent in cotton and 20 percent in tobacco and rice) result in
relatively modest income gains. Note further, however, that price increases in export crops result in proportionally greater real income gains than price changes in maize. Because export crops are a much larger share of production than they are of consumption, nominal income gains due to price increases are not diluted much by increases in the price index. By contrast, changes in maize producer prices may affect nominal incomes drastically (because maize is a large share of production), but this effect is dampened by a compensating change in the price index (because maize is also a large share of consumption).

Export and Fertilizer "Parity"

81. We now begin to combine the three basic pricing strategies outlined above. First, let us examine the effects of combining the fertilizer parity strategy with the export "parity" strategy.

82. The effects of pursuing these two strategies jointly is roughly similar to the sum of the effects of each strategy separately. Note, however, that in combining these approaches to price policy, we do not simply change the fertilizer price; we must raise the tobacco price as well to compensate for the higher fertilizer prices and keep tobacco production at the quota level. Remember that the basis for these simulations is pricing strategies rather than specific price levels.
TABLE 4.5

POLICY SIMULATION

EXPORT AND FERTILIZER *PARITY*
NORMAL WEATHER

<table>
<thead>
<tr>
<th></th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
<th>Fertilizer</th>
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<tr>
<td>Producer price (K/MT)</td>
<td>122</td>
<td>640</td>
<td>205</td>
<td>608</td>
<td>1364</td>
<td>398</td>
</tr>
<tr>
<td>Consumer price (K/MT)</td>
<td>156</td>
<td>834</td>
<td>445</td>
<td>850</td>
<td>0</td>
<td>0</td>
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<tr>
<td>CIF price (K/MT)</td>
<td>391</td>
<td>1093</td>
<td>655</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Smallholder production (MT)</td>
<td>1309787</td>
<td>62059.72</td>
<td>39623.94</td>
<td>37605.58</td>
<td>17996.27</td>
<td></td>
</tr>
<tr>
<td>Smallholder consumption (MT)</td>
<td>1160481</td>
<td>39584.59</td>
<td>20985.28</td>
<td>0</td>
<td>0</td>
<td>51060.26</td>
</tr>
<tr>
<td>ADMARC procurements (MT)</td>
<td>149305.4</td>
<td>22475.13</td>
<td>18638.66</td>
<td>37605.58</td>
<td>17996.27</td>
<td></td>
</tr>
<tr>
<td>Urban consumption (MT)</td>
<td>134826.7</td>
<td>4665.721</td>
<td>5935.851</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Exports (MT)</td>
<td>0</td>
<td>17809.41</td>
<td>12702.81</td>
<td>0</td>
<td>17996.27</td>
<td></td>
</tr>
<tr>
<td>Imports (MT)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>51060.26</td>
</tr>
<tr>
<td>Balance of payments (K 1000)</td>
<td>0</td>
<td>14853.05</td>
<td>5652.75</td>
<td>0</td>
<td>49127.81</td>
<td>-18126.39</td>
</tr>
<tr>
<td>ADMARC cashflow (K 1000)</td>
<td>-6289.92</td>
<td>.002</td>
<td>0</td>
<td>0</td>
<td>16898.49</td>
<td>0</td>
</tr>
</tbody>
</table>

Surplus maize added to storage (MT) | 14478.69 |
Net ADMARC cashflow (K 1000) | 10608.57 |
Net balance of payments (K 1000) | 51509.21 |
Smallholder income (K/HH/yr) | 271.7521 |
Smallholder real income | 266.9552 |
Urban income (K/HH/yr) | 1252 |
Urban real income | 1239.097 |
Fertilizer leakage (MT) | 1417.323 |
83. The direct effect of fertilizer parity pricing on ADMARC cash flow in this simulation is the elimination of K 5.8 million in fertilizer account losses due to subsidies. Higher fertilizer prices also decrease maize production, leading to a 26,000 MT drop in maize surpluses and a saving of K 4.8 million on the maize account. However, as noted above, the price needed to stimulate quota-level tobacco production is nearly K 100/MT higher. As a result, ADMARC tobacco profits shrink by K 1.7 million. Production of groundnuts, rice, and cotton is decreased by the rise in fertilizer prices, but do not affect cash flow because under the export "parity" strategy ADMARC is marketing them at cost. The net improvement in cash flow is K 8.8 million.

84. Fertilizer parity pricing directly reduces fertilizer demand by 18,500 MT, saving K 6.6 million in foreign exchange. Moreover, 5,900 MT of the demand reduction (worth K 2.1 million in foreign exchange) comes from reduced leakage of fertilizer to the estate sector. Foreign exchange earnings from tobacco are not affected, because the tobacco price is adjusted to keep production at the quota level. Production levels of the other export crops do decline, however, reducing the balance of payments gains in this simulation by K 1.4 million. Overall, foreign exchange earnings improve by K 5.2 million to K 51.5 million, a gain of K 14.4 million over the base run.
Maize Surplus and Subsidy Reduction with Export and Fertilizer "Parity"

85. What happens if we add to the pricing strategy outlined above a maize pricing scheme that nearly eliminates the maize surplus and subsidy? The actual price changes are small. The maize producer price is decreased from K 122/MT to K 118/MT (only K 0.44 per bag) and the maize consumer price is raised from K 156/MT to K 179/MT. In addition, the tobacco price is decreased from K 1,364/MT to K 1,356/MT to keep production at the quota level. Because these price changes are small, we intuitively do not expect substantial changes in the simulation results.

86. The changes in ADMARC revenues, however, are surprisingly large. Elimination of the maize subsidy alone saves ADMARC K 3.6 million. Recall that although the price changes are small, ADMARC handles over 130,000 MT of maize in this run, more than all other crops combined. Reduction of the maize surplus by 12,500 MT saves another K 2.2 million. A slight increase in tobacco revenues (due to the lower producer price) brings the total ADMARC cash flow gains to K 6.1 million. In this run, ADMARC cash flow stands at K 16.7 million, a net increase of K 20.5 million over the base run.

87. Smallholder real income is only diminished very slightly by imposing both fertilizer parity and maize surplus and subsidy reduction.
in addition to export "parity". In this last run smallholder real incomes are only K 2 per household lower than in the export parity simulation, but smallholder households are still K 8 better off than in the base run. For urban dwellers, however, the story is different. Urban real incomes under this strategy are K 22 lower than in the base run. However, this decline amounts to less than two percent of urban incomes.

Comparison of Agricultural Pricing Strategies

88. We have explored each of the pricing strategies in some detail. We now come to the task of comparing them directly with one another in a comprehensive fashion. This treatment illustrates how alternative proposals for specific pricing policies could be compared with respect to competing government objectives.

89. Recall the five major government objectives: self-sufficiency in maize, government revenue, foreign exchange earnings, smallholder real incomes, and urban real incomes. The pricing model outlined here is designed to provide measures of these objectives for hypothetical pricing simulations. In Table 4.7, we summarize these measures for the pricing strategies that have been discussed here. By reading down the columns of Table 4.7 one can readily compare a given indicator, e.g. ADMARC cash flow, for all of the strategy simulations. Indicators of rank-order preference have also been assigned to each element of the table. For example, in terms of ADMARC cash flow the last strategy
ranks highest (rank of one) and the base run ranks lowest (rank of six). For self-sufficiency in maize we assume that the objective is a long-run balance between supply and domestic demand for an average year provided sufficient stocks have been accumulated to protect against adverse weather conditions. Since Malawi already has substantial stocks of maize we penalise policy runs that lead to large surpluses (e.g., the base run). As noted earlier, if it is thought that Malawi can be an exporter of maize in the long run, one would not necessarily seek to secure a balance between supply and domestic demand. Instead, one would aim to generate a long-run balance between average procurements on the one hand, and domestic demand and expected exports on the other.

A number of important observations can readily be made from Table 4.7. By any measure except urban real income, there is ample room for improvement over the base run. In fact, in terms of maize self-sufficiency, ADMARC cash flow and balance of payments, the base run ranks dead last. A comparison among the rank orderings leads to the conclusion that the current policy ensures more-than-ample maize supply and low urban prices, at great expense to government revenue and export earnings. This says nothing about the motives behind the current policy, only about its effects in comparison with a wide range of alternatives.

If government revenue and balance of payments are primary objectives, then the rank orderings indicate that the strategies in this paper have been discussed roughly in order of increasing desirability.
### Table 4.7
Comparison of Pricing Strategies, with Rank Ordering
(Rank orders in parentheses 1 = highest rank)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Maize Surplus (MT)</th>
<th>Net ADMARC Cashflow (1000 K)</th>
<th>Net Balance of Payments (1000 K)</th>
<th>Smallholder Real Income (K/HH/yr)</th>
<th>Urban Real Income (K/HH/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Run</td>
<td>76,100</td>
<td>-3,800</td>
<td>37,100</td>
<td>258</td>
<td>1,252</td>
</tr>
<tr>
<td></td>
<td>(6)</td>
<td>(6)</td>
<td>(6)</td>
<td>(4)</td>
<td>(1)</td>
</tr>
<tr>
<td>Fertilizer Parity</td>
<td>54,100</td>
<td>4,500</td>
<td>40,300</td>
<td>256</td>
<td>1,252</td>
</tr>
<tr>
<td></td>
<td>(5)</td>
<td>(4)</td>
<td>(5)</td>
<td>(5)</td>
<td>(1)</td>
</tr>
<tr>
<td>Maize Surplus and Subsidy Reduction</td>
<td>1,900</td>
<td>14,800</td>
<td>44,600</td>
<td>255</td>
<td>1,243</td>
</tr>
<tr>
<td>Export &quot;Parity&quot;</td>
<td>40,700</td>
<td>1,800</td>
<td>46,200</td>
<td>268</td>
<td>1,249</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td>(5)</td>
<td>(3)</td>
<td>(1)</td>
<td>(3)</td>
</tr>
<tr>
<td>Export and Fertilizer &quot;Parity&quot;</td>
<td>14,500</td>
<td>10,600</td>
<td>51,500</td>
<td>267</td>
<td>1,249</td>
</tr>
<tr>
<td></td>
<td>(3)</td>
<td>(3)</td>
<td>(2)</td>
<td>(3)</td>
<td>(2)</td>
</tr>
<tr>
<td>Maize Surplus &amp; Subsidy Reduction With Export and Fertilizer &quot;Parity&quot;</td>
<td>1,900</td>
<td>16,700</td>
<td>52,900</td>
<td>266</td>
<td>1,230</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>(1)</td>
<td>(1)</td>
<td>(3)</td>
<td>(6)</td>
</tr>
</tbody>
</table>
In fact, the last run ranks first for both of these indicators. This run ranks nearly last, however, for urban real income. As has been pointed out many times, these are strategies and not specific proposals, and the desirable level of maize surpluses is necessarily a policy decision.

**Evaluation of Weather Effects**

92. The analysis presented above is based on a model calibrated to Malawi's 1984 agricultural performance. How much do the results of this analysis depend on the particular conditions prevailing during that year? Are particular pricing strategies more vulnerable than others to variations in weather, insect pests, crop diseases, and similar unpredictable factors? In this section we conduct further analyses to try to shed light on these questions.

93. We have run all the simulations described above assuming that the weather conditions in 1984 are roughly normal. In order to test the sensitivity of the model to variations in yield from external factors, we have recomputed all the simulations for four other weather scenarios.

- Good weather for maize
- Bad weather for maize
- Good weather for all crops
- Bad weather for all crops
Although weather is the factor specified in these scenarios, the same approach would apply to other factors, such as pests and diseases. For each of these scenarios, the yields of the affected crops are assumed to be increased or decreased by a fixed percentage. These percentages are assumptions of the average yield fluctuation to be expected for the country as a whole under unusually large weather variations. The percentages of yield variation are as follows:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local maize</td>
<td>5%</td>
</tr>
<tr>
<td>Improved maize</td>
<td>10%</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>15%</td>
</tr>
<tr>
<td>Rice</td>
<td>20%</td>
</tr>
<tr>
<td>Cotton</td>
<td>30%</td>
</tr>
<tr>
<td>Tobacco</td>
<td>15%</td>
</tr>
</tbody>
</table>

Note that we are not attempting to forecast the effect of changes in external factors on agricultural or economic performance. Instead, we are assuming a given effect on yields, and then calculating the implications for the smallholder sector. We also assume that there is no anticipation of the yield variations by either the smallholders or the government. Smallholders do not change their allocation of inputs, and official prices are not altered from their "normal weather" values. The yield variations described above will drastically affect the outcome of any particular price policy. As an example, we look at the range of results that are possible under the different weather conditions.
scenarios with the base-run prices, those planned for 1984/85. Table 4.8 illustrates the potential influence of yield variation on agricultural economic performance.

95. We examine first the overall range of variation of the key indicator variables. The range of variation observed in response to these assumed yield changes are generally larger than those observed in response to the alternative pricing strategies analyzed above. The range of variation is also greater than that which characterizes the historical record of Malawi, indicating, as suggested above, that the assumed yield fluctuations would reflect unusually large weather variations.

96. Maize surpluses, as one would expect, rise with increases in maize yields. The magnitudes of the changes in surpluses (over 60,000 MT) might at first seem surprising, until one remembers that the total production of maize is over 1.3 million metric tons. Even small percentages of this huge volume are substantial. Another surprise comes when one ponders why maize surpluses appear to decrease, all else being equal, when the weather is good for the other crops. The reason for this behavior is not, as one might suspect, reallocation of inputs to the other crops. Remember, the model assumes that smallholder producer behavior does not anticipate these yield changes. Instead, maize surpluses decrease because smallholder income, and therefore maize consumption, increases when other crops do well.
<table>
<thead>
<tr>
<th>Normal Weather</th>
<th>Good Weather for Maize</th>
<th>Bad Weather for Maize</th>
<th>Good Weather for all crops</th>
<th>Bad Weather for all crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize Surplus (MT)</td>
<td>76,300</td>
<td>138,300</td>
<td>14,400</td>
<td>114,600</td>
</tr>
<tr>
<td>Net ADMARC Cash Flow (1000 K)</td>
<td>-3,800</td>
<td>-15,200</td>
<td>7,500</td>
<td>-7,700</td>
</tr>
<tr>
<td>Net Balance of Payments (1000 K)</td>
<td>37,100</td>
<td>36,900</td>
<td>37,300</td>
<td>53,800</td>
</tr>
<tr>
<td>Smallholder Real Income (K/HH/yr)</td>
<td>258</td>
<td>265</td>
<td>251</td>
<td>276</td>
</tr>
<tr>
<td>Urban Real Income (K/HH/yr)</td>
<td>1252</td>
<td>1252</td>
<td>1252</td>
<td>1252</td>
</tr>
</tbody>
</table>

Note: Urban real incomes are static because in the model they are determined by official consumer prices, which are not affected by variations in yield.

97. Foreign exchange earnings and ADMARC cash flows increase, as one would expect, when the weather favors export crops. The export crop yield variations modeled here produce changes in ADMARC cash flows of over K5 million and changes in balance of payments of over K15 million. When the weather favors maize, however, ADMARC cash flows suffer (by over K10 million) from the purchase of unsalable surplus maize. Export earnings are essentially unaffected by changes in weather conditions for maize, unless, of course, maize itself is a viable export
commodity. Maize and export crop fluctuations contribute about equally to the variation, over K 15 per household, in smallholder incomes.

98. The magnitude of these variations in key indicators gives rise to some concern about pricing policies. If unpredictable weather changes are so influential, how can we have any confidence about the outcome of a particular policy initiative? Furthermore, can we be confident that any particular policy will be beneficial in the face of such uncertainty?

99. Though these questions seem outwardly similar, and though they are related, their essences and their answers are very different. The first question has already been answered by Table 4.8. If we believe that variation of this magnitude in external factors is likely, we should accept that it is impossible to forecast the outcome of a particular policy initiative more accurately than the ranges of fluctuation of the key indicators.

100. The first question above asks how the results of a given policy are affected by unforeseeable influences. The second question asks how the desirability of a given policy relative to the alternatives, rather than its particular outcome, is affected by unpredictable external factors. Whereas the answer to the first question is "a great deal", we can now demonstrate that the answer to the second is "not much at all".

101. We answer the second question by considering how changes in external factors affect the rank-order preference of the different strategies. If one strategy serves a given objective better than another, regardless
of the uncertainties in external conditions, our preference for that strategy is unaffected by the uncertainties. In other words, if a single strategy is best—for some objective—under all conditions, we can adopt that strategy with the confidence that the outcome will be the best that could be done with whatever circumstances result. If, on the other hand, the relative preferability of the different strategies were affected by unpredictable external factors, the policy choice would necessarily boil down to a careful weighing of the risks.
Table 4.9
Comparison of Maize Surplus Levels for Alternative Pricing Strategies under Different Weather Scenarios

<table>
<thead>
<tr>
<th>Weather Affects Maize</th>
<th>Maize Surplus in Metric Tons, with rank orders in parentheses</th>
<th>Weather Affects All Crops</th>
<th>Weather Affects Maize</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal Weather for maize</td>
<td>Good Weather for maize</td>
<td>Bad Weather for maize</td>
</tr>
<tr>
<td>Base Run</td>
<td>76,300</td>
<td>(6)</td>
<td>138,300</td>
</tr>
<tr>
<td>Fertilizer Parity</td>
<td>54,100</td>
<td>(5)</td>
<td>114,300</td>
</tr>
<tr>
<td>Maize Surplus and Subsidy Reduction</td>
<td>1,900</td>
<td>(1)</td>
<td>61,200</td>
</tr>
<tr>
<td>Export &quot;Parity&quot;</td>
<td>40,700</td>
<td>(4)</td>
<td>102,600</td>
</tr>
<tr>
<td>Export and Fertilizer &quot;Parity&quot;</td>
<td>14,500</td>
<td>(3)</td>
<td>74,600</td>
</tr>
<tr>
<td>Maize Surplus and Subsidy Reduction with Export and Fertilizer &quot;Parity&quot;</td>
<td>1,900</td>
<td>(2)</td>
<td>61,400</td>
</tr>
</tbody>
</table>

Note: Rank order for normal weather conditions is dependent on the pricing policy's ability to generate a surplus as close as possible to zero. Rank order for the other weather conditions is determined by computing the net accrual to stocks of a good year and a bad year. That is, one wants to secure a situation in which the accumulation of stocks in a bad year is more or less offset by accumulation in a good year with no tendency for the trend level of stocks to increase or decrease.
Table 4.10
Comparison of Net ADMARC Cash Flow for Alternative Pricing Strategies Under Different Weather Scenarios

<table>
<thead>
<tr>
<th>ADMARC Cash Flow in K 1000, with rank orders in parentheses</th>
<th>Normal Weather</th>
<th>Good Weather for Maize</th>
<th>Bad Weather for Maize</th>
<th>Good Weather for all crops</th>
<th>Bad Weather for all crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Run</td>
<td>-3,800</td>
<td>-15,200</td>
<td>7,500</td>
<td>-7,700</td>
<td>-100</td>
</tr>
<tr>
<td></td>
<td>(6)</td>
<td>(6)</td>
<td>(6)</td>
<td>(6)</td>
<td>(6)</td>
</tr>
<tr>
<td>Fertilizer Parity</td>
<td>4,500</td>
<td>-6,500</td>
<td>15,500</td>
<td>700</td>
<td>8,100</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td>(4)</td>
<td>(4)</td>
<td>(4)</td>
<td>(4)</td>
</tr>
<tr>
<td>Maize Surplus and Subsidy Reduction</td>
<td>14,800</td>
<td>4,900</td>
<td>24,600</td>
<td>12,200</td>
<td>16,900</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>(2)</td>
<td>(2)</td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Export &quot;Parity&quot;</td>
<td>1,800</td>
<td>-9,600</td>
<td>13,100</td>
<td>-4,800</td>
<td>4,500</td>
</tr>
<tr>
<td></td>
<td>(5)</td>
<td>(5)</td>
<td>(5)</td>
<td>(5)</td>
<td>(5)</td>
</tr>
<tr>
<td>Export and Fertilizer &quot;Parity&quot;</td>
<td>10,600</td>
<td>-400</td>
<td>21,600</td>
<td>4,100</td>
<td>13,200</td>
</tr>
<tr>
<td></td>
<td>(3)</td>
<td>(3)</td>
<td>(3)</td>
<td>(3)</td>
<td>(3)</td>
</tr>
<tr>
<td>Maize Surplus and Subsidy Reduction with Export and Fertilizer &quot;Parity&quot;</td>
<td>16,700</td>
<td>6,100</td>
<td>27,300</td>
<td>10,600</td>
<td>18,900</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(1)</td>
<td>(1)</td>
<td>(2)</td>
<td>(1)</td>
</tr>
</tbody>
</table>

DiskLS-85-01/MAL-RED-1/2-19-85/ae-dlw
Table 4.11
Comparison of Net Balance of Payments for Alternative Pricing Strategies Under Different Weather Scenarios

<table>
<thead>
<tr>
<th>Balance of Payments in K '000, with rank orders in parentheses</th>
<th>Normal Weather for Maize</th>
<th>Good Weather for Maize</th>
<th>Bad Weather for all crops</th>
<th>Good Weather for all crops</th>
<th>Bad Weather for all crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Run</td>
<td>37,100</td>
<td>36,900</td>
<td>37,300</td>
<td>53,800</td>
<td>20,400</td>
</tr>
<tr>
<td></td>
<td>(6)</td>
<td>(6)</td>
<td>(6)</td>
<td>(6)</td>
<td>(6)</td>
</tr>
<tr>
<td>Fertilizer Parity</td>
<td>40,300</td>
<td>40,000</td>
<td>40,500</td>
<td>56,500</td>
<td>24,100</td>
</tr>
<tr>
<td></td>
<td>(5)</td>
<td>(5)</td>
<td>(5)</td>
<td>(5)</td>
<td>(5)</td>
</tr>
<tr>
<td>Maize Surplus and Subsidy Reduction</td>
<td>44,600</td>
<td>44,400</td>
<td>44,800</td>
<td>61,400</td>
<td>27,400</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td>(4)</td>
<td>(4)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Export &quot;Parity&quot;</td>
<td>46,200</td>
<td>45,900</td>
<td>46,400</td>
<td>58,100</td>
<td>27,900</td>
</tr>
<tr>
<td></td>
<td>(3)</td>
<td>(3)</td>
<td>(3)</td>
<td>(4)</td>
<td>(3)</td>
</tr>
<tr>
<td>Export and Fertilizer &quot;Parity&quot;</td>
<td>51,500</td>
<td>51,300</td>
<td>51,700</td>
<td>63,100</td>
<td>33,500</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>(2)</td>
<td>(2)</td>
<td>(2)</td>
<td>(2)</td>
</tr>
<tr>
<td>Maize Surplus and Subsidy Reduction with Export and Fertilizer &quot;Parity&quot;</td>
<td>52,900</td>
<td>52,700</td>
<td>53,100</td>
<td>64,500</td>
<td>34,800</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(1)</td>
<td>(1)</td>
<td>(1)</td>
<td>(1)</td>
</tr>
</tbody>
</table>
Table 4.12
Comparison of Smallholder Incomes for Alternative Pricing Strategies Under Different Weather Scenarios

<table>
<thead>
<tr>
<th>Smallholder Incomes in K/HH/yr, with rank orders in parentheses</th>
<th>Normal Weather</th>
<th>Good Weather for Maize</th>
<th>Bad Weather for Maize</th>
<th>Good Weather for all crops</th>
<th>Bad Weather for all crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Run</td>
<td>258</td>
<td>265</td>
<td>251</td>
<td>276</td>
<td>241</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td>(4)</td>
<td>(4)</td>
<td>(4)</td>
<td>(4)</td>
</tr>
<tr>
<td>Fertilizer Parity</td>
<td>256</td>
<td>263</td>
<td>249</td>
<td>273</td>
<td>239</td>
</tr>
<tr>
<td></td>
<td>(5)</td>
<td>(5)</td>
<td>(6)</td>
<td>(5)</td>
<td>(5)</td>
</tr>
<tr>
<td>Maize Surplus and Subsidy Reduction</td>
<td>255</td>
<td>261</td>
<td>249</td>
<td>272</td>
<td>238</td>
</tr>
<tr>
<td></td>
<td>(6)</td>
<td>(6)</td>
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Tables 4.9 through 4.12 show how the key objective indicators are affected by yield fluctuations in each of the price policy strategies. By comparing the rank-order preference of the different strategies for each weather scenario, we see that the relative desirability of any strategy is almost totally unaffected by yield variation. 10/ Looking at the first row of Table 4.11, for example, we see that although the net balance-of-payments effect under the base run price policy varies by more than K 30 million in different weather scenarios, in each case this outcome is the lowest of any of the strategies considered. In fact, in Table 4.12 the relative preferability of the strategies is totally unaffected by the different weather scenarios.

In no case do Tables 4.9 through 4.12 show significant changes in rank-order. The relative preferability of the strategies only changes in four cases. In each of those cases, scenarios adjacent in rank are interchanged. On this basis, then, we conclude that the advisability of each of these strategies is not significantly affected by yield variation induced by external factors.

10/ Urban real income is not considered in these tables because, as noted above, it is completely unaffected (in the model) by yield variations.
V. CONCLUSIONS

104. As emphasized above, it is not the intention of this report to devise or advocate specific pricing policies for Malawi. Nevertheless, this analysis does allow us to quantify the trade-offs among competing objectives; this should be a valuable input into policy making. Here we briefly summarize the major trade-offs.

105. Increases in the maize surplus, for example, could be achieved through a number of means, including raising the producer price of maize, decreasing the producer prices for other crops, and decreasing the price of fertilizer. To achieve, say, a 20,000 metric ton increase in maize surplus would only require a very slight increase in maize producer prices (approximately four percent). Making this price change and absorbing the additional surplus would cost ADMARC over K5 million in cash flow. The ensuing decrease in exports and increase in fertilizer imports would cost Malawi K2.5 million in foreign exchange earnings. To accomplish the same objective through decreases in export crop prices would cost ADMARC accounts only K2 million, but would result in losses of K6 million in foreign exchange. Lowering fertilizer prices to achieve the same result would be more costly still, resulting in ADMARC cash flow losses of K7 million and balance of payments losses of K3 million. None of these three mechanisms would affect smallholder or urban incomes by more than one percent.

106. Improvement in ADMARC cash flows can be achieved through any of the three basic strategies outlined in this report, namely fertilizer
parity, maize surplus and subsidy reduction, and export crop parity. For example, a K 5 million improvement in ADMARC accounts could be accomplished through an increase in fertilizer prices of approximately 15 percent. A secondary benefit would be a K 2 million improvement in balance of payments, but maize surplus would decline by approximately 15,000 MT. Generating the same cash flow improvement with adjustments (of roughly three percent) to maize pricing would similarly increase foreign exchange earnings by K 2 million, but diminish maize surpluses by 20,000 MT. Both of these strategies would diminish smallholder and urban real incomes by one-half percent or less. The same K 5 million improvement in cash flow could be obtained by following the export "parity" strategy almost fully. Balance of payments gains of K 8 million would result, and smallholder real incomes would improve by approximately three percent, but maize surpluses would diminish by 35,000 MT. Urban incomes would not be significantly affected in any of these three cases.

107. Foreign exchange earnings could be improved by pursuing any of the three basic strategies, but most efficiently through a combination of export and fertilizer parity schemes. Generating a balance-of-payments gain of K 10 million, for example, through this approach would also produce a K 10 million improvement in ADMARC cash flow. Maize surpluses would be reduced by 40,000 MT, but smallholder real incomes would improve by two percent.

108. Improvement in smallholder real incomes could be accomplished by changes in producer prices for maize, export crops, or fertilizer.
However, maize and fertilizer subsidies prove to be very expensive ways of meeting this objective. Export parity improves smallholder real incomes by K.10 per household annually, and in the process increases both ADMARC cash flow by over K.5 million and foreign exchange earnings by K.9 million. However, maize surpluses would decline by over 35,000 MT.

109. Improvements in urban real income are very difficult to achieve through agricultural pricing policy. The reasons for this have been explained in Section IV, in the discussion of maize subsidy reduction. Food crops are simply a very small share of urban expenditures. Cutting the urban maize price in half, for example, would improve urban real incomes by less than six percent. A more modest proposal, such as one that would improve urban real incomes by one percent, would cost K.1.6 million in cash flow. None of the other objectives would be significantly affected.

110. This quantification of the trade-offs suggests that the Government of Malawi should seriously consider the following preferred pricing strategy:

- No change in maize pricing
- Increases in export crop prices, where these prices are far below parity values.
- Increases in fertilizer prices, toward the parity values.
Such a pricing strategy would maintain maize self-sufficiency, without leading to excessive accumulation of stocks. It would dramatically improve ADMARC cash flows, foreign exchange earnings, and smallholder incomes. And it would have almost no effect on urban incomes.

To more precisely quantify the effects of a particular pricing policy, further analytical work is required. Similarly, extensions of this approach would be needed to define an optimal pricing strategy to fit a given set of objectives. It is hoped that the Government of Malawi will continue to encourage and support analytical contributions to its policy review.
### Table 4.6

**Policy Simulation**

Maize Surplus and Subsidy Reduction, with Export and Fertilizer *Parity*

Normal Weather

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<th></th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
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**Surplus maize added to storage (MT)** | 1924.594 |
**Net ADMARC cashflow (K 1000)**         | 16701.32 |
**Net balance of payments (K 1000)**      | 52881.8  |
**Smallholder income (K/HH/yr)**          | 267.5606 |
**Smallholder real income**               | 266.3421 |
**Urban income (K/HH/yr)**                | 1252     |
**Urban real income**                     | 1229.717 |
**Fertilizer leakage (MT)**               | 1417.323 |
### MALAWI AGRICULTURAL PRICING MODEL
REDUCED FORM VERSION OF 5 DEC 1984

**CALIBRATION DATA**

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<th></th>
<th>Maize</th>
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**Surplus maize added to storage (MT)** | 114000 |
**Net ADMARC cashflow (K 1000)** | -11232.78 |
**Net balance of payments (K 1000)** | 21978.66 |
**Smallholder income (K/HH/yr)** | 255 |
**Urban income (K/HH/yr)** | 1252 |
**Fertilizer leakage (MT)** | 9000 |
BASE RUN 1985
GOOD WEATHER FOR MAIZE: YIELDS UP 5%, IMPROVED MAIZE 10%

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Surplus maize added to storage (MT) 138341.1
Net ADMARC cashflow (K 1000) -15177.74
Net balance of payments (K 1000) 36873.2
Smallholder income (K/HH/yr) 268.929
Smallholder real income 265.353
Urban income (K/HH/yr) 1252
Urban real income 1252
Fertilizer leakage (MT) 7299.213
FERTILIZER PARITY
GOOD WEATHER FOR MAIZE: YIELDS UP 5%, IMPROVED MAIZE 10%

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Surplus maize added to storage (MT) | 114298.4 |
Net ADMARC cashflow (K 1000) | -6487.078 |
Net balance of payments (K 1000) | 40046.52 |
Smallholder income (K/HH/yr) | 266.3673 |
Smallholder real income | 262.8253 |
Urban income (K/HH/yr) | 1252 |
Urban real income | 1252 |
Fertilizer leakage (MT) | 1417.323 |
MAIZE SURPLUS AND SUBSIDY REDUCTION
GOOD WEATHER FOR MAIZE: YIELDS UP 5%, IMPROVED MAIZE 10%

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<th></th>
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<th>Cotton</th>
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Surplus maize added to storage (MT) | 61153.25
Net ADMARC cashflow (K 1000) | 4914.188
Net balance of payments (K 1000) | 44373.79
Smallholder income (K/HH/yr) | 249.827
Smallholder real income | 261.1748
Urban income (K/HH/yr) | 1252
Urban real income | 1243.46
Fertilizer leakage (MT) | 7299.213
POLICY SIMULATION

EXPORT *PARITY*
GOOD WEATHER FOR MAIZE: YIELDS UP 5%, IMPROVED MAIZE 10%

<table>
<thead>
<tr>
<th></th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
<th>Fertilizer</th>
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<tr>
<td>Producer price (K/MT)</td>
<td>122</td>
<td>640</td>
<td>205</td>
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<td>Consumer price (K/MT)</td>
<td>156</td>
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Surplus maize added to storage (MT) | 102647.4 |
Net ADMARC cashflow (K 1000)        | -9551.841 |
Net balance of payments (K 1000)    | 45939.67  |
Smallholder income (K/HH/yr)        | 280.0086  |
Smallholder real income             | 275.086   |
Urban income (K/HH/yr)              | 1252      |
Urban real income                   | 1249.097  |
Fertilizer leakage (MT)             | 7299.213  |
EXPORT AND FERTILIZER *PARITY*
GOOD WEATHER FOR MAIZE: YIELDS UP 5%, IMPROVED MAIZE 10%

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<tr>
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Surplus maize added to storage (MT) 74574.94
Net ADMARC cashflow (K 1000) -389.04
Net balance of payments (K 1000) 51300.13
Smallholder income (K/HH/yr) 276,805
Smallholder real income 273,836
Urban income (K/HH/yr) 1252
Urban real income 1249.097
Fertilizer leakage (MT) 1417.323
MAIZE SURPLUS AND SUBSIDY REDUCTION, WITH EXPORT AND FERTILIZER *PARITY*  
GOOD WEATHER FOR MAIZE: YIELDS UP 5%, IMPROVED MAIZE 10%

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<tr>
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Surplus maize added to storage (MT) | 61420.97 |
Net ADMARC cashflow (K 1000)       | 6051.47  |
Net balance of payments (K 1000)   | 52680.6  |
Smallholder income (K/HH/yr)       | 274.2609 |
Smallholder real income            | 273.0318 |
Urban income (K/HH/yr)             | 1252     |
Urban real income                  | 1229.717 |
Fertilizer leakage (MT)            | 1417.323 |
BASE RUN 1995
BAD WEATHER FOR MAIZE: MAIZE YIELD DOWN 5%, IMPROVED MAIZE 10%

<table>
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<tr>
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<th>Maize</th>
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<tr>
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Surplus maize added to storage (MT) 14398.63
Net ADMARC cashflow (K 1000) 7519.611
Net balance of payments (K 1000) 37337.24
Smallholder income (K/HH/yr) 254.2872
Smallholder real income 250.9078
Urban income (K/HH/yr) 1252
Urban real income 1252
Fertilizer leakage (MT) 7299.213
POLICY SIMULATION

FERTILIZER PARITY
BAD WEATHER FOR MAIZE: MAIZE YIELD DOWN 5%, IMPROVED MAIZE 10%

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<tr>
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Surplus maize added to storage (MT) | -5925.375
Net ADMARC cashflow (K 1000) | 15529.39
Net balance of payments (K 1000) | 40500.44
Smallholder income (K/HH/yr) | 252.1503
Smallholder real income | 248.7974
Urban income (K/HH/yr) | 1252
Urban real income | 1252
Fertilizer leakage (MT) | 1417.323
MAIZE SURPLUS AND SUBSIDY REDUCTION
BAD WEATHER FOR MAIZE: MAIZE YIELD DOWN 5%, IMPROVED MAIZE 10%

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<tr>
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Surplus maize added to storage (MT) -57202.5
Net ADMARC cashflow (K 1000) 24574.59
Net balance of payments (K 1000) 44763.17
Smallholder income (K/HH/yr) 238.0583
Smallholder real income 248.8715
Urban income (K/HH/yr) 1252
Urban real income 1243.46
Fertilizer leakage (MT) 7299.213
**POLICY SIMULATION**

**EXPORT *PARITY* **

BAD WEATHER FOR MAIZE: MAIZE YIELD DOWN 5%, IMPROVED MAIZE 10%

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<tr>
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<td>FOB price (K/MT)</td>
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<td>834</td>
<td>445</td>
<td>850</td>
<td>2730</td>
<td>355</td>
</tr>
<tr>
<td>CIF price (K/MT)</td>
<td>391</td>
<td>1093</td>
<td>655</td>
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**Surplus maize added to storage (MT)** | -21077.19 |

**Net ADMARC cashflow (K 1000)** | 13089.77 |

**Net balance of payments (K 1000)** | 46373.94 |

**Smallholder income (K/HH/yr)** | 265.4714 |

**Smallholder real income** | 260.7853 |

**Urban income (K/HH/yr)** | 1252 |

**Urban real income** | 1249.097 |

**Fertilizer leakage (MT)** | 7299.213 |
**Policy Simulation**

**Export and Fertilizer *Parity*:**

Bad Weather for Maize: Maize Yield Down 5%, Improved Maize 10%

<table>
<thead>
<tr>
<th></th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
<th>Fertilizer</th>
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<tbody>
<tr>
<td>Producer price (K/MT)</td>
<td>122</td>
<td>640</td>
<td>205</td>
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<td>398</td>
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<td>0</td>
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<tr>
<td>FOB price (K/MT)</td>
<td>186</td>
<td>834</td>
<td>445</td>
<td>850</td>
<td>2730</td>
<td>355</td>
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<tr>
<td>CIF price (K/MT)</td>
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Surplus maize added to storage (MT)  -45423.07
Net ADMARC cashflow (K 1000)  21570.6
Net balance of payments (K 1000)  31722.73
Smallholder income (K/HH/yr)  264.6993
Smallholder real income  260.0268
Urban income (K/HH/yr)  1252
Urban real income  1249.097
Fertilizer leakage (MT)  1417.323
### Maize Surplus and Subsidy Reduction, with Export and Fertilizer *Parity*

**Bad weather for maize: maize yield down 5%, improved maize 10%**

<table>
<thead>
<tr>
<th></th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
<th>Fertilizer</th>
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### Surplus maize added to storage (MT)
-57388.91

### Net ADMARC cashflow (K 1000)
27318.43

### Net balance of payments (K 1000)
53087.12

### Smallholder income (K/HH/yr)
260.8402

### Smallholder real income
259.6523

### Urban income (K/HH/yr)
1252

### Urban real income
1229.717

### Fertilizer leakage (MT)
1417.323
POLICY SIMULATION

BASE RUN 1985

GOOD WEATHER FOR ALL CROPS: MAIZE YIELD UP 5%, IMPROVED MAIZE 10%, GROUNDNUTS 15%, RICE 20%, COTTON 30%, TOBACCO 15%

<table>
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<tr>
<th></th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
<th>Fertilizer</th>
</tr>
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<tbody>
<tr>
<td>Producer price (K/MT)</td>
<td>122</td>
<td>624</td>
<td>169</td>
<td>438</td>
<td>1037</td>
<td>315</td>
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<tr>
<td>Consumer price (K/MT)</td>
<td>156</td>
<td>644</td>
<td>540</td>
<td>657</td>
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<td>0</td>
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<tr>
<td>FOB price (K/MT)</td>
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<tr>
<td>CIF price (K/MT)</td>
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<td>655</td>
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Surplus maize added to storage (MT) 114629.9
Net ADMARC cashflow (K 1000) -7735.852
Net balance of payments (K 1000) 53832.22
Smallholder income (K/HH/yr) 279.449
Smallholder real income 275.7333
Urban income (K/HH/yr) 1252
Urban real income 1252
Fertilizer leakage (MT) 7299.213
Fertilizer parity

Good weather for all crops: maize yield up 5%, improved maize 10%, groundnuts 15%, rice 20%, cotton 30%, tobacco 15%

<table>
<thead>
<tr>
<th></th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
<th>Fertilizer</th>
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<tbody>
<tr>
<td>Producer price (K/MT)</td>
<td>122</td>
<td>624</td>
<td>169</td>
<td>438</td>
<td>1037</td>
<td>398</td>
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<tr>
<td>Consumer price (K/MT)</td>
<td>156</td>
<td>644</td>
<td>540</td>
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<tr>
<td>FOB price (K/MT)</td>
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<td>655</td>
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Surplus maize added to storage (MT) | 90992.75
Net ADMARC cashflow (K 1000) | 713.546
Net balance of payments (K 1000) | 56470.96
Smallholder income (K/HH/yr) | 276.6596
Smallholder real income | 272.9808
Urban income (K/HH/yr) | 1232
Urban real income | 1232
Fertilizer leakage (MT) | 1417.323
GOOD WEATHER FOR ALL CROPS: MAIZE YIELD UP 5%, IMPROVED MAIZE 10%, GROUNDNUTS 15%, RICE 20%, COTTON 30%, TOBACCO 15%

AT THE OFFICIAL TOBACCO PRICE OF 1037 KW/MT, TOBACCO PROCUREMENT OF 18165.37 MT EXCEEDS THE QUOTA OF 18000 MT. THE APPROXIMATE SHADOW PRICE IS 1024.596 KW/MT.

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<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
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<tr>
<td>Producer price (K/MT)</td>
<td>105</td>
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<td>169</td>
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<td>1037</td>
<td>315</td>
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<td>CIF price (K/MT)</td>
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<td>1093</td>
<td>655</td>
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POLICY SIMULATION
02-18-1985 15:26:45

EXPORT *PARITY*
GOOD WEATHER FOR ALL CROPS: MAIZE YIELD UP 5%, IMPROVED MAIZE 10%, GROUNDNUTS 15%, RICE 20%, COTTON 30%, TOBACCO 15%

AT THE OFFICIAL TOBACCO PRICE OF 1267 KW/MT, TOBACCO PROCUREMENT OF 20697.07 MT EXCEEDS THE QUOTA OF 18000 MT. THE APPROXIMATE SHADOW PRICE IS 1054.367 KW/MT.

<table>
<thead>
<tr>
<th></th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
<th>Fertilizer</th>
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<tr>
<td>Producer price (K/MT)</td>
<td>122</td>
<td>640</td>
<td>205</td>
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<td>634</td>
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<tr>
<td>FOB price (K/MT)</td>
<td>186</td>
<td>834</td>
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Surplus maize added to storage (MT) 77688.19
Net ADMARC cashflow (K 1000) -4767.893
Net balance of payments (K 1000) 58117.96
Smallholder income (K/HH/yr) 292.4077
Smallholder real income 287.3248
Urban income (K/HH/yr) 1252
Urban real income 1249.097
Fertilizer leakage (MT) 7299.213
**Export and Fertilizer Parity**

Good weather for all crops: maize yield up 5%, improved maize 10%, groundnuts 15%, rice 20%, cotton 30%, tobacco 15%.

At the official tobacco price of 1364 K/MT, tobacco procurement of 26495.71 MT exceeds the quota of 18000 MT. The approximate shadow price is 1135.187 K/MT.

<table>
<thead>
<tr>
<th>Produce price (K/MT)</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
<th>Fertilizer</th>
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<tr>
<td>FOB price (K/MT)</td>
<td>186</td>
<td>834</td>
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<td>850</td>
<td>2730</td>
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<td>CIF price (K/MT)</td>
<td>391</td>
<td>1093</td>
<td>655</td>
<td>0</td>
<td>355</td>
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Smallholder production (MT) 1388297, 71499.84, 47549.73, 48887.25, 18000.01
Smallholder consumption (MT) 1203575, 40105.39, 21276.01, 0, 0, 49007.32
ADMARC procurements (MT) 184722, 31394.45, 26272.72, 48887.25, 18000.01
Urban consumption (MT) 134826.7, 4665.721, 5935.851, 0, 0
Exports (MT) 0, 26728.73, 20336.87, 0, 18000.01
Imports (MT) 0, 0, 0, 0, 49007.32
Balance of payments (K 1000) 0, 22291.76, 9049.908, 0, 49140.02, -17397.6
ADMARC cashflow (K 1000) -12771.16, 0, 9.999999E-04, 0, 16902.01, 0

Surplus maize added to storage (MT) 49895.32
Net ADMARC cashflow (K 1000) 4130.843
Net balance of payments (K 1000) 63084.09
Smallholder income (K/HH/yr) 2911054
Smallholder real income 2859668
Urban income (K/HH/yr) 1252
Urban real income 1249.097
Fertilizer leakage (MT) 1417.323
POLICY SIMULATION

MAIZE SURPLUS AND SUBSIDY REDUCTION, WITH EXPORT AND FERTILIZER *PARITY*
GOOD WEATHER FOR ALL CROPS: MAIZE YIELD UP 5%, IMPROVED MAIZE 10%, GROUNDNUTS 15%, RICE 20%, COTTON 30%, TOBACCO 15%

AT THE OFFICIAL TOBACCO PRICE OF 1356 KW/MT,
TOBACCO PROCUREMENT OF 20699.78 MT
EXCEEDS THE QUOTA OF 18000 MT.
THE APPROXIMATE SHADOW PRICE IS 1128.237 KW/MT.

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<th>Maize</th>
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<th>Tobacco</th>
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<tr>
<td>186</td>
<td>834</td>
<td>445</td>
<td>850</td>
<td>2730</td>
<td>355</td>
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Smallholder production (MT) 1369129
Smallholder consumption (MT) 1202068
ADMARC procurements (MT) 167061.4
Urban consumption (MT) 130808.4
Exports (MT) 0
Imports (MT) 0
Balance of payments (K 1000) 0
ADMARC cashflow (K 1000) -6489.282

Surplus maize added to storage (MT) 36252.97
Net ADMARC cashflow (K 1000) 10556.71
Net balance of payments (K 1000) 64497.09
Smallholder income (K/HH/yr) 286.6072
Smallholder real income 285.302
Urban income (K/HH/yr) 1252
Urban real income 1229.717
Fertilizer leakage (MT) 1417.323
POLICY SIMULATION

BASE RUN 1985
BAD WEATHER FOR ALL CROPS: MAIZE YIELD DOWN 5%, IMPROVED MAIZE 10%, GROUNDNUTS 15%, RICE 20%, COTTON 30%, TOBACCO 15%

<table>
<thead>
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<th></th>
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<th>Rice</th>
<th>Cotton</th>
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<tbody>
<tr>
<td>Producer price (K/MT)</td>
<td>122</td>
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Surplus maize added to storage (MT) 39207.5
Net ADMARC cashflow (K 1000) -122.255
Net balance of payments (K 1000) 20404.2
Smallholder income (K/HH/yr) 243.769
Smallholder real income 240.5273
Urban income (K/HH/yr) 1252
Urban real income 1252
Fertilizer leakage (MT) 7299.213
POLICY SIMULATION

FERTILIZER PARITY
BAD WEATHER FOR ALL CROPS: MAIZE YIELD DOWN 5%, IMPROVED MAIZE 10%, GROUNDNUTS 15%, RICE 20%, COTTON 30%, TOBACCO 15%

<table>
<thead>
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<th></th>
<th>Maize</th>
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<td>398</td>
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Surplus maize added to storage (MT) | 18439.38
Net ADMARC cashflow (K 1000) | 8135.813
Net balance of payments (K 1000) | 24101.16
Smallholder income (K/HH/yr) | 241.0579
Smallholder real income | 238.6419
Urban income (K/HH/yr) | 1252
Urban real income | 1252
Fertilizer leakage (MT) | 1417.323
MAIZE SURPLUS AND SUBSIDY REDUCTION
BAD WEATHER FOR ALL CROPS: MAIZE YIELD DOWN 5%, IMPROVED MAIZE 10%, GROUNDNUTS 15%, RICE 20%, COTTON 30%, TOBACCO 15%

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<th>Rice</th>
<th>Cotton</th>
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<td>166</td>
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<tr>
<td>FOB price (K/MT)</td>
<td>186</td>
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<td>445</td>
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<td>2730</td>
<td>335</td>
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Surplus maize added to storage (MT) -30056.63
Net ADMARC cashflow (K 1000) 16899.81
Net balance of payments (K 1000) 27392.2
Smallholder income (K/HH/yr) 227.2552
Smallholder real income 237.5777
Urban income (K/HH/yr) 1252
Urban real income 1243.46
Fertilizer leakage (MT) 7299.213
**POLICY SIMULATION**

**EXPORT *PARITY***

BAD WEATHER FOR ALL CROPS: MAIZE YIELD DOWN 5%, IMPROVED MAIZE 10%, GROUNDNUTS 15%, RICE 20%, COTTON 30%, TOBACCO 15%

<table>
<thead>
<tr>
<th></th>
<th>Maize</th>
<th>Groundnuts</th>
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<td>850</td>
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<td><strong>CIF price (K/MT)</strong></td>
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| Surplus maize added to storage (MT) | 10815.31 |
| Net ADMARC cashflow (K 1000) | 4456.631 |
| Net balance of payments (K 1000) | 27728.56 |
| Smallholder income (K/HH/yr) | 251.7061 |
| Smallholder real income | 247.2631 |
| Urban income (K/HH/yr) | 1252 |
| Urban real income | 1249.097 |
| Fertilizer leakage (MT) | 7299.213 |
**POLICY SIMULATION**

**EXPORT AND FERTILIZER *PARITY*:
BAD WEATHER FOR ALL CROPS: MAIZE YIELD DOWN 5%, IMPROVED MAIZE 10%, GROUNDNUTS 15%, RICE 20%, COTTON 30%, TOBACCO 15%**

<table>
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<tr>
<th>Produce price (K/MT)</th>
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<th>FOB price (K/MT)</th>
<th>CIF price (K/MT)</th>
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<td>Maize</td>
<td>Groundnuts</td>
<td>Rice</td>
<td>Cotton</td>
</tr>
<tr>
<td>122</td>
<td>640</td>
<td>205</td>
<td>608</td>
</tr>
<tr>
<td>156</td>
<td>834</td>
<td>445</td>
<td>850</td>
</tr>
<tr>
<td>186</td>
<td>834</td>
<td>445</td>
<td>850</td>
</tr>
<tr>
<td>391</td>
<td>1093</td>
<td>655</td>
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<td>Smallholder production (MT)</td>
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<td>31699.16</td>
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<td>Smallholder consumption (MT)</td>
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<td>ADMARC procurements (MT)</td>
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<td>11046.18</td>
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<td>4665.721</td>
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<td>Exports (MT)</td>
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<td>5110.333</td>
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<td>Imports (MT)</td>
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<td>ADMARC cashflow (K 1000)</td>
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**Surplus maize added to storage (MT)**: -13420.56

**Net ADMARC cashflow (K 1000)**: 13179.36

**Net balance of payments (K 1000)**: 33494.26

**Smallholder income (K/HH/yr)**: 250.9065

**Smallholder real income**: 246.4776

**Urban income (K/HH/yr)**: 1252

**Urban real income**: 1249.097

**Fertilizer leakage (MT)**: 1417.323
MAIZE SURPLUS AND SUBSIDY REDUCTION, WITH EXPORT AND FERTILIZER PARITY

BAD WEATHER FOR ALL CROPS: MAIZE YIELD DOWN 5%, IMPROVED MAIZE 10%, GROUNDNUTS 15%, RICE 20%, COTTON 30%, TOBACCO 15%

<table>
<thead>
<tr>
<th></th>
<th>Maize</th>
<th>Groundnuts</th>
<th>Rice</th>
<th>Cotton</th>
<th>Tobacco</th>
<th>Fertilizer</th>
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<tbody>
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<td>Producer price (K/MT)</td>
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<td>655</td>
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<td>33142.18</td>
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<td>26455.06</td>
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<td>11300.36</td>
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<td>Urban consumption (MT)</td>
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</tbody>
</table>

Surplus maize added to storage (MT) = -24814.16

Net ADMARC cashflow (K 1000) = 18930.68

Net balance of payments (K 1000) = 34788.66

Smallholder income (K/HH/yr) = 246.9978
Smallholder real income = 245.8729

Urban income (K/HH/yr) = 1252
Urban real income = 1229.717

Fertilizer leakage (MT) = 1417.323